附件1：同意接收中国研究人员的欧盟项目清单

编号	领域	项目名称	依托单位	网页介绍	关键词	摘要	人员要求	外方联系方式
1	Molecules of Life: Biological Mechanisms, Structures and Functions	Sweet Origins of Life: Peering into the Past with Today's Biochemistry	THE HEBREW UNIVERSITY OF JERUSALEM		Prebiotic chemistry, origins of life	Approximately four billion years ago, chemical and geological processes on the ancient Earth caused a continuous increase in the complexity of organic molecules, ultimately leading to RNA, DNA, proteins, polysaccharides, membrane-forming amphipaths, to metabolism and the roots of biology. But how did it all begin? How did chemistry become biology? There are many indications to the starting point, i.e., the huge set of small molecules that existed on early Earth, as well as the end point of chemical evolution - which is the beginning of biology and the first living organisms. In order to unravel the gap of what happened in between, it is crucial to analyze plausible routes to the origin of life. While much effort to date in the context of formation of primordial polymers has focused on the generation of nucleic acids, and to a lesser extent the formation of peptides, the role of sugars in the chemical origins of life has never been investigated - outside the roles of sugars as structural elements of nucleic acids and in metabolism. Sugars are ubiquitous biomolecules, providing an energy source, taking part in biosynthesis, providing structural support, and even acting as catalysts. Sugars are often found in conjugation with other biomolecules (e.g., glycolipids). I hypothesize that the tightly intertwined biological dependencies of sugars and other biopolymers, and their mutualistic relationships, reflect a long co-evolutionary process. The main goal of this proposal is to bridge the gap from early prebiotic chemistry to today's complex biochemistry by studying mutually catalytic networks involving sugars. Following our preliminary findings which successfully demonstrated the formation of oligomers composed of sugars and amino acids, my team will generate and characterize a multitude of heterogenous glycan-containing conjugates - and study their emergent assembly and function. This study will furnish a deep understanding of how and why life's biochemistry emerged.		moran.fp@mail.huji.ac.il

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2	Molecules of Life: Biological Mechanisms, Structures and Functions	Structure and Regulation of Bacterial Biofilm-Promoting Exopolysaccharide Secretion Systems	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	www.krasteva-lab.com	Bacterial biofilms, cryo-EM, exopolysaccharides, glycobiology, c-di-GMO signaling	Bacteria are commonly defined as unicellular organisms; however, they constantly exchange substances and information with their confrères and the environment, and can efficiently shelter themselves and achieve homeostasis by building multicellular collaborative macrocolonies called biofilms. Members of these sessile communities can undergo significant functional differentiation and are typically embedded in complex extracellular matrix that secures both mechanical protection and a medium for intercellular exchange. Importantly, the switch between sessile and motile life-styles in pathogenic bacteria can correlate directly with the development of chronic vs. acute infections, whereas extracted bacterial matrix components can find a variety of beneficial biotechnological applications. Exopolysaccharides (EPS) are a major biofilm matrix component and are typically produced by trans-envelope secretion nanomachines, many of which are controlled at multiple levels by the intracellular second messenger c-di-GMP. Here, we will consolidate our expertise in biofilm formation, cyclic dinucleotide signaling, bacterial secretion and integrative structural biology to decipher EPS secretion system assembly and function in several medically and industrially relevant species. We will use complementary recombinant and in situ structural biology approaches together with established genetic and imaging techniques to decipher the molecular events controlling EPS biogenesis from transcription initiation, interdependent protein folding and cooperative subunit interactions; through secretion system assembly, formation of supramolecular secretory nanoarrays and EPS modifications; to harnessing the biosynthetic processes for the engineering of novel anti-infectives or beneficial EPS superproducers. Over the last years we have spearheaded these studies by unprecedented mechanistic insights into several secretion systems and have demonstrated the feasibility of such an ambitious project.	Structural biology, Bacterial genetics, Bacterial imaging, Biopolymers	pv.krasteva@iecb.u-bordeaux.fr
3	Molecules of Life: Biological Mechanisms, Structures and Functions	When enzymes join forces: unmasking a mitochondrial biosynthetic engine	UNIVERSITA DEGLI STUDI DI PAVIA		biochemistry, enzymes, coenzyme Q, redox biology, metabolonm	Enzymes have been classically investigated as standalone catalysts operating in a relatively diluted milieu. However, the cell micro-compartments are highly crowded environments and biological catalysis cannot be fully understood on the bases of simple diffusive models. We are tackling this challenge by reconstituting a full-scale biosynthetic pathway where multiple enzymes coordinate within a metabolon - a structurally defined setting that allows the vectorial transfer of substrates and products. Our system for exploration is the fascinating biosynthesis of coenzyme Q, an essential redox mediator for many pathways. The juxtaposition between its highly polar head group and hydrophobic tail renders this compound a challenging feat to handle. To synthesise its highly substituted aromatic head group, nature has amassed a large soluble supra-molecular complex consisting of no less than eight functionally distinct proteins that adheres to the inner-mitochondrial membrane. This infrastructure can extract the substrate whilst providing a shielded, hydrophobic environment for molecular transit. We will systematically characterize the functional, structural and evolutionary aspects of the involved protein machineries in interplay with the membrane. Our approach starts by exploiting ancestral sequence reconstruction to generate proteins of enhanced stability. We will build the metabolon in vitro to assess how the enzymatic activities are coupled in the context of a metabolon. Structural studies will reveal how the active sites are spatially organized with respect to the order of the enzymatic steps and substrate trafficking. Our integrated strategy will unveil the pivotal evolutionary transitions that create a biosynthetic machinery. This research will go beyond classical enzymology by exploring a new paradigm of cellular biochemistry where metabolic pathways are fuelled and governed through interactions between enzymes, and between enzymes and other proteins.	biochemist, structural biologist, enzymologist, molecular mechanism	andrea.mattevi@unipv.it

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4	Molecules of Life: Biological Mechanisms, Structures and Functions	Decoding protein persulfidation signaling	LEIBNIZ-INSTITUT FUR ANALYTISCHE WISSENSCHAFTEN-ISAS-EV	www.group-filipovic-sulfaging.com		Life originally emerged and flourished in hydrogen sulfide (H2S)-rich environment and literature published in the past decade started to recognize that H2S is a mediator of many physiological and pathological processes. Exposure to H2S can put animals into suspended animation-like state while the lifespan extensions by the dietary restriction are caused by H2S accumulation. Disturbances in its production are linked to the development of neurodegenerative diseases and cancer, among many others. A new post-translational modification (PTM) of cysteine residues called protein persulfidation (i.e., converting cysteine residues PSH to persulfides, PSSH) has been suggested as a unifying mechanism behind all these effects. Therefore, an understanding of protein persulfidation has not only a fundamental potential, e.g. unraveling new signaling pathways, but also a pharmacological potential in fighting aging and diseases. However, the underlying mechanisms of H2S-mediated PSSH formation are still unclear, mainly due to the lack of a reliable and selective methodology for PSSH labeling. Here, using cutting-edge methodology for PSSH labeling developed by our team, combined with proteomics, metabolomics and molecular biology, and by working on different model systems (cells, C. elegans, rodents) we intend to (i) gain high-resolution structural, functional, quantitative, and spatio-temporal information on PSSH dynamics and position this evolutionary conserved PTM in the global cell signalling scheme, particularly in relation to other cysteine PTMs, (ii) understand the intricate relation between aging and PSSH and (iii) identify the protein targets whose change of function by persulfidation is implicated in aging and disease progression. The ultimate objective is to pave the way for the development of innovative therapeutic strategies that will permit targeted redox control of cell metabolism, and delay aging and disease progression.		milosf@gmail.com
5	Integrative Biology: from Genes and Genomes to Systems	Deciphering the role of regulatory factors driving epigenetic inheritance of alternative chromatin states	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	https://cordis.europa.eu/project/id/101141930	Epigenetics; cancer; 3D genome; Polycomb; Drosophila; ES Cells; Gastruloids	Epigenetics, the study of molecules and mechanisms that perpetuate alternative gene activity states in the context of the same DNA sequence, is an exciting field with important epistemological and biomedical implications, but the molecular mechanisms underlying epigenetic inheritance are still little understood. Polycomb group proteins are pleiotropic chromatin components that have been suggested to be capable of driving epigenetic inheritance and their dysregulation leads to cell fate changes and is associated with cancer. Recently, we discovered that a transient decrease in expression of a Polycomb gene can drive the formation of tumors of epigenetic nature, i.e. in the absence of DNA mutations. The goal of WaddingtonMemory is to decipher how epigenetic components can lead to stable changes in cell fate. Specifically, we will: Aim 1: Identify the molecular steps leading to epigenetic cell fate derailment following transient Polycomb protein depletion in Drosophila. We will perform a time-course study using bulk and single-cell multiomic and imaging approaches in order to dissect the dynamics of cell fate transformation. Aim 2: Identify the Polycomb-targets leading to cell fate dysregulation and decipher their mechanistic role. We will test candidate factors identified in Aim 1 in order to identify those that drive cell fate derailment and to elucidate their mode of action. Aim 3: Test the role of epigenetic inheritance in mammalian cell differentiation. We will analyse the role of epigenetic inheritance in mouse gastruloids, an in vitro system that reflects cell differentiation events typically found in early embryogenesis. Together, this groundbreaking project will reveal how epigenetic components drive cell fate derailment and it will establish robust paradigms that can be utilized by the scientific community to discriminate between epigenetic inheritance and DNA sequence-mediated cell transformation.lli		giacomo.cavalli@igh.cnrs.fr

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6	Integrative Biology: from Genes and Genomes to Systems	How do cells form an embryo: Intracellular, temporal, and phenotypic dissection of mammalian gastrulation	WEIZMANN INSTITUTE OF SCIENCE		Mammalian Embryonic Development, Gastrulation, Epigenetics and Genome Regulation, Systems Biology, Single Cell Genomics, Pluripotent Stem Cells, Transgenics	In multicellular orIn multicellular organisms, how variation is achieved while cells comprise identical genetic information represents a fundamental open challenge my group strives to engage in the coming years. The development of a single fertilized egg into a complete embryo represents an especially beautiful embodiment of this problem. The process of differentiation is defined by the capacity of the cell ensemble to acquire increasingly more specialized internal states in a coordinated fashion. We are therefore excited by recent breakthroughs in single-cell transcriptomics and epigenomics since these can capture the emergence of embryonic cellular diversification at incredible resolution. But, we believe there is an urgent need in the field to match descriptive single cell atlases with models and experimental frameworks to derive novel understanding of function and regulation in this process. To this end, we will undertake three complementary approaches – all implemented during specification of the basic mammalian body plan (gastrulation) in vivo. (i) We will scrutinize parallel and converged differentiation in embryonic and extraembryonic lineages at absolute time. This will be achieved in both mouse and rabbit, providing unprecedented molecular insight into the evolutionary hourglass theory. (ii) Building on our recently developed capabilities, we will systematically dissect epigenetic mechanisms shaping and memorizing intracellular states. Importantly, we will do so by controlling for cell type and effects that propagate in and between tissues over time. (iii) Finally, we will chart and manipulate extracellular signaling affecting cell specification in the 3D embryonic space. Our study will provide mechanistic understanding and much-needed quantitative models that truly represent embryonic development as a concurrent interacting ensemble with far-reaching implications for other fields, such as regenerative medicine, cancer, aging, and synthetic embryogenesis.	Mammalian Embryonic Development, Gastrulation, Epigenetics and Genome Regulation, Systems Biology, Single Cell Genomics, Pluripotent Stem Cells, Transgenics	yonatan.stelzer@weizmann.ac.il
7	Integrative Biology: from Genes and Genomes to Systems	How to evolve without centromeres: meiotic recombination dynamics in holocentric plants	MAX-PLANCK-GESELLSCHAFT ZUR FORDERUNG DER WISSENSCHAFTEN EV		Genomics, holocentric chromosomes, meiosis, karyotype evolution, centromere	Centromeres strongly affect genomic architecture and meiotic recombination distribution and also play a key role in constraining karyotype evolution. The recombination landscape is also heavily influenced by chromosome number and structure (i.e., karyotypes), as at least one crossover per chromosome (and rarely more than three) occurs in most species, making chromosome number the primary driver of recombination frequency. In addition, centromeres inhibit recombination, and therefore crossovers tend to occur mostly at chromosome ends. However, several unrelated eukaryotic lineages do not have centromeres, or at least, not conventional ones. Such is the case for plants with holocentric chromosomes, where hundreds of small centromere-like units are evenly distributed across the length of the chromosome. Notably, holocentricity has evolved repeatedly across the tree of life and at least four times during plant evolution. Holocentric plant species offer a unique opportunity to study the plasticity of meiotic recombination control. These species have lost typical centromeres, making them ideal for investigating how the recombination landscape was reshaped after the transition to holocentricity. Moreover, holocentricity unleashes changes in the karyotype, offering the possibility to analyze the effects of chromosome breaks and fusions on recombination frequency and distribution. The HoloRECOMB project aims are as follows: I. Analyze how transitions to holocentricity affect meiotic recombination dynamics in different holocentric plant lineages. II. Explore the effect of chromosome breaks and fusions on crossover number and distribution. III. Examine whether the crossover regulation in holocentric plants acts in a similar manner as in monocentric ones. Understanding how holocentricity affects recombination dynamics will provide insights into important mechanistic aspects of meiosis with potential practical applications for crossover regulation in centromeric regions.	Genomics, cytogenetics, meiosis, molecular biology, plant transformation	amarques@mpipz.mpg.de

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8	Integrative Biology: from Genes and Genomes to Systems	Deciphering signalling pathway dynamics during cell-fate commitment in stem cells	ACADEMISCH ZIEKENHUIS LEIDEN		cell fate, scRNAseq, lineage tracing, signalling, stochasticity	Understanding the identity and intensity of the specific extracellular signals that a cell experiences at different times during its differentiation is essential to develop advanced cellular therapies. However, uncovering the sequence of these signaling events, their intensities, timing, and relevance in development and disease is proving to be very challenging. Here, I propose to build i-SignalTrace: a CRISPR/Cas9-based molecular recorder with the capacity to store both lineage information and signalling pathway activity for multiple signals over time in single cells. By performing kinetic experiments and mathematical modeling, I will use i-SignalTrace to extract the probability of signalling pathways to be activated in stem cells when subject to different extracellular signals and reconstruct the lineage tree of pathway activities during differentiation with single-cell resolution. In combination with single-cell RNA sequencing, i-SignalTrace will make it possible to characterize transition and intermediate states along differentiation trajectories, and quantify the integration between extracellular signals and autonomous programs of gene expression. These results will allow predicting the differentiation trajectories that stem cells follow when subject to external perturbations, and deciphering the role of heterogeneity in signalling pathway activity during cell-fate commitment. Using i-SignalTrace, I will identify missing or redundant signalling pathways induced during in vitro differentiation protocols. Therefore, I expect that exploitation of i-SignalTrace will allow establishing new criteria to design protocols to differentiate stem cells on demand. As a proof-of-concept, I propose a framework to improve the functionality of monolayer-derived cardiomyocytes. Taken together, i- SignalTrace will find applications in both fundamental developmental biology and translational regenerative medicine, which will benefit a much wider scientific community.		a.alemany@lumc.nl
9	Cellular, Developmental and Regenerative Biology	Signaling decoded in ENhanCEr states – a molecular basis for plasticity in development and differentiation	KOBENHAVNS UNIVERSITET		Transcription, enhancer, signaling, development, endoderm, pluripotency	Transcription is regulated by transcription factors (TFs) bound at enhancer elements located long-distances from the genes they regulate. How does this account for dynamic responses to the environment via signaling? Canonical views invoke signal induced changes in TF expression/modification or cofactor localization, but here we suggest that TF occupancy could be present before and after the signal, establishing competence, ensuring plasticity and blocking premature commitment. For ERK signaling, a central regulator of embryonic stem cell (ESC) differentiation, we found enhancers were regulated via selective recruitment of RNA Polymerase II (RNAPII) and associated cofactors. In this case, TFs do not play a direct role in enhancer regulation, but safeguard future activation in response to changes in signaling. In the context of developmental biology this paradigm could explain the dynamic nature of cell specification in the early mammalian embryo. In this proposal, we seek to understand enhancer specific regulation by ERK, exploit our ability to manipulate ERK to disentangle mechanism and focus on preimplantation development to explore how these phenomena explain plasticity. To circumvent heterogeneity created by feedback inhibition we developed a unique ESC line for cell intrinsic and synchronous ERK induction. We combine these ESCs with rapid TF degradation mutants to isolate homogeneous cell states that can be exploited to generate unique datasets and identify key factors within ERK response. We address how coactivator phosphorylation promotes selective recruitment of Mediator/RNAPII, explore the fundamental nature of enhancer activity and ask how uncoupling of transcriptional regulation from TF binding underpins developmental plasticity. By exploiting our capacity to modulate enhancer activity via signaling, we not only address how signaling regulates transcription to drive differentiation choices, but how enhancers themselves regulate gene expression.		Joshua.Brickman@sund.ku.dk

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10	Cellular, Developmental and Regenerative Biology	Analysis, control, and engineering of spatiotemporal pattern formation	UNIVERSITAT KONSTANZ	https://cordis.europa.eu/project/id/863952		A central problem in developmental biology is to understand how tissues are patterned in time and space - how do identical cells differentiate to form the adult body plan? Patterns often arise from prior asymmetries in developing embryos, but there is also increasing evidence for self-organizing mechanisms that can break the symmetry of an initially homogeneous cell population. These patterning processes are mediated by a small number of signaling molecules, including the TGF-β superfamily members BMP and Nodal. While we have begun to analyze how biophysical properties such as signal diffusion and stability contribute to axis formation and tissue allocation during vertebrate embryogenesis, three key questions remain. First, how does signaling cross-talk control robust patterning in developing tissues? Opposing sources of Nodal and BMP are sufficient to produce secondary zebrafish axes, but it is unclear how the signals interact to orchestrate this mysterious process. Second, how do signaling systems self-organize to pattern tissues in the absence of prior asymmetries? Recent evidence indicates that axis formation in mammalian embryos is independent of maternal and extra-embryonic tissues, but the mechanism underlying this self-organized patterning is unknown. Third, what are the minimal requirements to engineer synthetic self-organizing systems? Our theoretical analyses suggest that self-organizing reaction-diffusion systems are more common and robust than previously thought, but this has so far not been experimentally demonstrated. We will address these questions in zebrafish embryos, mouse embryonic stem cells, and bacterial colonies using a combination of quantitative imaging, optogenetics, mathematical modeling, and synthetic biology. In addition to providing insights into signaling and development, this high-risk/high-gain approach opens exciting new strategies for tissue engineering by providing asymmetric or temporally regulated signaling in organ precursors.		patrick.mueller@uni-konstanz.de
11	Cellular, Developmental and Regenerative Biology	Systematic mapping of the chloroplast protein import system	THE HEBREW UNIVERSITY OF JERUSALEM		chloroplast, import, translocation, high-throughput microscopy, chlamydomonas	Protein import into a membrane-bound organelle in eukaryotes has been intensively studied, leading to the discovery of the central intracellular import machineries. Yet, this field has undergone a fundamental paradigm shift following recent discoveries of non-canonical import pathways in the mitochondria and ER. While the chloroplast is still thought to have but one import machinery (TIC/TOC), accumulating evidence indicate it, too, has non-canonical pathways. Technological constraints have so far barred the systematic search for alternative import pathways, as well as the exploration of central aspects relating to this import system: Are there additional import pathways other than the canonical chloroplast translocon apparatus? What ensures correct targeting of proteins in the highly crowded cytosol to the chloroplast? What mediates between quality control processes and protein import? In Chloro-Import, we will go beyond the state-of-the-art by implementing multipronged, genome-wide, unbiased approaches we developed or adopted to elucidate all the targeting pathways en route to the chloroplast in Chlamydomonas. Specifically, we will use advanced genome-wide screening to comprehensively elucidate chloroplast import pathways (Aim1); uncover the functional organization of import pathways using genetic-interaction profiling and protein-protein-interaction mapping (Aim2); and conduct an in-depth biochemical investigation of the function of unstudied/novel import factors (Aim3). To the best of our knowledge, this is the first-ever study of this scale in a photosynthetic eukaryote cell. The outcome will be a complete map of the chloroplast protein-import system (pathways, components, regulators) and a genetic platform for this system's in-depth characterization. It will further offer insight into basic questions in chloroplast functioning, and may also pave the way to the synthetic engineering of crops that are more efficient for projected climate changes.		michal.breker@mail.huji.ac.il

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12	Cellular, Developmental and Regenerative Biology	The Sleeping Embryo	MAX-PLANCK-GESELLSCHAFT ZUR FORDERUNG DER WISSENSCHAFTEN EV			The implantation of the blastocyst into the uterine wall is a key step of the reproductive cycle, which mediates the connection of the embryo to the maternal tissues during the early stages of pregnancy. However, in some species, including the house mouse, this process can be put on hold, while the embryo falls into a reversible state of suspended animation, known as diapause. The dormant embryos can reside in a “deep sleep” over extended periods of time (e.g. bypassing unfavourable environmental conditions), without compromising their developmental potential. Although, the maternal hormonal control of implantation and the process of transient mouse embryogenesis have been intensively studied, the embryonic diapause is still an extremely enigmatic state. Several lines of evidence, based on my preliminary data, suggest that diapause is not a stasis, but instead is a dynamic process with underlying mechanisms that can appear redundant during transient embryogenesis. Here I aim to decipher the cryptic embryo-intrinsic mechanisms of embryo dormancy, using the mouse as a model system. I will elucidate the cellular processes that coordinate and capacitate the embryo for diapause on epigenetic, transcriptional and cell signalling levels. Using interspecies chimeras and blastoids, I will extend my analysis to non-diapausing species and artificial embryo-like structures. Thus, by manipulating the flow of embryogenesis, I will uncover hidden, dormant mechanisms, safeguarding the developmental potential of the early mammalian embryo.		ivan.bedzhov@mpi-muenster.mpg.de
13	Cellular, Developmental and Regenerative Biology	Plasticity of the Pluripotency Network	THE UNIVERSITY OF EXETER	https://lsi.exeter.ac.uk/groups/smith-group/	pluripotent stem cells; embryonic development, gene regulatory network; single cell transcriptomics	A few days after fertilisation mammalian embryos form a blastocyst comprised of three tissues; trophoblast and hypoblast are the forebears of extraembryonic structures, while naive epiblast cell are the pluripotent source of the embryo proper. Classical mouse embryological studies indicate that lineage potencies are determined concomitant with segregation of the three founder tissues. Textbook definitions of pluripotency thus exclude extraembryonic potential. Consistent with this paradigm, mouse embryonic stem cells are generally ineffective in producing trophoblast or hypoblast derivatives. However, we have discovered that human naïve pluripotent cells have high intrinsic competence for trophoblast formation. Furthermore, unlike in mouse, extraembryonic transcription factors are present in human epiblast in vivo. These findings challenge the dogma of early lineage restriction but may be compatible with the ancestral origin of pluripotency. We hypothesise that extraembryonic plasticity underlaid by entwined regulatory networks is the evolutionary template of pluripotency. Consequently, signal modulation to suppress extraembryonic specification may be crucial for capture of stem cells representative of naïve epiblast in most mammals. We will examine human and non-human primates, farm animals in which embryos undergo extended development before implantation, and a marsupial in which pluripotent cells are generated from the trophoblast. In a cross-disciplinary approach we will employ transcriptomics, embryo and stem cell experimentation, and formal computational modelling to uncover the core biological program moulded by evolution into different forms. We aim to establish hitherto elusive chimaera-competent embryonic stem cells from species of importance for research, biomedical applications and livestock improvement. We will obtain fresh insight into the molecular logic governing early development, lineage plasticity, pluripotent identity, and stem cell self-renewal.	stem cell biologist; developmental biologist; molecular biologist; computational biologist	austin.smith@exeter.ac.uk

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14	Cellular, Developmental and Regenerative Biology	Mitochondrial signaling drives parasite differentiation	BIOLOGICKE CENTRUM AKADEMIE VID CESKE REPUBLIKY VEREJNA VYZKUMNA INSTITUCE	https://www.paru.cas.cz/en/sections/molecular-parasitology/laboratory-of-functional-biology-of-protists/	Mitochondria, signaling, redox biology, ROS, differentiation	Mitochondria perform three essential functions: ATP production, metabolite synthesis and cellular signaling. These signals, communicating the bioenergetic and biosynthetic fitness of the organelle to the nucleus, play a powerful role in determining cellular fate. The incorporation of mitochondrial reactive oxygen species (mROS) in cellular signaling is an interesting evolutionary outcome, as excess levels of these potent oxidizers have been implicated in many pathologies. While most research focuses on these outcomes of oxidative stress, much less is known about how mROS drive a range of physiological responses. Furthermore, the available studies are limited to a few traditional model organisms, featuring complex cellular systems with numerous mitochondria at different energetic states. Here, we propose to utilize the unicellular parasites, Trypanosoma brucei and T. congolense, as simplified but elegant models to define mROS-driven cellular differentiation. As these protists undergo programmed development between several distinct life cycle forms, there are striking changes to the structure and physiology of their single mitochondrion that manifest in elevated ROS levels. Importantly, we demonstrated that these ROS molecules are essential for the developmental progression of the parasite. Employing these well-chosen models and combining next-generation biosensors, advanced bioenergetic methods, redox proteomics and a CRISPR/Cas9 genetic screen, we will answer the following fundamental questions: Does mROS drive Trypanosoma cellular differentiation? What molecular processes are responsible for the elevated mROS levels during differentiation? How is the redox signal propagated to the rest of the cell? The proposed research aspires to unravel the fundamental mechanisms underlying the intricate communication between mitochondria and the rest of the cell, featuring cellular hallmarks of cell fate decisions.		azikova@paru.cas.cz

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15	Physiology in Health, Disease and Ageing	Decoding mitochondrial selective autophagy in synaptic homeostasis during ageing	ETHNIKO KAI KAPODISTRIAKO PANEPISTIMIO ATHINON		Mitophagy, ageing, neuron, neurodegeneration, sunapse	Age-dependent accumulation of damaged mitochondria and synaptic loss represent early pathological hallmarks of brain ageing leading to neuronal death. Mitochondria-selective autophagy (mitophagy) is triggered to eliminate defective organelles promoting cellular and organismal survival. Mitophagy declines with age, while its induction extends lifespan and confers neuroprotection across diverse species. Although the pivotal role of mitophagy in neuronal physiology is steadily emerging, its contribution to synaptic homeostasis remains elusive. Building on our previous pioneering studies, SynaptoMitophagy aims to reveal the molecular underpinnings of age-dependent synaptic impairment, focusing on mitochondrial maintenance and turnover. We will combine the nematode Caenorhabditis elegans, which offers a well-defined nervous system, with cutting-edge technologies, such as super resolution imaging, microfluidics and optogenetics, to manipulate spatiotemporally mitochondrial damage and monitor synaptic mitophagy at nanoscale resolution, in vivo. Mammalian neurons will be used to address the functional conservation of synaptic mitophagy components. The objectives are four-fold: 1) Establish mitophagy reporters for in vivo monitoring of mitochondrial fate at synapses during ageing and under neuroprotective conditions 2) Use optogenetic tools to stimulate synapse-restricted mitochondrial damage and, thereby, to detect mitophagy induction and its contribution to neurotransmission. 3) Characterize the synaptic defects and assess behavioral deficits arising from mitophagy impairment. 4) Conduct forward genetic screen for synaptic mitophagy modulators, towards augmenting mitochondrial quality control and resistance to age-related synaptic failure. The cumulative results of this proposal will decode the molecular mechanisms of neuronal mitophagy compartmentalization at synapses during ageing, providing critical insights with broad relevance to human health and quality of life.	Ageing, mitochondria, autophagy, mitophagy, neurodegeneration	palikarask@med.uoa.gr
16	Physiology in Health, Disease and Ageing	EXPANDing Immune Cells and their Tumor Antigens during checkpoint immunotherapy	VIB VZW			Cancer immunotherapy using immune checkpoint blockade (ICB) has revolutionized the treatment of advanced-stage cancers. One of the major limitations of ICB is that durable responses are observed only in a subset of patients and in some specific cancer types. We recently analyzed tumor biopsies from breast cancer patients collected during ICB and indeed observed only in a subset of patients that tumor-infiltrating T-cells undergo rapid expansion when exposed to ICB. We characterized the gene expression programs underlying this expansion at single-cell level and realized that - although these expanding T-cells are the main executors of therapeutic response to ICB - several key questions regarding their function remain unanswered. First, we lack accurate knowledge about where in the heterogeneous tumor microenvironment (TME) and in which metabolic niches T-cell expansion occurs. Secondly, based on their TCR sequence we cannot predict upfront which T-cells will expand (or rather act as bystander T-cells), nor can we say to which tumor antigens these expanding T-cells are directed. Thirdly, it is not known which molecular events underlie the generation of the tumor antigens regulating T-cell expansion. Fourthly, we also observed an expansion of the B-cell repertoire and were left with similar questions as for expanding T-cells. For instance, where are expanding B-cells located, how do they interact with expanding T-cells, and do they perhaps even recognize the same tumor antigens. In EXPAND IT, we will use several innovative (single-cell) technologies to provide answers to these questions. These insights will much better characterize the mechanisms driving response to ICB, but will also provide important answers on how to sensitize patients not responding to ICB. Our findings could also contribute to the discovery of high-avidity anti-tumor TCRs that can be used in novel TCR-based cellular therapies.		Diether.Lambrechts@kuleuven.be

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17	Physiology in Health, Disease and Ageing	Deciphering and exploiting ferroptosis regulatory mechanism in cancer	JULIUS-MAXIMILIANS-UNIVERSITAT WURZBURG			Ferroptosis is a cell death modality triggered by the accumulation of oxidised lipids, a process known as lipid oxidation, and associated with a multitude of pathological conditions, including ageing, neurodegeneration, and cancer. On the flip side, recent studies demonstrated that targeting pathways contributing to the prevention or repair of oxidised lipids is a powerful strategy to eradicate therapeutically challenging entities, including neuroblastoma, a pediatric malignancy reported to be remarkably sensitive to ferroptosis. However, therapeutic breakthroughs targeting this pathway are elusive due to our incomplete understanding of the factors controlling this process. DeciFERR will address this critical knowledge gap and identify strategies to trigger ferroptosis. This will be accomplished by discovering and characterising novel mechanisms regulating the stability of key ferroptosis suppressors, thus providing opportunities to develop tailored strategies to target ferroptosis-sensitive entities. This project rests on our pioneering works identifying two major break systems operating against lipid peroxidation, glutathione peroxidase 4(GPX4) and ferroptosis suppressor protein 1 (FSP1). In Aim 1, using a combination of novel cellular model and target-oriented phenotypic screens, we will characterise and target pathways involved in selenocysteine uptake, mobilisation and recycling, which we found essential for the stability of selenoproteins, including GPX4. In Aim 2, we will dissect metabolic and cellular states that determine the antioxidant capacity of membranes via FSP1-dependent mechanisms using a combination of cellular systems and functional genetic screens. DeciFERR will lead to a comprehensive understanding of how ferroptosis is orchestrated and will expand the druggable inventory, providing innovative strategies that will be put to test and could ultimately pave the way for efficacious therapies against malignancies that still defy current treatments.		office.friedmann-angeli@uni-wuerzburg.de
18	Physiology in Health, Disease and Ageing	HUNTING GHOST NEURONS IN THE NEUROENDOCRINE HYPOTHALAMUS	INSTITUT NATIONAL DE LA SANTE ET DE LA RECHERCHE MEDICALE		hypothalamus, heterogeneity, cell identity, energy balance, reproduction, hormones, obesity	The hypothalamus contains heterogeneous neurons that dictate behaviours and physiological functions through cross-talk mechanisms with peripheral hormones. Neuronal diversity is the key to enabling hypothalamic functions and, according to the neuroscience dogma, is mainly preset during embryonic life. But what if this model is incorrect? Can neuronal heterogeneity be plastically modulated throughout adult life as well? Here, based on my published work and solid preliminary results, I propose that special 'Ghost' neurons in the hypothalamus display plastic mechanisms of cell-identity reprogramming to accommodate neuroendocrine functions in adult life under physiological conditions. Such identity plasticity can become maladaptive and contribute to neuroendocrine disorders such as obesity. My central hypothesis is that atypical 'Ghost' neurons are hidden within mature populations of neuroendocrine brain neurons. The Ghostbuster project will hunt down these brain cells and uncover their role in physiology and metabolic disease. A multidisciplinary approach will be used toward this goal, uniting lineage tracing strategies, nutritional interventions, single-cell profiling of hypothalamic neurons, bioinformatic analyses, and viral-based tools for targeting Ghost cell-related genes. These strategies will be combined with behavioural, metabolic and hormonal assessments of mice models of Ghost neuron loss or gain of function. The project will overturn the dogma that post-mitotic neurons have negligible cell-reprogramming capacity and revolutionise our understanding of how brain functions are plastically regulated throughout life. We will shed light on key molecular targets that allow the reprogramming of neuronal functional identity for therapeutic use and provide a novel framework for understanding the fundamental biological mechanisms that cause neuroendocrine disorders such as obesity, infertility, and beyond.	single cell biology, neuroendocrinology, neuroscience, metabolism, nutrition, diabetes, obesity	carmelo.quarta@inserm.fr

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19	Neuroscience and Disorders of the Nervous System	Inducing functionality in retinal organoids with electrical activities derived from developing retina	STICHTING RADBOUD UNIVERSITAIR MEDISCH CENTRUM			Deriving mammalian retina from stem cells has had a large impact on the study of the biology of vision and is called organoid. Compared to in vivo retina, retinal organoids are far less functionally sophisticated in terms of their synapses, connectivity, discrimination between different light stimuli and their electrical action potentials. This project will overcome this functional constraint of retinal organoids by studying electrophysiological events-derived functional maturation of mouse retina during retinal development and then stimulating those events with the help of mathematical models in order to induce the same functionality in mouse and human retinal organoids. NeuFRO will achieve a resonance in the field by generating retinal organoids with the neuronal connectivity and the natural diversity of functions using interdisciplinary fields including electrophysiology, developmental biology, and computationally-derived electrical stimulation. Initially, I will create a holistic roadmap of the electrical features of immature mouse retina during development that shows self-organization through electrophysiology. With milli- to nanometer imaging precision, electrical activities derived the circuit formation will be spatiotemporally documented. Then I will decode this space-time code of intrinsic electrical patterns and neuronal connectivity using an ambitious strategy incorporating Hodgkin-Huxley and linear-nonlinear models. Next, such electrical response models will be applied to immature retinal organoids (mouse and human) by an innovative ‘sandwich’ electrophysiology technique during the development in vitro. With this approach, I will induce naturalistic electrical features in the retinal organoid, allowing the functional neurons to wire and fire appropriately into retinal organoids, particularly visual circuits. This ground-breaking approach will advance techniques for generating functional human retina.		zohreh.hosseinzadeh@radboudumc.nl
20	Neuroscience and Disorders of the Nervous System	Revealing the biological bases of speech and language by studying bat vocal learning	THE UNIVERSITY COURT OF THE UNIVERSITY OF ST ANDREWS	https://vernesllab.wordpress.com/	genetics, language, vocal learning, bats, genomics, neuroscience	The overarching goal of BATSPEAK is to shed light on the biological origins of speech and language by analysing the molecular mechanisms and neural circuitry that support vocal learning in the bat, using tools that I have pioneered in this species. Vocal learning is a fundamental building block of human spoken language and is a trait we share with few other animals. It has only been identified in 4 non-human mammal groups, of which bats are the only tractable model system in which the molecular and neural mechanisms can be addressed, thus providing a unique window onto the biological foundations from which human speech and language evolved. BATSPEAK has 3 aims: 1. To identify the genomic markers of vocal learning allowing us to probe the molecular mechanisms that underlie mammalian vocal learning 2. To characterise neural mechanisms underlying mammalian vocal learning 3. To determine direct, causative contributions of molecular and neural mechanisms to mammalian vocal learning behaviour This project will use bats as an exemplar species in which the molecular and neural mechanisms underlying mammalian vocal learning can be understood, and will contain 3 work packages: WP1. Comparative evolutionary genomics, coupled with gene function and gene expression analyses, to identify the molecular mechanisms underlying vocal learning WP2. Comparative neuroanatomy, electrophysiology, and transcriptomics to characterise a key neural circuit underlying vocal learning WP3. Generation of transient transgenic bats to test hypotheses of the role of molecular and neural mechanisms in vocal learning behaviour Understanding the bases of vocal learning in mammals will shed light on the biology underlying speech and language and provide a new mammalian model for the study of language related disorders.		scv1@st-andrews.ac.uk

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21	Neuroscience and Disorders of the Nervous System	Transcriptional Regulation Assessed in Neuronal Subtypes in three major interrelated Psychiatric disorders	ACADEMISCH ZIEKENHUIS GRONINGEN			Schizophrenia (SCZ), bipolar disorder (BP), and Major Depressive Disorder (MD) are three major psychiatric disorders that affect mood, thinking, and behavior. These disorders are strongly genetically intercorrelated, and exhibit pronounced clinical overlap, suggesting that they are different manifestations of a shared underlying neurobiology, along a spectrum. However, the neurobiological mechanisms and pathophysiology of these disorders are still poorly understood, limiting effective drug discovery. There is an urgent need for new models for drug testing, as animal models have major limitations, and current psychiatric organoids systems are dependent on patient derived stem cells, in which technical, genetic and biological diversity confound the interpretation, and obscure the underlying neuropathology. The major challenge of this ERC proposal is to develop organoid models for psychiatric disorders by targeting upstream transcription factors. Transcription factors are key molecules that drive cell type differentiation including neuronal network formation. Hence, the central hypothesis of this ERC proposal is that neuronal subtype associated transcription factors can function as targets to model these disorders using brain organoids. However, the neuronal transcriptional regulators that mediate these disorders are currently unknown, and difficult to identify. Novel genomics technologies allow for an unbiased characterization of the brain in order to detect cell types and genes that are dysregulated in disease, and can be used to identify putative upstream transcription factors. Here, I propose a selection of multi-omics profiling - strategies to a unique collection of high quality psychiatric human brain tissue aimed at reliably identifying key upstream transcription factors. We will subsequently target those transcription factors in brain organoid systems to establish neurobiological models of these disorders.	Bioinformatics, single-nucleus genomics, psychiatric disorders, data science	irholtman@gmail.com
22	Neuroscience and Disorders of the Nervous System	The Evolution and Function of Ancestral Brain States	TEL AVIV UNIVERSITY		reptiles, evolution, coding, brain states, visual processing, eye camera	One of the oldest enigmas in neuroscience is the function of brain states. During these states, dramatic transitions occur in the firing patterns of neurons in the cerebral cortex. These transitions are correlated with behaviour during wakefulness but, strikingly, are even more prominent during sleep, when interaction with the environment is limited. The similarities between sleep and awake patterns remains unexplained, thus complicating our understanding of the global function of brain states. Additionally, state transitions are prominent in both the cortex and hippocampus, but the interplay between these areas during different states remains ambiguous. Why is the function of brain states so elusive? A likely explanation is that state transitions are inextricably intertwined with many other processes, rendering their dissection difficult. This project is motivated by the notion that to understand brain states we need to: a) examine them in a simpler model system, b) understand how they evolved, c) identify which state properties are fundamental and which are species specific. I suggest that studying brain states in the cerebral cortex of reptiles offers a unique opportunity for achieving all three goals. We will utilize the simpler and highly structured state organization in Pogona Vitticeps, to expose the full repertoire of brain states in a naturally behaving animal. We will take advantage of the limited diversity of motor movements in Pogona, to expose the link between population patterns and defined behaviors. We will furthermore exploit the unique evolutionary positions of reptiles as closest to stem amniotes, in which the layered cortex and hippocampus first emerged, to reveal the forces that pushed the emergence of brain states in evolution. Finally, through a comparative analysis of brain state properties between different lizards and mammals we will extract the fundamental properties and functions of brain states and the network that supports them.		sheinmark@tauex.tau.ac.il

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23	Neuroscience and Disorders of the Nervous System	The early ticking of the central circadian pacemaker: when and how	ACHUCARRO BASQUE CENTER FOR NEUROSCIENCE FUNDAZIOA		circadian clock, development, suprachiasmatic nuclei, astrocytes, premature babies	The 24-h (circadian) timing system develops during the perinatal period and rules our physiology later in life. It has the essential task of anticipating daily recurring changes in the environment (day/night) to find the best time for each molecular and cellular process. It is organised hierarchically, with a master pacemaker in the hypothalamic suprachiasmatic nucleus (SCN), which is able to perceive environmental light and tell the body what time is it. Our modern 24/7 lifestyle favours a disruptive environment for the circadian system, which is especially negative during pregnancy. We have found, in mice and pre-term infants, that when mothers are exposed to glucocorticoids (GCs) at the wrong time of day, the offspring show behaviour disorders later in life. Our mechanistic findings showed for the first time, a role of the foetal clock before birth, challenging the view on the clock being immature and non-functional. StarTicking proposes to answer a long-standing question in the field: When and how the circadian clock starts ticking. With a multidisciplinary and integrated approach, we will go beyond the state-of-the-art to understand mechanistically the development of the central circadian pacemaker in mice and humans. We will investigate: 1) How the SCN forms by a detailed assessment of the developmental trajectory of the mouse SCN with single cell resolution. 2) When the SCN becomes functional by testing a yet unexplored player: Astrocytes as drivers of the gain of functionality of the mouse SCN. 3) What the influence of the early environment on the human SCN maturation is. The generation of a human SCN organoid will allow us to test maternal signals in vitro with high-throughput. We will link mechanistic findings to the development of SCN-driven rhythms in a cohort of pre-term babies. StarTicking will provide ground-breaking mechanistic evidence and valuable knowledge to alleviate the behavioural consequences of the circadian disruption early in life	Neuroscience, mouse, circadian system, development, astrocytes, circuit, neuroendocrinology	mariana.astiz@achucarro.org
24	Neuroscience and Disorders of the Nervous System	Growing Long Distance - RNA Control of Neuronal Extension	WEIZMANN INSTITUTE OF SCIENCE	https://www.weizmann.ac.il/Biomolecular_Sciences/fainzilber/	neuron growth, nerve regeneration, RNA localization, local translation, non-coding RNA	Neurons are the longest cells, extending axons over distances that can reach four orders of magnitude larger than their cell body diameters. How can they achieve such long distance growth? After initial engagement with target cells, neurons undergo stretch-induced elongation as the nervous system matures with the growth of the organism. The molecular mechanisms enabling such prodigious growth are unknown. Based on strong preliminary evidence, we tested the hypothesis that both the initial elongating and later stretch-induced axon growth act via a shared RNA localization mechanism. Very strikingly, we identified a specific subset of polyadenylated repeat element RNAs, hereby termed growth-inducing SINEs (GI-SINEs), as key growth regulators. GI-SINEs are induced from AP-1 promoter-associated extragenic loci, and interact with ribosomal proteins and the axon growth regulating RNA binding protein nucleolin, in neuronal cytoplasm. We will elucidate how this intrinsic mechanism controls neuron growth, determining (1) how known elongating growth regulators affect stretch-induced growth; (2) how local and global protein synthesis regulate neuron growth control; and (3) how growth regulates the GI-SINEs and how they regulate different growth modalities. We will apply a multidisciplinary suite of techniques and approaches to these challenges, including a new technology for characterization of nascent proteomes developed in-house. The proposed project will provide ground-breaking and fundamental mechanistic insights on neuronal growth, and will establish novel methods that will be widely applicable. Moreover, establishing that a repeat element RNA is an intrinsic effector linking AP-1 transcription to translation regulation is a breakthrough finding that opens new horizons for cell biology and neuroscience.		mike.fainzilber@weizmann.ac.il

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25	Neuroscience and Disorders of the Nervous System	Mechanisms of memory formation in cortical networks during learning of goal-directed behaviors	TEL AVIV UNIVERSITY	https://www.finkelstein.sites.tau.ac.il/		A central hypothesis in neuroscience is that changes in connectivity patterns between neurons support learning and memory formation. Most methods for examining connectivity between individual neurons rely on ex vivo experiments (e.g., in brain slices). However, in vivo measurements are required to study how neurons causally influence each other's activity ('causal connectivity') in the living brain, and how these causal interactions change over time. Thus, while brain networks are among the most studied biological networks, the cellular-level patterns and dynamics of causal connectivity in vivo remain unknown. Here, I propose to study how causal connectivity between individual neurons and across entire brain areas changes over time during learning of memory-guided behaviors. To this end, we will use novel causal optical methods to longitudinally map causal connectivity and neural activity at cell resolution in vivo, focusing on the motor cortex and related areas. We will combine these methods with a novel goal-directed behavior in mice that does not require pretraining, which will serve as a baseline to study learning mechanisms of more complex behaviors that rely on short-term memory. Specifically, we will map changes in causal connectivity during learning within the motor cortex (Aim 1) and across cortical areas (Aim 2) and relate it to the computational functions of the network. We will also perturb neurons based on their connectivity and coding properties to identify changes in network mechanisms for short-term memory and action selection at various learning stages (Aim 3). Finally, we will work towards identifying constraints on memory formation via optogenetic induction of artificial connectivity patterns. Taken together, this research will enable for the first time to causally study dynamics in network interactions across time on different spatial scales, and to test fundamental mechanisms of memory formation and representation in cortical networks.		arsenyf@tauex.tau.ac.il
26	Immunity, Infection and Immunotherapy	DELta Virus infection in animal and human hosts	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	https://www.igmm.cnrs.fr/en/team/rna-viruses-and-host-factors/	satellite viruses, circular RNA virus, Immunity, host-shifting, zoonosis, RNA viruses , virus-host interaction, deltaviruses , evolution, viral entry, viral packaging	The emergence and rapid transmission of viruses pose increasing risks and challenges to modern societies, threatening public health and economic stability. A thorough understanding of basic virology is therefore critical for an informed development of preventive and control strategies. Although for more than 40 years the only known member of deltaviruses was the human Hepatitis Delta virus (HDV), it was recently discovered that HDV-like agents are present in a variety of animal vectors and reservoirs including bats, rats, snakes, birds and insects. Metagenomic data indicate that these satellite viruses possess an unrecognized host shifting capacity enabling them to cross the species barrier. As no efficient antiviral treatment is available against HDV, the emergence of novel deltaviruses poses a significant potential threat to human health. To date, animal deltaviruses have not been functionally characterized and little is known about their basic biology. The proposed project (DELV) aims to generate essential knowledge about the biology of deltaviruses, their interactions with host cells, their zoonotic potential and evolutionary fitness. Using newly generated deltavirus molecular clones coupled to unbiased proteomic and genetic approaches, DELV will identify host factors interacting with deltaviruses in their natural animal and human hosts (Aim 1). Further, it will determine and characterize host factors that are essential for deltavirus replication in the human host when they cross the species barrier (Aim 2). Finally, DELV will discover viral elements favoring deltavirus host shifting and adaptation capacities (Aim 3). DELV aims to shape novel paradigms in virology, RNA biology and host-pathogen interactions. Knowledge generated through DELV will guide the development of novel antiviral strategies and will have profound implications for understanding the ecology and evolution of these newly discovered, yet mysterious, viral elements.		karim.majzoub@igmm.cnrs.fr

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27	Immunity, Infection and Immunotherapy	The role of fungal viruses in shaping fungal pathogenesis and mammalian host responses	THE HEBREW UNIVERSITY OF JERUSALEM			Fungal pathogens present a significant threat to global health. As eukaryotes, they share considerable homology with their hosts, necessitating the development of innovative, non-cross-reactive therapies. Mycoviruses, viruses of fungi, can transform fungal virulence. Yet, despite their ubiquity and importance, the underlying mechanisms driving mycoviral infection and their consequences on fungal pathogenesis remain understudied. Using a naturally mycovirus-infected Aspergillus fumigatus strain, a model human fungal pathogen, we found that the mycovirus bestows a survival benefit to the fungus under oxidative stress and in the murine lung. We posit that mycoviral pressure modulates fungal fitness and virulence, thereby shaping the fungal host repertoire and facilitating the emergence of new fungal diseases. The proposed research aims to elucidate the mycoviral, fungal and mammalian determinants governing fungal cell fate during infection. We will:1) determine the molecular details governing mycoviral impact on fungal fitness, virulence, and host adaptation, 2) identify fungal antiviral mechanisms, and 3) determine how mycoviral infection affects the mammalian antifungal response. This complex multipartite pathosystem (mycovirus-fungal host-mammalian host) is highly heterogenous and dynamic, and this diversity can trigger different infection outcomes. To this end, we have developed a suite of fluorescent probes of fungal and mycoviral infection and of fungal physiology that enable tracking of virus-fungus-host interactions at single-cell resolution, and assessment of the physiological state of phagocytosed fungi in the host tissue. We propose the first in vivo interaction map of a virus within a fungus within an animal in the context of in vivo infection. We anticipate that this work will fundamentally shift our paradigms of fungal pathogenesis, and lay the groundwork for the development of novel therapeutics that operate in an entirely unexploited target space.		neta.shlezinger1@mail.huji.ac.il
28	Immunity, Infection and Immunotherapy	Artifying fibroblasts: Perturbation modelling in the lung tumor phase space to rewire fibroblasts for immunotherapy.	EREVNITIKO KENTRO VIOIATRIKON EPISTIMON ALEXANDROS FLEMINGK	https://www.fleming.gr/research/ibi/researchers/tsoumakidou-lab	adaptive immunity, cancer, animal models, bioinformatics, gene editing	Lung cancer is the leading cause of cancer death. Immunotherapy improved survival rates, but efficacy is limited to selected patients. We recently discovered universal antigen presenting fibroblasts (apFibros) across human and murine lung tumors and showed that they directly stimulate cancer-specific CD4 T cells, creating immunological hot spots that support immune rejection. These studies achieved a breakthrough on the role of in situ cancer antigen presentation and proposed a novel model whereby tumors can sustain T cells independently of lymph nodes. Preliminary data suggest that lung apFibros help overcome resistance to checkpoint inhibitors. For their immunotherapeutic exploitation of apFibros two bottlenecks must be overcome: low numbers and incomplete understanding of their configurations. We will integrate computational and laboratory experiments and work in parallel in human and mouse models to generate perturbation datasets across single-cell/cell systems, transcriptomics/epigenomics, spatial/temporal levels, and dissect the molecular landscape that regulates fibroblast states. Our ultimate goal is to unravel perturbations that can diverge cancer-associated fibroblasts to antigen presenting states. The following questions are at the core of our proposal i) how do diverse fibroblast states emerge and evolve? ii) which gene regulatory networks drive specificity of these states? ii) which are the functional modules that are driven by apFibros and how are they mechanistically explained? iv) how can we transdifferentiate existing fibroblasts to acquire antigen presenting states? v) how can fibroblast reprogramming help overcome immunotherapy resistance? The proposed research should help advance mechanistic concepts in what we term the “adaptive immune mesenchyme”, decode the complexity of peripheral antigen presentation in tumors and beyond and promote targeting of the stroma for immunotherapy.	immunologist, bioinformatician, molecular biologist	tsoumakidou@fleming.gr

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29	Prevention, Diagnosis and Treatment of Human Diseases	Overcoming Resistance to Anti-cancer Drugs by Blocking Mutation-prone DNA Polymerases and the SOS Response	WEIZMANN INSTITUTE OF SCIENCE		cancer, anti-cancer drugs, metastasis, resistance to therapy	Background: A large fraction of cancer patients die because their tumors initially respond to drugs but later they evolve tolerance. Thus, resistance to diverse drugs, along with the soaring costs of new treatments, are emerging as major societal issues of the 2020s. Herein, we explore one of the most distressful examples, tolerance of lung cancer to EGFR-specific tyrosine kinase inhibitors (TKIs). Working hypothesis: In similarity to bacteria exposed to antibiotics, when cancer cells are exposed to TKIs they enlist SOS responses, which activate endogenous mutators. Hence, we will combine the relatively effective but mutagenic TKIs with drugs that disarm the mutators. This scheme will be applied on models of EGFR+ lung cancer, a disease that repeatedly evolves mutations and resistance, but eventually leaves millions of patients with no treatment choices. Specific aims: Our initial studies identified one triad of the SOS system: a sensor of cell death - GAS6, a mediator - AXL, GAS6' receptor, and a mutator - low-fidelity DNA polymerases. Remarkably, blocking AXL using an antibody irreversibly prevented relapses when combined with EGFR inhibitors. Along with establishing this triad, we will employ transcriptomics, protetomics and metabolomics to resolve parallel mutators and sensors. Likewise, we will explore alternative ways to block resistance, for example by directly targeting DNA polymerases, MYC and purine metabolism. Aiming at strategies that minimize SOS enlisting, we will explore the premise of boosting immune destruction of cancer cells. Significance: According to the current status quo, next-generation inhibitors are being applied when resistance emerges. However, this scheme does not cure, only buys time. ResistSOS offers an alternative that might eradicate resistance and cure disease models following treatments that are based on deep understanding and blocking the mutagenic SOS response.		Yosef.yarden@weizmann.ac.il
30	Prevention, Diagnosis and Treatment of Human Diseases	Inclusive Artificial Intelligence for Accessible Medical Imaging Across Resource-Limited Settings	UNIVERSITAT DE BARCELONA	https://aimix-erc.eu/	AI, medical imaging, obstetric medicine, accessible healthcare	Artificial intelligence (AI) is widely regarded as one of the most promising and disruptive technologies for future healthcare. As AI algorithms such as deep neural networks are suited for the processing of large and complex datasets, radiology is the medical speciality that has seen some of the most important applications of AI in the recent years. However, despite these advances, a major limitation of current AI developments in medical imaging is that they have overwhelmingly, and almost entirely, targeted applications in high-income countries. There is a concern, if the current trend continues, that AI will increase the already pronounced inequalities in global health, in particular for resource-limited settings such as rural Africa, where the majority of the African population lives. AIMIX will develop the first scientific framework for inclusive imaging AI in resource-limited settings. The project will greatly advance the current state-of-the-art, from existing AI methods mostly developed for high-income settings, towards new imaging AI algorithms that are fundamentally inclusive, i.e. (1) affordable for resource-limited clinical centres, (2) scalable to under-represented population groups, and (3) accessible to minimally trained clinical workers. Furthermore, AIMIX will investigate the socio-ethical principles and requirements that govern inclusive AI, and examine how they compare, conflict or complement those of trustworthy AI developed thus far in high-income settings. These innovations will be demonstrated for affordable and accessible AI-powered obstetric ultrasound screening by minimally trained clinicians such as midwives in rural Africa. Ultimately, AIMIX's scientific breakthroughs will enhance the democratisation of imaging AI in resource-limited settings, which will result in an important social impact, by empowering local communities, promoting inclusion, and reducing disparities between populations from low- and high-income societies.	AI, medical imaging, obstetric medicine, accessible healthcare	karim.lekadir@ub.edu

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31	Prevention, Diagnosis and Treatment of Human Diseases	Targeting DNA repair pathways, sparking anti cancer immunity	UNIVERSITA DEGLI STUDI DI TORINO			This project will test for the first time the hypothesis that therapeutic inactivation of DNA repair pathways in cancer cells can be exploited for patient benefit by reawakening an anti-tumor immune response. Genomic instability and molecular heterogeneity, which occur in cancer cells with DNA repair deficiencies, fuel tumour progression and are associated with poor outcome. An exception is represented by Mismatch repair (MMR) deficient cancers as these tumours are exceedingly genetically heterogeneous but show favourable prognosis and remarkable response to immunotherapy. The molecular basis for the clinical outcome of MMR deficient cancers has long remained a mystery. Only recently it has become apparent that their biological properties are associated with increased levels of mutations, which unleash adaptive immunity and trigger immunosurveillance. We have reported that when MMR is impaired, cancers cells grow in immune-deficient mice but are unable to do so in immune competent animals. MMR inactivation increased the mutational burden and led to dynamic mutational profiles, resulting in persistent renewal of neoantigens and engagements of antigen-specific T cells. These data suggest an unprecedented high risk-high gain approach: the pharmacological blockade of proteins involved in DNA-repair as an anticancer therapy. This unconventional strategy builds on the concept that the immune system can identify and selectively target tumor cells carrying DNA alterations. Using in vitro and in vivo functional assays we will systematically assess whether and how inactivation of DNA repair genes provokes an immune response and restrict cancer growth. Notably, TARGET will discover and develop inhibitors of MMR and other DNA repair proteins that induce tumor immunity. The identification of DNA repair pathways which, when disabled, reawaken the immune system will provide transformative knowledge and could lead to the development of an entirely new class of anticancer drugs.		alberto.bardelli@unito.it

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32	Prevention, Diagnosis and Treatment of Human Diseases	Deuterium labeling of GLUCOse improves magnetic resonance imaging Sensitivity to CANcer metabolism	MEDIZINISCHE UNIVERSITAET WIEN		magnetic resonance imaging, cancer metabolism, glucose metabolism, deuterium metabolic imaging	The targeted scientific breakthrough of GLUCO-SCAN is the development and clinical evaluation of a disruptive whole-body molecular imaging concept for cancer assessment. The only currently established whole-body molecular imaging device is positron emission tomography (PET). Glucose (Glc)-sensitive PET is widely used in cancer diagnosis and treatment assessment, but has several major limitations: PET involves harmful ionizing radiation, is expensive, not widely available, and cannot differentiate between cancer-specific and normal cellular glucose uptake. These limitations prohibit an even more widespread use of PET, e.g. for screening. We propose a new Magnetic Resonance Imaging (MRI) concept, whole-body deuterium metabolic imaging (DMI) that will overcome these limitations. Deuteration is a simple chemical procedure with which it is possible to artificially label a broad range of molecules with an equally broad range of potential applications, e.g., targeting Glc metabolism in cancer. After ingestion, this labeled Glc is metabolized in cells and the label is transferred to all metabolic products, which can be tracked by DMI. Building on our recent preliminary results in Nature Biomed, we propose a combination of novel MRI hardware, dynamic spectroscopic data sampling, deep learning algorithms, and a clinical validation to answer the following three research questions in a 5-year project: (i) Is DMI a viable alternative for whole-body cancer assessment? (ii) How is DMI positioned compared to Glc-sensitive PET? (iii) Can DMI be performed on widely available MRI systems and simultaneous with standard MRI? GLUCO-SCAN will fill a gap in current medical imaging by offering an alternative for whole-body PET examinations and potentially even for screening of high risk populations. Ultimately, it will pave the way for a new generation of MR scanners with all-in-one whole-body imaging capability that would capture morphologic and molecular information simultaneously.	magnetic resonance imaging	wolfgang.bogner@meduniwien.ac.at
33	Prevention, Diagnosis and Treatment of Human Diseases	Exercised breastmilk: a kick-start for childhood obesity prevention	NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU			Innovative preventive strategies are urgently required to halt the rising prevalence of childhood obesity given the inefficacy of current interventions. Mother-to-child transmission of obesity accounts for a large proportion of childhood obesity, more than what can be explained by genes. Nutrition during the first 3 months of life is crucial, with rapid weight gain in this period associated with subsequent obesity. Breastmilk is considered optimal for infant nutrition, but its composition depends on the mother's metabolic health: the concentrations of some breastmilk compounds linked to infant obesity are associated with maternal body mass index. Maternal lifestyle factors, such as diet, can alter breastmilk composition. Little is, however, known about the effect of exercise during lactation. Exercise is a major regulator of systemic metabolism affecting multiple tissues and organs. In this ambitious, inter-disciplinary project, I will determine how exercise during lactation influences breastmilk composition in women with overweight/obesity and whether exercise-induced changes in breastmilk will influence infant obesity risk. My preliminary data show acute effects of exercise on breastmilk concentrations of adiponectin and lipid metabolites relevant for energy metabolism. In ExMilk, I will determine both acute effects and adaptations after regular exercise on a complex matrix of breastmilk compounds. By linking breastmilk data to comprehensive data for the infants, I will investigate the potential mechanisms underlying the effects of maternal exercise on infant obesity risk, mediated by changes in breastmilk composition. To reach my goals, I will perform gold-standard randomised trials and analyse biological samples from mothers and infants on multi-omics platforms. My experience in metabolomics and exercise intervention trials in reproductive-aged women will enable me to break new ground in understanding how exercise during lactation modifies infant obesity risk.	exercise, milk, obesity, metabolomics, microRNA, extracellular vesicles, hormones	trine.moholdt@ntnu.no

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34	Prevention, Diagnosis and Treatment of Human Diseases	Understanding respiratory tract infections through minimally-invasive, daily nasal sampling in children	ACADEMISCH ZIEKENHUIS LEIDEN	https://aleph.investigativedata.org/entities/eu-cordis-101075118.f8604fe9648f17af72be1a3e0f46a31bff0719aa	Mucosal immunology. Respiratory tract infection. Transmission. Host-pathogen interactions. Pediatrics	Pneumonia is the number one infectious cause of death in children worldwide. Many of the viruses and bacteria that cause pneumonia regularly infect, or colonize, the upper respiratory tract (URT) without causing disease. This drives community transmission but is also an important source of immunity. The processes and key host immune and microbiota factors that determine the infection kinetics, transmission and development of immunity during such infections need elucidation. I have recently optimized minimally-invasive nasal sampling analysis methods using Synthetic Absorptive Matrix (SAM) strips that now allow me to address these knowledge gaps. Through the daily collection of such well-tolerated nasal samples in children, I will study non-pathological, naturally-acquired URT infections, but also controlled infections in an ethical and safe manner using the live attenuated influenza vaccine. In addition, I will perform high frequency nasal sampling in groups of schoolchildren to precisely measure transmission events over time and even infer exposure. Incoming bacteria, viruses and the resident URT microbiome as well as mucosal host innate and adaptive immune responses will be quantified in parallel throughout infections using existing and new high-throughput assays, including an antigen array and microfluidic qPCR for 32 pathogens. Multi-omics integrative time-series analyses and mathematical modelling will be used to identify parameters that are central and predictive for pathogen acquisition, replication and clearance; as well as for transmission and immune boosting. Key novel markers and concepts will be validated using state-of-the-art in vitro mucosal models. The comprehensive and detailed understanding of URT infections obtained in this project can lead to better diagnostics, mucosal targeted therapies and vaccines, and provide a basis for the improved predictions of pathogen spread and public health effects of interventions at the population level.		S.p.jochems@lumc.nl
35	Prevention, Diagnosis and Treatment of Human Diseases	Light-induced synthesis of protein-drug conjugates for imaging and therapy	UNIVERSITAT ZURICH	101001734	Radiochemistry, imaging, theranostics, photochemistry, antibodies	The ability to functionalise a biologically active protein with a range of different cargo molecules is crucial to accessing new tools for use in fundamental science and clinical medicine. For instance, antibody-conjugates that graft reporter molecules including fluorescent tags or radioactive metal ion chelates play vital roles in diagnostic imaging with optical and nuclear medicine techniques like positron emission tomography (PET). State-of-the-art advances in chemotherapy also take advantage of the biophysical properties of antibodies in the design of highly potent antibody-drug conjugates (ADCs) that facilitate specific delivery and uptake of cytotoxic or radiotoxic payloads to disease lesions. Surprisingly, almost all existing methods to produce protein-conjugates rely on thermally-mediated coupling chemistries. In PhotoPHARMA, the goal is to break away from the convention of using heat to drive protein functionalisation by designing new photochemical reagents that are activated by the absorption of light. Light-induced activation has the potential to solve many of the practical issues encountered in the synthesis of radiolabelled antibodies and other protein-conjugates. The work encompasses 4 main Objectives: Objective 1. Explore the biochemical scope of light-induced reactions for bimolecular protein-ligation Objective 2. Synthesis, characterisation and biological studies of photo(radio)labelled antibodies for use in diagnostic imaging and therapy Objective 3. Develop automated technologies for photoradiochemical synthesis of 89Zr-antibodies Objective 4. Establish the GLP-synthesis and Chemistry, Manufacturing and Controls (CMC) for future translation of photoradiolabelled 89Zr-antibodies to the clinic The long-term goals are to facilitate the synthesis and clinical translation of protein-drug conjugates by introducing a radical new technology based on the fast, reliable and automated approach of using light-induced chemistry.		Jason.holland@chem.uzh.ch

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36	Environmental Biology, Ecology and Evolution	A range-wide transplant experiment using participatory science and genomic prediction to assess local adaptation in forest trees	EIDGENOSSISCHE FORSCHUNGSANSTALT WSL	www.mygardenoftrees.eu	local adaptation, plant breeding, climate change, forests, statistical genetics, GxE	How organisms adapt to their environments is the most fundamental question in evolutionary biology and is of utmost importance given climate change threats. Identifying key traits involved in adaptations and understanding how they interact with each other, and with the environment, is a particularly urgent task for foundation and resource-production species, such as forest trees. Existing experiments assessing local adaptation lack scalability and predictability in natural environments, especially at the species range margins. Landscape genomics studies could reveal adaptive loci across environmental gradients, but they are hindered by the assumptions of a neutral model and the highly polygenic nature of most traits. To address these shortcomings, I will conduct a species range-wide transplant experiment using participatory science and genomics to (i) reveal major patterns and drivers of adaptation and (ii) to build a predictive model for selecting optimal seed sources for a given location that accounts for gene-environment interactions and demography. I will develop a participatory network of foresters as well as ordinary citizens, who will establish a large number (>2500) of micro gardens (4 to 36 m2). Seeds source populations of Fagus sylvatica and Abies alba, and their sister species, will be selected from across their ranges. To evaluate plant performance in novel climate conditions, garden locations will also cover locations beyond the species' current distribution range. Early survival and growth traits, which are under the highest selection pressure in trees, will be monitored and analyzed herein. An unprecedented nearly full factorial design transplant data set will be obtained using a genomic prediction (GP) model that exploits the genetic similarity between populations and the environmental similarity between garden locations. Finally, I will implement the GP model for forest managers to aid assisted migration decisions with evoluti	local adaptation, plant breeding, climate change, forests, statistical genetics, GxE	katalin.csillery@wsl.com
37	Environmental Biology, Ecology and Evolution	Proving causality of liquid-liquid phase separation for the acquisition of nuclear-like functions by Giant Viruses Viral Factories	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS			Giant Viruses (GVs) encode thousands of ORFan genes but their study has been nearly impossible due to the lack of genetic tools for reverse genetics. The aims of ViDaMa and the tools I designed will shed light into this Viral protein Dark Matter. Particularly, I will study how new genes from Mimivirus were engineered during evolution to acquire nuclear-like function for their Viral Factories (VFs). VFs physically separate viral DNA replication and transcription from translation and likely segregate DNA into active and silent. How these functions are accomplished remains elusive. I will demonstrate causality of liquid-liquid phase separation (LLPS) for the acquisition of nuclear-like functions of the Viral Factories (VFs) of Mimivirus. To do so, I will: 1) Generate genome-wide loss-of-function screens for the identification of gene function and proteome-wide localization of virtually all Mimivirus and its host Acanthamoeba proteins. 2) Combine biochemistry and cell biology to dissect the nature, functions and components of the VFs of Mimivirus. 3) Strip down VFs to their minimal components in order to utilize them to improve production efficiency and purity of mRNA during in vitro transcription. ViDaMA will empower the GVs scientific community with genome-wide and proteome-wide data of gene function and protein localization. It will transform the field from mostly descriptive to allow the dissection of the molecular mechanisms behind viral phenotypes. ViDaMa will also address the molecular mechanisms that allow the VFs to acquire nuclear-like functions, directly tackling the viral eukaryogenesis theory. The new classification of VFs as membrane-less organelles and the study of the molecular mechanism behind their biogenesis and functions will shed light into general mechanism of LLPS. The generation of in vitro VFs promises an optimization of in vitro transcription systems with tremendous impact on mRNA therapeutics at the development and production level.		hugo.bisio@igs.cnrs-mrs.fr

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38	Environmental Biology, Ecology and Evolution	Forecasting Global Change Impacts On Ecosystems Using a Unified Plant Functional Spectrum	TARTU ULIKOOL			Functional traits of organisms determine their responses to the environment, disturbances, biotic interactions, but also their effects on ecosystem processes. Therefore trait-based approaches can potentially advance our understanding of complex ecological questions. However, straightforward approaches for accurate predictions of community composition and ecosystem functioning from traits are not yet available. Studies have considered different traits, which hampers synthesis, and analytical tools have been limited. Trait-based predictions need a holistic approach incorporating all aspects of the functional structure of plant communities within a unified plant functional space (UPFS) that considers the independent information provided by above- and belowground traits. PLECTRUM takes advantage of the UPFS and provides solutions for three of the most intractable problems for trait-based ecology: (i) the dimensionality of functional variation across ecosystems, (ii) predicting functional structure from environmental variables, and (iii) using this knowledge to forecast the effects of global change on functional structure, ecosystem functioning, and species' extinction risk. I will combine the information from massive datasets of vegetation plots and plant traits with the first global standardized sampling of key above- and belowground traits. I will use this data to quantify functional dimensionality across ecosystems, and estimate the position of thousands of species in the UPFS. Then, I will use species distributions in the UPFS analogous to images and apply deep learning methods to link the functional structure of communities to ecosystem functioning and environmental change. The methodological toolbox developed in the project, combined with the synergy of aboveground and root traits, will allow us to forecast the effects of different global change scenarios on plant communities and their functioning across scales.		perezcarmonacarlos@gmail.com
39	Environmental Biology, Ecology and Evolution	X-chromosome driven speciation through testes-expressed genes: comparative population genomics meets scRNA analysis in primates	AARHUS UNIVERSITET		spermatogenesis, speciation, primates, population genetics, single cell omics, fertility	Primate X chromosomes evolve extraordinary fast and are also tightly associated with the establishment of reproductive barriers between emerging species. The hypothesis of this proposal is that genetic conflicts between the X chromosome and the rest of the genome during spermatogenesis cause rapid X chromosome evolution and build reproductive barriers. Genetic conflicts for transmission to haploid gametes, called meiotic drive, will cause non-adaptive evolution, which is expected to be countered by other genomic elements that will then be under selection. Such an arms race is expected to lead to a very rapid evolution of the X chromosome and a fast accumulation of incompatibilities between isolated populations, leading to speciation. The goal of the project is to identify the underlying mechanisms and the genes responsible for meiotic drive using primates as the study system. A priori candidate processes include X-linked genes under repeated fast evolution with a focus on genes targeted by pachytene piRNAs and on ampliconic genes. Population genomics analysis will generate specific hypotheses that will then be tested by following expression of candidate genes during spermatogenesis through scRNAseq, and validate findings by ultrasensitive, in situ, staining of single transcripts and immunohistochemistry. Finally, the behaviour of key genes and processes will then be investigated in incipient speciation events. Specifically, 850 individuals of 250 species of primates with full genome data will be analysed for candidate genes on the X chromosome. These genes will be investigated in large scale comparative scRNA sequencing analyses of >10,000 individual testicular cells from 14 primate species, including all great ape species, thus allowing expression trajectories through spermatogenesis to be inferred and followed up in functional experiments. The success criterion is to report on primate speciation genes together with their biological mode of action.		mheide@birc.au.dk

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40	Environmental Biology, Ecology and Evolution	Molecular and Genome Evolution of Prokaryotic Plasmids	CHRISTIAN-ALBRECHTS-UNIVERSITAET ZU KIEL	https://www.mikrobio.uni-kiel.de/de/ag-dagan	Plasmid evolution	Plasmids are autonomously replicating extra-chromosomal elements that play a major role in prokaryote ecology and evolution. The study of plasmid evolution has so far focused mostly on their biodiversity and effect on their host ecology and evolution. Nonetheless, the fundamentals of plasmid genome evolution remain to a large extent uncharted territory. Plasmids reside within a host cell that supplies their environmental, energetic and metabolic requirements. Consequently, natural selection operates on plasmids in two hierarchical levels: one component is the plasmid replication and inheritance within the host cell, and the other is the host fitness within the population. Studying the determinants of plasmid evolutionary success thus requires the expansion of classic population genetics theory to populations of plasmids within bacterial cells. The overarching aim of pMolEvol is to create a novel unified framework for plasmid molecular and genome evolution. This includes: 1) to quantify the effect of multilevel drift and selection on plasmid genetic diversity, 2) supply a framework for quantification of plasmid fitness and its effect on plasmid evolution, 3) characterize patterns and rate of plasmid genome evolution. Our conceptual framework will be based on empirical data from plasmid evolution experiments and reconstruction of past events from genomic information. The conceptually novel measures and approaches developed in pMolEvol open up avenues for the extension of classic population genetic theory to prokaryotic organisms. Across all domains of life, genetic information is stored, replicated and translated by similar mechanisms. Focusing on plasmids, we aim to uncover the general principles that govern the evolution of autonomously replicating genetic elements. Our ultimate goal is to describe plasmid evolution from emergence to extinction.	molecular evolution, phylogenetics	tdagan@ifam.uni-kiel.de
41	Environmental Biology, Ecology and Evolution	From wild to crop: unravelling the impact of root domestication on drought tolerance	INSTITUT DE RECERCA I TECNOLOGIA AGROALIMENTARIES		domestication; roots; rhizosphere; drought; soil; crops	Crop domestication revolutionised human life. This process induced changes in plant traits that produced plants that grew faster and generated higher yields. However, remarkably little is known about how plant roots have changed throughout the domestication process. Climate change is causing increasing droughts in many parts of the world. Given that roots are the way that water enters the plant, they are key for understanding drought tolerance. Root traits from crop ancestors could offer a route to increasing drought tolerance of modern crops. To do this, we need to focus our efforts on the impact of domestication on roots and the rhizosphere (the zone around the root including microbes), rather than only aboveground traits as traditionally done. WILD-ROOTS will therefore test the overall hypothesis that crop domestication led to changes in root and rhizosphere traits which decreased the drought tolerance of crops compared to their wild relatives. WILD-ROOTS will make a holistic study of the roots and rhizospheres of a wide range of crops from diverse origins. There will be a focus on root exudation and volatile organic compound (VOC) emission, which are vital root processes that are crucial for many types of interactions with plants, animals, microbes and the soil itself. Changes in root exudates and VOCs have been observed during drought conditions, but their roles in the drought tolerance of plants remains unclear. WILD-ROOTS will (1) evaluate domestication effects on the roots and rhizosphere, then (2) elucidate the mechanisms relating belowground traits to drought tolerance, and finally (3) use this knowledge to modernise crop models and identify belowground traits to be exploited for drought-proofing current crops. The results will reshape our fundamental knowledge of both the crop domestication process and how root exudation influences drought tolerance, as well as offering new approaches to boost the food security of current and future agricultural systems.		catherine.preece09@gmail.com

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42	Environmental Biology, Ecology and Evolution	Environmental thresholds for drought- and heat-related tree mortality	ITA-SUOMEN YLIOPISTO	www.geho.fi	tree mortality, forest disturbances, remote sensing, computer vision, deep learning	One of the most pressing ecological questions is how trees and forests can survive in increasing intensity and frequency of droughts and extreme heat. Wide-spread drought-related tree mortality has been witnessed globally over the last decade and in 2022, Europe suffered from the worst drought in 500 years. Understanding and predicting the impact of drought and heat on tree mortality is limited due to lack of knowledge on the environmental conditions that lead to tree mortality. For the first time, it is feasible to quantify spatial and temporal tree mortality patterns and capture tree structure and species over large geographic regions at the individual tree-level. This enables me to aim to uncover environmental thresholds and key environmental drivers of drought- and heat-related tree mortality at the species-level for various forest biomes. Use of state-of-the-art remote sensing and deep learning methods allows me to capture where, when and what kind of trees (species, structure) have died for tens of millions of trees to increase our understanding of spatial and temporal tree mortality patterns. My approach uses laser scanning data to provide detailed tree 3D characterization and calculation of tree position within tree community (competition) and the landscape (water availability, microclimate). Then, combining these variables with information on tree xylem vulnerability, pest insects, soil temperature and climate, we can ultimately reveal species-specific environmental thresholds and key drivers of drought- and heat-related tree mortality. This research will open new horizons, bringing ecophysiology, remote sensing, forest ecology and entomology together, and developing methods to quantify drivers of tree mortality in much greater depth than has been possible to date. From these findings, we will be able to inform forest managers and policy makers which forests are at risk for increasing the resilience of future forests.	GIS, remote sensing, computer science, forest ecology, forest entomology, ecophysiology	samuli.junttila@uef.fi
43	Environmental Biology, Ecology and Evolution	Revealing the ancient plant ethylene biosynthesis and ACC signaling pathway	KATHOLIEKE UNIVERSITEIT LEUVEN		Ethylene, plants, evolution, marchantia	When ancestral plants colonized the land 450 million years ago, they needed to adapt to harsh environmental conditions when giving up their aquatic lifestyle. I hypothesize that during this water-to-land transition, the volatile plant hormone ethylene became an important growth regulator to face terrestrial stressors. In fact, modern-day crops use ethylene to regulate stress responses, and perhaps ethylene served this role in pioneering land plants to cope with the harsh conditions coinciding with this habitat transition. During my postdoc, I showed that ethylene signaling was functionally assembled in ancestral Charophyte green algae, prior to land colonization. Now I question why and how early land plants produced ethylene. While seed plants make ethylene using ACC as precursor, non-seed plants follow a different, yet unknown ethylene biosynthesis pathway, which I want to reveal using the liverwort Marchantia polymorpha, a model species representing early life on earth. I also question why non-seed plants make ACC, but not use it for ethylene synthesis. Recent studies revealed that ACC itself can act as a signaling molecule, independent from ethylene, by an unknown signaling pathway to regulate plant development. I also postulate that both the alternative ethylene biosynthesis and ACC signaling pathway might have an origin in ancient algae, prior to land colonization, and might be conserved in seed plants, possibly exerting important functions yet to be uncovered. Using functional genetics in representative species of algae and crops, ETHYLUTION will unravel the importance and role of ACC and ethylene that allowed plants to thrive on earth, perhaps one of the most impactful events in the evolutionary history of plants.	Plant biologist, molecular biologist, evolutionary biologist	bram.vandepoel@kuleuven.be

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44	Environmental Biology, Ecology and Evolution	Melding behavioural ecology and biomaterials research to track the evolution of mechanical super-performance of spider silk composites	UNIVERSITAET GREIFSWALD	https://zoologie.uni-greifswald.de/struktur/abteilungen/erc-junior-research-group-evolutionary-biomechanics/	spider silk; evolutionary biomechanics; biological materials; behavioural ecology; comparative morphology; fibre composite	Many organisms assemble biological materials into architectures and tools that add and extend biological functions - with profound ecological effects, and inspiring human technologies. However, there is no general concept of how evolutionary bio-material innovation arises from both the physiological and the behavioural recombination of compounds. SuPerSilk aims to understand how mechanical super-performance evolves by disentangling the concerted effects of both physiological and behavioural factors on structure-function relationships, utilizing spiders and their silk products as a model system. Specifically, SuPerSilk will (1) determine if the diversification into different types of silk glands facilitated the evolvability of spider silk performance, (2) test if the behavioural combination of different spider silks into compound threads provides a fast track for the evolution of thread performance and an extension of performance limits, (3) test whether similar thread functions evolved via repeated or alternative pathways, and (4) establish a roadmap for the targeted bioprospecting of silk compounds with specific properties. Being the first project that will jointly track the evolution of base materials and their behaviourally assembled compound products, SuPerSilk will address a timely question in evolutionary biology: if and how the evolvability of physical traits can be modified by the evolution of novel behaviours and vice versa. The outcome will be a precedent for the integrative study of animal products that will establish a new line of research: evolutionary materials. In addition, by probing the structure-function relationship of behaviourally assembled silk composites, SuPerSilk will reinvigorate efforts to develop super-tough biofibres for industrial applications, a field that has stagnated in recent years, and enable the engineering of bio-fabrics with tailorable properties.	silk; biological materials; polymer; fibre composite; biomechanics ; zoology	j.wolff@uni-greifswald.de
45	Environmental Biology, Ecology and Evolution	Real-time (co)evolution in a multitrophic community under current and future climates	JOHANNES GUTENBERG-UNIVERSITAT MAINZ		experimental evolution, community ecology, aquatic community, plant biotic interactions, evolutionary genetics	In nature, organisms live in communities and form complex trophic interactions. Understanding how multitrophic communities evolve and respond to environmental changes is a fundamental and pressing challenge in face of global change. While research in evolutionary biology revealed that a warming climate can drive adaptive evolution of individual organisms in the community, studies from community ecology showed that a warming climate can alter trophic interactions and community structure, which in turn changes the (co)evolutionary trajectory of interacting species. Thus, integrating evolutionary and ecological responses is crucial to understand the climate responses of individual species and communities. However, methodological challenges have hampered empirical studies until now. EvolCommunity will address these challenges by experimentally evolving populations of three interacting species (aphid, duckweed, and daphnia) in their native communities using outdoor mesocosms with different climate conditions. We will quantify how warming shapes the function and evolution of the multitrophic community in real-time. By manipulating climate-driven plant evolution, we will determine whether plant evolution alters the community's response to climate change. We will also assess whether the interacting species coevolve in the community by quantifying the reciprocal selection imposed from their evolutionary changes. We will investigate the molecular mechanisms underlying (co)evolution using state-of-the-art genetic tools. Using a combination of experimental evolution, community manipulation, and cutting-edge genetic and analytic tools, EvolCommunity will push the research boundaries of evolutionary ecology by revealing the mechanisms and processes of community evolution at work. The outcomes will open new research avenues in evolutionary ecology by establishing a new methodological framework that integrates evolutionary biology and community ecology in natural communities.	Evolutionary genetics, plant-environment interactions, experimental evolution, synthetic biology, community ecology, chemical ecology	shuqing.xu@uni-mainz.de

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46	Environmental Biology, Ecology and Evolution	Elemental Ecology: towards an element-based functional ecology	CENTRO DE INVESTIGACION ECOLOGICA Y APLICACIONES FORESTALES	https://stoikos.creaf.cat/	elements, nutrients, ecosystem functioning, biodiversity	Life on Earth, as we have known it for millennia, is at stake. Human activities are putting all kinds of ecosystems under increased stress because of land-use change and the alteration of the biogeochemical cycles of nitrogen (N), phosphorus (P) and carbon (C), thus inducing climate warming. Functionally diverse ecosystems are more productive and stable than less diverse ones, and biogeochemical changes affect both biodiversity and the elemental composition of organisms (their elementome), changing how they and their ecosystems function. It is, therefore, imperative to provide evidence about how the interactions between elementomes, biodiversity, and climate drive ecosystem functioning if we are to avoid the serious threat of reducing essential resources for life within the context of global change. STOIKOS will achieve an in-depth understanding of the interaction between elementomes and biodiversity in determining ecosystem functioning by introducing the concept of elemental diversity, and moving functional ecology from using functional traits to elementomes, an easy and universal way to compare all sort of organisms. STOIKOS will particularly test the hypothesis that community-weighted elementomes and elemental diversity explain ecosystem functioning better than functional traits and their diversity. STOIKOS will integrate data from observations (field campaigns), long-term monitoring sites, microcosm experiments and theoretical modelling to provide synergies amongst their outputs to build the foundations of an elemental-based ecology. This will allow STOIKOS' hypotheses to be tested at the individual, species and community/ecosystem scales using new and game-changing methodologies and study systems. The cutting-edge science of STOIKOS will not only provide the foundations of an elemental-based ecology, but will also deliver new ecological theory and methodological tools that will help us predict the future of ecosystems and assess the fragility of our biosphere.	data analysis, community ecologist, modeller, biogeochemical cycles	m.fernandez@creaf.uab.cat
47	Environmental Biology, Ecology and Evolution	NEutRally buoyant ParticlEs In the DEep Sea: turnover, origin and global impact on the marine carbon cycle	UNIVERSITAT WIEN		microbial oceanography, microbes, deep sea	Export of organic matter produced in the sunlit surface waters into the ocean's interior removes about one third of the anthropogenically produced carbon dioxide. The amount of organic matter sinking into the deep ocean, however, is not sufficient to support the carbon demand of the heterotrophic food web in the ocean's interior as revealed by several studies. Consequently, the oceanic carbon budget cannot be closed. Recently, we identified a hitherto unrecognised non-sinking, non-living particulate organic matter (POM) pool in the dark ocean with rather stable concentrations throughout the water column. This particle pool has not yet been considered in the deep-sea carbon budgets. Its origin and fate remain enigmatic as well as its nutritional role for the deep-sea biota. We aim at deciphering the compositional differences between the sinking and non-sinking detrital POM and compare their properties with that of the dissolved organic matter using state-of-the-art methods including proteomics. Specific focus will also be put on the composition and activity of the particle-associated biota in the ocean's interior. We will analyse, for the first time ever, the composition of the biota and the biogeochemistry of these two classes of detrital particles in the deep North Atlantic. The results of NEREIDES will help elucidating the origin and fate of these enigmatic suspended particles and allow testing a major unresolved aspect in deep-sea biogeochemistry, i.e., whether these suspended particles provide the missing carbon to resolve the current mismatch in our measurements between organic carbon supply and demand of the heterotrophic deep-sea biota. The obtained results will form the base to model the dynamics of the non-sinking particles in the ocean on a global scale. Thus, NEREIDES will fill a major knowledge gap in the oceanic carbon cycling.	particle flux, biological pump, omics, microbes	gerhard.herndl@univie.ac.at

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48	Biotechnology and Biosystems Engineering	Discovering the developmental transition of cortical parenchyma cells into different cell fates	LEIBNIZ - INSTITUT FUER PFLANZENGENETIK UND KULTURPFLANZENFORSCHUNG		Root biology, anatomy, rhizosphere, abiotic stress, microbiome, microscopy, phenotyping, functional-structural plant modeling	The root cortex is a primary ground tissue of the root organ and plays an important and adaptive role in plant growth and function. Root cortical parenchyma, thin-walled cells in the cortex, have great potential to change both in structure and function during plant development, even after cell differentiation. Root cortical cells can have many different post-differentiation fates that form different cortical tissues (e.g. aerenchyma, exodermis) in succession, or even simultaneously through the deposition or degradation of lignin and suberin and programmed cell death. The formation of these different cortical tissues have the potential to influence stress adaptation and plant performance, for example by altering the radial movement of water and solutes, the metabolic efficiency required for nutrient exploitation, and the synthesis and deposition of exudates. I will investigate the developmental transition of cortical cells into different cell fates and the extent to which root cortical parenchyma have different cell fate trajectories to form simultaneous or successive cortical tissues. I will discover the potential of tissues for synergistic interactions to capture soil resources and modify of rhizosphere properties, and the genes that control these processes at a single-cell resolution to discover when and where signals occur in the cortex. I will use a combination of breakthrough technologies and interdisciplinary expertise including state-of-the-art imaging, analytical chemistry, microbial ecology, and cutting-edge molecular biology methods to tackle the fundamental questions of how and why root cortical parenchyma have different post-differentiation cell fates. FATE will enable us to engineer crop roots to optimize soil foraging and resource capture. The payoffs of this project will be significant for European agriculture, as nutrient limitation is a primary constraint on crop growth and will become an increasing challenge due to climate change.		schneiderh@ipk-gatersleben.de
49	Biotechnology and Biosystems Engineering	Harvesting Light for Life: Green Proteins as the Interface between Sun Energy and Biosphere	UNIVERSITA DEGLI STUDI DI VERONA	https://www.grinsun.it/	photosynthesis, chlorophyll binding proteins, light harvesting, spectral tuning	Life on earth feeds on photons. Photosynthesis in green algae and land plants has been the world's most successful biological process and has conquered the most diverse environments. Photosynthetic reaction centres are extremely well conserved, an unlikely basis for the ability to adapt. Antenna systems are widely diversified and yet only the Light-Harvesting Complexes (LHCs) have been selected for growth in the land environment. The distinctive property of GreenCut organisms lies in their light-harvesting mechanisms, which ensure efficient photon harvesting and photoprotection. Despite being the most abundant membrane proteins on earth, binding most of chlorophyll that makes the planet green, the secrets of LHCs are still concealed because we lack experimental systems that make possible the reverse and forward genetic analysis of LHCII proteins. Indeed, the clustered-genes encoding LHCII has resisted targeting by classic genetics. I propose an in-depth analysis of LHCII proteins in algae and plants by deploying a new technology that we have developed with our experience in studying LHCs. Firstly, we deleted all genes-encoding LHCII in model species of both land plants and green algae by genome editing and complemented plant ΔLHCII lines with site-directed, mutated sequences, demonstrating that reverse genetics can reveal the domains involved in the regulation of photon harvesting, photoprotection and growth. Secondly, forward genetics, on the other hand, will enable the identification of protein determinants by selecting specific phenotypes on complementing mixotrophic algal ΔLHCII lines with randomly mutagenized sequences. This will lead to a map of structures and functions that identifies the specific biological role of each component of the antenna system in vivo and in vitro. The project's outcome will be the ability to design in a rational way the light-harvesting systems of plants and algae in the context of sustainable agriculture and bio-industry.	biophysics, energy transfer, fast spectroscopy, optical methods	roberto.bassi@univr.it

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50	Biotechnology and Biosystems Engineering	RNA-based gene writing in human cells	UNIVERSIDAD POMPEU FABRA			CRISPR development has enormously accelerated genetic engineering principles, and precise methods to modify small alleles (such as base or prime editing) are now available. However, generating large genomic changes still presents enormous challenges. Large modifications, such as gene transfers, are performed generally with viral vectors, which have been associated with toxicities in the clinic, and often lack versatility needed for basic science experimentation. Newer CRISPR-based techniques for gene transfer suffer from significant efficacy and safety problems when used for large message writing. The overall goal of SCRIBE is to create new strategies for gene writing and define their molecular principles. These new writers will use RNA to both encode and transfer the message. The SCRIBE strategies will take advantage of the retrotransposon capacity for writing genes from RNA, and the precision of CRISPR in addressing specific sites of the genome. Thus, the “find” function will be dominated by CRISPR components, and “copy-paste” activity will be executed by retroelement components. To develop and optimize such a technology, we will use evolutionary analysis to select those retroelements with the highest activity and orthogonality, and modulate their message writing capacity by engineering their components. We will test various CRISPR and retrotransposon combinations, and adapt both of them to converge into a unified molecular machine. We will use artificial intelligence applied to protein design and a novel concept of synthetically oriented evolution to accelerate emergence of the new function. Finally, we will deploy new gene writing principles for RNA-based in vivo gene delivery. In sum, we will develop a new family of tools for engineering life. The real breakthrough will be the establishment of gene writing as a simple and general method for both research advancement and applied purposes.	AI, synthetic evolution, gene writing, RNA, retroelements, synthetic biology	marc.guell@upf.edu
51	Biotechnology and Biosystems Engineering	Engineering homeostasis into living materials	INM - LEIBNIZ-INSTITUT FUER NEUE MATERIALIEN GEMEINNUETZIGE GMBH		Synthetic Biology, Engineered Living Materials, Optogenetics	Engineered Living Materials (ELMs) are dynamically emerging at the intersection of synthetic biology and materials sciences and are providing solutions in a rapidly growing number of application fields. Current areas of application comprise, for example, biomedicine, textiles, sensors, soft robotics, electronics, or construction materials. From a conceptual point of view, ELMs provide the opportunity of endowing materials with properties and functions long sought for in materials sciences, such as adaptivity and interactivity, evolvability, hierarchical design, self-reproduction, energy harvesting from the environment, synthesis from renewable resources, as well as biodegradability. Despite intensive research, however, a key defining property of life is largely missing in ELMs, that is homeostasis. Homeostasis is the ability of a system to maintain an inner steady state despite external fluctuations that impact this state. For example, mammals maintain a constant body temperature despite varying external temperatures. In STEADY, we will develop and test the concept of engineering homeostasis into living materials. To this aim, we will develop three genetically encoded modules, (i) a sensor to sense the actual state of a specific mechanical property of the material, (ii) a controller to process the sensor signal, and (iii) an actuator, that, based on the controller’s output, steers the material towards the setpoint. The design of the homeostatic system will be highly modular, so that the sensor and actuator can be adapted in order to maintain homeostasis for other properties or functions of the material. The tools developed here are not restricted to ELMs but may also be used to confer homeostasis to polymer-based soft materials with regard to maintaining a desired feature. Thus, STEADY will open novel opportunities for engineering materials to be robust and resilient to changing environmental conditions.		Wilfried.weber@leibniz-inm.de

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52	Biotechnology and Biosystems Engineering	Practical oxyfunctionalisation biocatalysts by engineering monooxygenases into peroxyzymes.	TECHNISCHE UNIVERSITEIT DELFT			Chemistry is far away from being a mature science: many desirable transformations are still out of scope. One important example is the selective (oxy)functionalisation of non-activated C-H bonds, which still represents a dream reaction of organic chemistry. This is because balancing high reactivity (needed for the activation of inert C-H bonds) with selectivity is difficult to achieve. Enzymes, specifically monooxygenases, are catalysts that principally solve this challenge. Monooxygenases, however, are not practical catalysts for organic chemistry. This is because they have evolved to enable the survival of their host organisms and not to suit the needs of organic chemists. In particular the complex molecular architecture of monooxygenases (necessitating O2, stoichiometric reductants and additional catalytic components) together with mechanistic challenges arising from their complex molecular architecture impede their chemistry-wide application. PeroxyZyme aims at solving these issues and establish evolved monooxygenases (peroxyzymes) as practical catalysts for organic chemistry. Peroxyzymes will be able to function with simple hydrogen peroxide rather than via the natural, albeit complex and vulnerable electron transport chains. This fundamental change in the monooxygenases' catalytic mechanisms will be achieved by a mechanism-driven and experimentally validated semi-rational engineering approach. Evolved peroxyzymes will be characterised using up-to date (ultra)fast spectroscopy identifying catalytic bottlenecks and possible inactivation mechanisms. This molecular understanding will provide the basis for further improvement of first generation peroxyzymes. The practical usefulness of evolved peroxyzymes will be demonstrated on preparative-scale by using them in non-aqueous reaction media enabling high product concentrations and space-time yields.		f.hollmann@tudelft.nl
53	Biotechnology and Biosystems Engineering	Reversible and irreversible cardiac electroporation: Establishing the fundamentals to advance cardiac treatments	UNIVERZA V LJUBLJANI			Cardiovascular diseases are the No. 1 healthcare challenge in the world, among which ischemic heart disease and atrial fibrillation are the most prevalent. Better treatment strategies are greatly needed to reduce the medical, economic, and social burden of these conditions. Electroporation (application of intense pulsed electric field) is showing tremendous potential for treatment of atrial fibrillation, enabling a safer and shorter treatment procedure compared with existing thermal ablation approaches. Moreover, recent pioneering studies provide evidence that electroporation can also be used as a nonviral vector for intracellular delivery of therapeutic nucleic acids that promote cardiac regeneration, potentially offering a way to cure the so-far incurable ischemic heart disease. For treatment of atrial fibrillation, electroporation must be irreversible, resulting in the death of cardiac muscle cells, to locally destroy (ablate) the arrhythmogenic cardiac tissue. Conversely, for treatment of ischemic heart disease electroporation must be reversible, meaning that the pulsed electric field transiently enhances cellular uptake of nucleic acids while the cells are able to survive and express the delivered transgene(s). Due to a lack of fundamental understanding of cardiac electroporation, there are currently no reliable methods able to ensure electroporation (ir)reversibility and the desired treatment outcome. This project is designed to decipher the biophysical mechanisms of cardiac electroporation at the molecular, cellular and tissue level as to develop methodologies that will enable optimal implementation of both irreversible and reversible electroporation. By combining bottom-up experiments in primary cardiac cells and tissue slices with computational modeling and advanced data analysis I will create the foundations needed to streamline further (pre)clinical research and realize the potential of electroporation to advance cardiac treatments.		lea.rems@fe.uni-lj.si

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54	Biotechnology and Biosystems Engineering	Targeting skin glycosylation patterns to protect threatened salamanders from disease driven extinction	UNIVERSITEIT GENT	https://glossiproject.wixsite.com/my-site	amphibian - chytridiomycosis - skin glycosylation	Disease driven amphibian declines are frequently compared to the extinction of dinosaurs and have become an icon of the global biodiversity crisis. The deadly skin disease chytridiomycosis is causing the greatest recorded loss of biodiversity attributable to a disease. The recently introduced chytrid fungus Batrachochytrium salamandrivorans (Bsal) is expanding its range in Europe, remains unmitigated and thus poses an imminent threat to western Palearctic urodele (= salamanders and newts) diversity. While hypersusceptible species invariably die after exposure, other species show a much more variable, individual and dose dependent response, ranging from self-limiting infections with self-cure to lethal disease. My group recently discovered that host susceptibility correlates with the skin glycosylation pattern of salamanders, with cutaneous galactose content predicting variation in intensity of Bsal colonization. The variability of the skin glycosylation pattern offers a unique opportunity for marker directed selection of disease resistant salamanders. The overarching hypothesis of GLOSSI (Glycosylation in Salamander Skin Infection) is that variability of hereditary glycosylation patterns in the salamander skin underpins differential Bsal colonization and allows the selection of colonization resistant host lineages. To study the contribution of skin glycosylation patterns towards the development of salamander resistance against the Bsal epidemic, GLOSSI will combine laboratory and field trials to study 1) the temporal dynamics and heritability of glycosylation patterns and associated susceptibility to Bsal infection in urodeles, 2) the potential of natural selection towards increased resistance in infected, natural urodele populations and its impact on population dynamics, 3) the host genetics that underpin the epidermal glycosylation pattern and implications for disease resistance. GLOSSI will lead to novel strategies for curbing disease driven loss of biodiversity.		an.martel@ugent.Be
55	Mathematics	Computational Hardness Of RepresentAtion Learning	UNITED NATIONS EDUCATIONAL SCIENTIFIC AND CULTURAL ORGANIZATION	https://sites.google.com/view/choral-ictp/home?authuser=0	high-dimensional statistics; neural networks; inference; spin glasses; random matrix theory; information theory; theory of machine learning; computational gaps;	Rich internal representations of complex data are crucial to the predictive power of neural networks. Unfortunately, current statistical analyses are restricted to over-simplified networks, whose representations (i.e., weight matrices) are either random, and/or project the data in comparatively very large or very low dimensional spaces; in many applications the situation is very different. The modelisation of realistic data is another issue. There is an urgent need to reconcile theory and practice. Based on a synergy of the mathematical physics of spin glasses, matrix-models from physics, and information and random matrix theory, CHORAL's statistical framework will delimit computational gaps in the learning, from structured data, of much more realistic models of neural networks. These gaps will quantify the discrepancy between: (i) the statistical cost of learning good representations, i.e., the minimal amount of training data required to reach a satisfactory predictive performance; (ii) the cost of efficiency, i.e., the amount of data needed when learning using tractable algorithms, such as approximate message-passing and noisy gradient descents. Comparing these costs will quantify when learning is computationally hard or not. To achieve this, CHORAL will first focus on dictionary learning, another essential task of representation learning, and then move on to multi-layer neural networks, which can be thought of as concatenated dictionary learning problems. CHORAL's ambitious program, by defining benchmarks for algorithms used in virtually all fields of science and technology will have a direct practical impact. Equally important will be its conceptual impact: the study of information processing systems has become a major source of inspiration for mathematics.		jbarbier@ictp.it

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56	Mathematics	Control for Deep and Federated Learning	FRIEDRICH-ALEXANDER-UNIVERSITAET ERLANGEN-NUERNBERG	https://dcn.nat.fau.eu/codefel	Applied Mathematics, Machine Learning	Machine Learning (ML) is forging a new era in Applied Mathematics (AM), leading to innovative and powerful methods. But the need for theoretical guarantees generates challenging, fundamental, deep mathematical questions. This great challenge can be addressed from the perspective of other, more mature areas of AM. CoDeFeL seeks to do so from the rich interface between Control Theory (CT) and ML, contributing to the analytical foundations of ML methods, significantly enlarging, and updating the range of applications of CT. As our recent results show, classification, regression, and prediction problems in Supervised Learning (SL) and the Universal Approximation Theorem can be successfully recast as the simultaneous or ensemble controllability property of Residual Neural Networks (ResNets). Following this path, we will develop ResNets of minimal complexity and cost, addressing the deep, intricate issue of linking the structure of the data set to be classified with the dynamics of the networks trained. Taking the turnpike principle as our inspiration, we will build new simplified ResNet architectures. This, however, raises major challenges for the genuinely nonlinear dynamics that ResNets represent.Adjoint methods will also be developed and applied, to understand the sensitivity of ResNets, and proposing techniques for Adversarial Training and computing Saliency Maps, applicable in Unsupervised Learning. The project is strongly inspired on the challenges arising in relevant applications in digital medicine and internet recommendation systems, among other areas. Accordingly, we will also develop a body of rich, hybrid, cutting-edge methods for data-aware modelling, combining ResNet surrogate models and those inspired on Mechanics, with the aid of Model Predictive Control strategies. New Federated Learning methodologies with privacy preservation guarantees will also be developed. The computational counterparts will be brought together in a new CoDeFeL GitHub repository.	Interface Machine Learning / Control Theory, Mathematical foundations of Machine Learning	enrique.zuazua@fau.de, enrique.zuazua@deusto.es

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57	Mathematics	Sample complexity for inverse problems in PDE	UNIVERSITA DEGLI STUDI DI GENOVA		inverse problems	This project will develop a mathematical theory of sample complexity, i.e. of finite measurements, for inverse problems in partial differential equations (PDE). Inverse problems are ubiquitous in science and engineering, and appear when a quantity has to be reconstructed from indirect measurements. Whenever physics plays a crucial role in the description of an inverse problem, the mathematical model is based on a PDE. Many imaging modalities belong to this category, including ultrasonography, electrical impedance tomography and photoacoustic tomography. Many different PDE appear, depending on the physical domain. Currently, there is a substantial gap between theory and practice: all theoretical results require infinitely many measurements, while in all applied studies and practical implementations, only a finite number of measurements are taken. We argue that this gap is crucial, since the number of measurements is usually not very large, and has important consequences, regarding the choice of measurements, the priors on the unknown and the reconstruction algorithms. Many safe and effective modalities have had very limited use due to low reconstruction quality. Within a multidisciplinary approach, by combining methods from PDE theory, numerical analysis, signal processing, compressed sensing and machine learning, we will bridge this gap by developing a theory of sample complexity for inverse problems in PDE. This will allow for the deriving of a new mathematical theory of inverse problems for PDE under realistic assumptions, which will impact the implementation of many modalities, guiding the choice of priors and measurements. Consequently, emerging imaging modalities will become closer to actual usage. As a by-product, we will also derive new compressed sensing results which are valid for a general class of problems, including nonlinear and ill-posed, and sparsity constraints. Collaborations with experts in the relevant fields will ensure the project's success.		giovanni.alberti@unige.it
58	Mathematics	Finite and Descriptive Combinatorics	THE UNIVERSITY OF WARWICK	https://warwick.ac.uk/fac/sci/maths/research/grants/mc	limits of discrete structures, Borel and measurable combinatorics, extremal and probabilist combinatorics	This project will explore emerging deep connections and build new bridges between some areas that study finite combinatorial structures (such as extremal and probabilistic combinatorics, distributed algorithms, etc) and those that study analytic objects (such as the limit theory of discrete structures, descriptive set theory, measured group theory, random processes on infinite graphs, statistical physics, etc), with applications going both ways. One part of this project is to apply combinatorial methods in search of constructive answers to analytic problems whose currently known solutions rely on the Axiom of Choice. One such direction is to investigate a possible transference principle that allows to turn some existence results for finite graphs obtained via the very powerful occupancy method into measurable solutions of the corresponding problems of descriptive combinatorics. Similarly, the project will explore promising connections between descriptive set theory, efficient distributed algorithms, invariant random processes on infinite vertex-transitive graphs, etc. Some problems that the project will investigate from this point of view are the Spectral Gap Conjecture, Mycielski's divisibility problem, and the existence of measurable graph factors and colourings. Also, various important unsolved problems of extremal combinatorics will be approached via the limits of discrete structures (which are analytic objects that encode large-scale properties). In addition to using some established techniques (such as flag algebras and the stability method), the project will look for novel ways of applying the analytic aspects of limit objects that have a great potential in this respect. New software for general-purpose flag algebra calculations will be written and made freely available. The project will also study some general fundamental questions about graph limits (such as approximability by finite graphs, identification using partial subgraph counts, etc).	limits of discrete structures, Borel and measurable combinatorics	o.pikhurko@warwick.ac.uk

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59	Mathematics	Statistical theory and methodology for the combination of heterogeneous and distributed data	UNIVERSITY OF WARWICK		Statistical theory; semi-supervised learning; data fusion; differential privacy; partial identification; efficient estimation	Data is now collected at unprecedented scales across many industries, meaning that there is huge potential for evidence-based advances in science, technology and public policy. However, to harness this potential we must navigate repositories that are often a far cry from the idealised datasets, carefully collected and curated under perfect conditions, that are usually imagined when new statistical methodology is introduced. Data are often gathered quickly and cheaply, patched together from multiple locations, with limited regard to enforcing experimental standards. We may have the large sample sizes we desire, but there will be missing values, misaligned datasets, contamination and, depending on the sector, there may be noise added purposefully to satisfy individuals' and regulatory bodies' privacy concerns. We propose to address such difficulties through the development of new statistical methodology and theoretical frameworks that explicitly incorporate various forms of data heterogeneity and measurement error. This will be divided into four main areas: 1. Accounting for sampling bias when a complete dataset is complemented by additional incomplete datasets. This will be studied through the lens of semiparametric theory for functional estimation. 2. Combining two or more datasets that record overlapping but distinct sets of variables, where few or no complete records of all variables are available. These file matching problems will be studied using new developments in statistical optimal transport. 3. Examining the effect of the violation of missing data assumptions. Here we will introduce techniques from robust statistics to mitigate the error due to misspecifying assumptions about sampling bias. 4. Securing individuals' private data through the intentional use of noisy measurement. Here we contribute to the growing field of differential privacy, specifically the user-level local variant, where distributed batches of observations are privatised simultaneously.		tom.berrett@warwick.ac.uk
60	Mathematics	Assumption-Lean (Causal) Modelling and Estimation: A Paradigm Shift from Traditional Statistical Modelling	UNIVERSITEIT GENT	https://users.ugent.be/~svsteela/	debiased machine learning; causal inference; nonparametric statistics	I propose a cutting-edge and transformative paradigm for statistical modelling that is crucial to enhance the quality of data analyses. Leveraging my expertise in causal inference and semiparametric statistics, I will establish the fundamental principles of a comprehensive estimation theory, which maps model parameters onto generic, interpretable, model-free estimands (e.g., association or effect measures) with favourable efficiency bound, and harnesses the power of debiased (statistical/machine) learning techniques to estimate these. My core objective is to develop a flexible and accessible data modelling framework, called ‘assumption-lean modelling’. This framework will deliver minimal bias and maximal interpretability, even in the presence of model misspecification, along with honest confidence bounds that account for model uncertainty. Debiased learning is at the core of this research. While gaining popularity, a rigorous scientific optimality theory is lacking. I shall draw on my expertise in (bias-reduced) double robust estimation to develop optimal debiased learning estimators. These utilize learners that optimize strategically chosen loss functions to achieve low variance and high stability, along with confidence intervals that are valid under weak conditions on the learners. I will connect to timely, exciting developments in statistics, such as debiased learning of function-valued parameters and the construction of confidence bounds for such parameters. I will offer novel avenues into these problems by incorporating the assumption-lean modelling principles and connecting to real-world needs. I will develop assumption-lean modelling strategies to tackle significant challenges in causal modelling, including target trial emulation, causal mediation analysis, and statistical modelling of dependent outcomes. I will deliver methods with potential impact on all empirical sciences, as well as on the foundations of the discipline of statistical modelling.	mathematical statistics; biostatistics; statistical learning	Stijn.Vansteelandt@ugent.be

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61	Fundamental Constituents of Matter	Supersolids: unveiling an extraordinary quantum phase of matter	UNIVERSITA DEGLI STUDI DI FIRENZE		superfluids, quantum gases, supersolids, quantum phase transitions	Supersolids are a paradoxical quantum phase of matter that combines the properties of superfluids and crystals, searched for long time in quantum solids and many other systems. Recently, we discovered a novel cluster phase in a quantum gas of magnetic atoms which realizes a supersolid. However, the limited size, the inhomogeneity, and the lack of appropriate detection methods have allowed so far to assess only very basic properties of supersolids. Here I propose an innovative density-phase microscope and original ideas that combine the best of matter-wave and condensed-matter methods to unveil the extraordinary properties of supersolids. With a two-layer superfluid-supersolid configuration we will measure both density and phase of the supersolid. With controllable optical potentials we will realize large, homogeneous crystal geometries in 1D and 2D. With high-resolution optical addressing we will manipulate locally the wavefunction, e. g. creating phase patterns or force fields, and we will follow the local dynamics. Our main goal is to explore fundamental properties that are largely unknown even theoretically: variable superfluid density under rotation; variable angular momentum of quantized vortices; dissipation-less deformation of the crystal; Josephson effect without barriers; quantum entanglement properties. We will also attempt the realization of new types of supersolid, to prove the generality of the phenomena: with coupled supersolid layers, we will move towards supersolidity in 3D; using a quasi-2D environment, we will attempt to realize two proposed types of strongly interacting and strongly correlated supersolids. Our work will establish connections between supersolids and other patterned quantum phases, such as pair-density waves in superconductors and in helium superfluids, intertwined phases in low-dimensional superfluids, and pasta phases in neutron stars. Our work might open directions for the realization of materials with novel functionalities.		modugno@lens.unifi.it
62	Fundamental Constituents of Matter	Finding All Integrable Models	THE PROVOST, FELLOWS, FOUNDATION SCHOLARS & THE OTHER MEMBERS OF BOARD, OF THE COLLEGE OF THE HOLY & UNDIVIDED TRINITY OF QUEEN ELIZABETH NEAR DUBLIN			Symmetry plays an important role in our current understanding of nature. For instance, in the development of the Standard Model of particle physics the understanding of the gauge group of symmetries was crucial. There is a class of models, called integrable systems, which have so many symmetries that they are exactly solvable. Such models have the exciting possibility to be understood in all aspects and thus give valuable insights into physical phenomena. In this way integrable models offer a unique approach to tackling open problems in physics, such as, for instance, describing strongly coupled systems. The aim of this proposal is to develop a new method to find and classify new integrable systems. Our approach is based on a new framework which was very recently put forward by the PI and his group. This new approach was applied to models that are closely related to regular integrable systems from string theory, quantum field theory and condensed matter physics. Several new models were discovered in this way but their physical and mathematical properties still remain to be understood. FAIM will be particularly focussed on models that have long-range interactions. These models are crucial in understanding strong coupling behaviour in for instance integrable models that appear in the AdS/CFT correspondence. Understanding long-range interactions is paramount to the computation of correlation functions in these models. Long-range interactions are also important for quantum systems in condensed matter such as cellular automatons. More generally, integrable structures appear in basically all areas of physics. For this reason, finding new integrable models and classifying them will have a large multidisciplinary impact, with exciting applications ranging from condensed matter to string theory. This will potentially help us understand physical phenomena in various different fields.		deleeuwm@tcd.ie

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63	Fundamental Constituents of Matter	Thermalization at High Energies	UNIVERSITEIT GENT			Thermalization of closed quantum systems is central to the modern understanding of matter, from ultracold to ultrahot. High-TheQ studies thermalization of quantum fields excited by nuclear collisions at RHIC and LHC to energy densities equivalent to trillions of Kelvins. In such extreme environments hadrons melt and the equilibrium state is the quark-gluon plasma. Theoretical control over thermalization at high energies is crucially needed for understanding when and how this equilibrium phase emerges in the experiments. The current theoretical paradigm for thermalization in quantum chromodynamics is based on hydrodynamic and non-thermal attractors (fixed points). They are novel examples of universal dynamics of non-equilibrium quantum fields. Both were found in idealized settings of nuclear collisions with high degree of symmetries and in particular corners of a microscopic parameter space. The goal of High-TheQ is to understand thermalization in quantum field theory beyond these idealizations. Do hydrodynamic attractors appear for off-central nuclear collisions? Is there a gravity dual to a non-thermal attractor? Do non-thermal and hydrodynamic attractors have a common origin, such as spontaneous symmetry breaking? To answer these questions, High-TheQ will adopt an interdisciplinary methodology, including data-driven approaches, mathematics of transseries and higher-curvature gravity. High-TheQ is firmly rooted in my long-term efforts on ab initio modelling of thermalization at strong coupling, pioneering the use of transseries in non-equilibrium dynamics of relativistic systems and introducing hydrodynamic attractors. This gives me a unique opportunity to decisively advance the field with High-TheQ.		michal.p.heller@ugent.be
64	Fundamental Constituents of Matter	A revolutionary archaeological Pb observatory for astrophysical neutrino sources	UNIVERSITA' DEGLI STUDI DI MILANO-BICOCCA	res-nova.unimib.it	neutrino, dark matter, cryogenics	One of the most energetic events in the Universe is the core-collapse Supernova (SN) where almost all the star's binding energy is released as neutrinos. These particles are direct probes of the processes occurring in the stellar core and provide unique insights into the gravitational collapse and the neutrino properties. Currently, astroparticle physics is in need of SN observations and of a detection technique highly sensitive to all neutrino flavors. RES-NOVA will revolutionize how we detect neutrinos from astrophysical sources by deploying the first array of cryogenic detectors made from archaeological Pb. Neutrino detection in RES-NOVA is facilitated by the newly discovered Coherent Elastic neutrino-Nucleus Scattering (CEvNS). It enables the first measurement of the full SN neutrino signal, eradicating the uncertainties related to flavor oscillations. To fully exploit the advantages of CEvNS, RES-NOVA ennobles Pb from being a passive shielding to the most sensitive detector component. Pb has the highest cross-section, 10^4 times higher than all used detection channels, enabling the deployment of a cm-scale neutrino observatory. The unconventional approach of RES-NOVA is to use ultra-pure archaeological Pb and run it as a cryogenic detector with low-energy threshold (<1 keV) and unprecedented background (<0.001 c/ton/keV/s). These features also open new opportunities in multi-messenger astronomy, Dark Matter, and neutrino property studies. The success of my pioneer work in operating archaeological Pb-based cryogenic detectors is pivotal for RES-NOVA realization. RES-NOVA will survey 90% of the potential galactic SNe, with only a total detector volume of (30 cm)^3. Future detector upgrades will enhance our SN-sensitivity into the uncharted territory >1 Mpc and increase the SN observation rate. RES-NOVA has the potential to lay the foundations for a future generation of European neutrino telescopes, as all its SN neutrino detectors are currently going offline.	cryogenic detectors, low-background	luca.pattavina+china@unimib.it

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65	Fundamental Constituents of Matter	Testing Fundamental Physics with Highly Charged Ion Clocks	PHYSIKALISCH-TECHNISCHE BUNDESANSTALT	https://www.quantummetrology.de/eqm/research/highly-charged-ions/introduction/	highly charged ions, trapped ions, quantum logic spectroscopy, optical clocks, optical frequency metrology, tests of fundamental physics, search for new physics	Precision spectroscopy of highly charged ions (HCI) provides insight into atomic systems in which electrons are highly correlated, strongly relativistic, and experience strong internal fields. Thus, HCI are excellent systems to probe and refine our understanding of physics under these extreme conditions. They are the most sensitive known atomic species to probe for possible changes in fundamental constants and offer advantageous properties to study coupling of hypothetical dark matter fields to normal matter. For these applications, high-precision optical spectroscopy of HCI is required. In the past, the spectroscopic resolution of optical transitions in HCI was limited by Doppler-broadening to hundreds of megahertz. We have recently demonstrated the first hertz-level laser spectroscopy of an optical fine-structure transition in highly charged argon using sympathetic cooling and quantum logic with a co-trapped logic ion in a Paul trap, improving the spectroscopic precision by nine orders of magnitude compared to the previous state-of-the-art. Here, we propose to further develop quantum techniques for controlling HCI and to push spectroscopic resolution in order to realise next generation optical clocks based on promising reference transitions in HCI. We will employ these novel types of optical clocks to advance our understanding of atomic structure and to probe for physics beyond the standard model. Sub hertz-level isotope shift spectroscopy of highly charged calcium ions will be performed to improve current bounds on hypothetical fifth forces that couple neutrons and electrons. Furthermore, we will perform optical clock-type spectroscopy on HCI that offer up to a 20-fold higher sensitivity to a possible change in the fine-structure constant and a non-gravitational coupling between dark matter and normal matter than existing clocks. Through frequency comparisons with other clocks, we will improve bounds on these new physics effects.	trapped ions, quantum logic spectroscopy, optical clocks, optical frequency metrology, tests of fundamental physics, search for new physics	piet.schmidt@quantummetrology.de
66	Fundamental Constituents of Matter	From conformal symmetries and integrability to the Electron-Ion Collider	UNIVERSITY OF HAMBURG	https://www.physik.uni-hamburg.de/th2/ag-moch/conformal-eic.html		The primary goal of this research proposal is to lay the foundations for precision predictions for the physics program in deep-inelastic scattering (DIS) at the Electron-Ion-Collider (EIC). The commissioning of the EIC will open a new era in the exploration of the strong interaction physics and the hadron structure at an unprecedented level of detail. This is expected to lead, among other results, to the clarification of the proton spin puzzle. The crucial ingredient for the success of this undertaking is the ability to confront experimental data to precise predictions for a those benchmark processes, which will form a core part of the EIC physics program: inclusive lepton-hadron DIS, including polarized beams; DIS charm- or bottom-quark production; deeply-virtual Compton scattering in off-forward kinematics. Capitalizing on recent theoretical advances, driven to a significant extent by the work of the PI, this proposal outlines a challenging and ambitious program to advance quantum chromodynamics (QCD) perturbation theory in order to achieve a theoretical description of the key observables at the EIC at percent level precision. The proposal puts forward a novel research methodology based on the systematic use of conformal symmetry and integrability, as realized in gauge theories with extended supersymmetry, such as the N=4 supersymmetric Yang-Mills (SYM) theory to reveal structural information on QCD results. Observables in lepton-hadron DIS are particularly well suited to turn the connections between N=4 SYM theory and QCD into a powerful computational tool, which leads to significant simplifications due to the hidden symmetries underlying integrable systems. Progress in this direction will open new avenues for research and will establish new bridges between the scientific communities in phenomenology and mathematical physics. The new QCD results will be used in the course of the project to explore precision phenomenology at the EIC.		sven-olaf.moch@desy.de

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67	Condensed Matter Physics	Spatio-temporal shaping of electron wavepackets for time-domain electron holography	UNIVERZITA KARLOVA		Electron-photon interaction, holography, time-resolved electron microscopy, cathodolumine scence	Advanced techniques of electron microscopy and spectroscopy require tools, which enable to control various degrees of freedom of electron beams (phase profile, temporal structure, orbital angular momentum, etc.). The inelastic quantum coherent interaction between light waves and electron wavepackets allows to structure the temporal probability distribution of electrons with attosecond precision, which may enable probing the coherent dynamics of optical excitations or plasmonic near-fields of nanostructures and metamaterials. Up to now, only electron-photon interactions mediated by solid-state structures have been considered, which have severe limitations. In this project I will develop a versatile tool for quantum coherent shaping and full characterisation of the phase profile and amplitude of the electron wave function in electron microscopes. The interaction will be mediated by the ponderomotive potential of spatio-temporally shaped light fields in vacuum. The electron wavepackets will be controlled on nanometer spatial and sub-femtosecond time scales that are natural for light waves. The optical coherence imprinted to the electron wavepackets will be exploited in two ways: i) I will explore the possibility to transfer the temporal coherence from density-modulated electron wavepackets to radiation and bound electron excitations in two-level quantum systems by detecting phase-resolved cathodoluminescence and coherent Smith-Purcell radiation driven by swift electrons. ii) I will introduce time-domain electron holography, which will exploit the temporal coherence of shaped electron wavepackets for phase-resolved imaging of optical excitations in nanostructures. The approaches proposed in this project open new pathways for electron-mediated optical quantum-coherent control and spectroscopy with atomic spatial resolution.	Theoretical physicist, quantum electrodynamics	m.kozak@matfyz.cuni.cz
68	Condensed Matter Physics	Phase-resolved THz-Higgs Spectroscopy on Superconductors	TECHNISCHE UNIVERSITAET DRESDEN		Higgs, superconductors, THz, high-harmonics generation, ultrafast	T-Higgs develops “Higgs Spectroscopy” as novel tool to probe the order parameter in superconductors. It will allow unprecedented insights into the structure and dynamics of the condensate and shine new light onto the physics of unconventional superconductors. In particular high temperature superconductivity calls for new probes to reveal its pairing mechanism. T-Higgs can also be applied to intriguing phenomena like light- induced superconductivity, superconductivity in “twisttronics” or under extreme conditions matching the ongoing importance of superconductivity in quantum materials. T-Higgs is a high-field phase-resolved non-linear THz spectroscopy on order parameter excitations of the superconducting ground state itself, the Higgs oscillations. Probing the internal structure of the condensed Cooper pairs this reveals not only the symmetry of the order parameter but also couplings of the condensate to external modes and their interplay with superconductivity.	optics, ultrafast laser, low temperatures, superconductivity	stefan.kaiser@tu-dresden.de

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69	Condensed Matter Physics	Switching Polytypes and Symmetries by Discrete vdW Sliding	TEL AVIV UNIVERSITY		Layered materials, graphene	While the artificial design of pristine crystalline structures and the construction of dedicated periodic playgrounds for atoms and electrons in a solid have transformed our world, much is yet to be explored. I posit that the marvels of van der Waals polytypes should go much beyond and suggest that they offer a remarkable opportunity to rapidly, efficiently, and distinctively swap between numerous different crystals, symmetries, and dispersions at will. We have recently reported several new crystals made from identical 2D layers that differ only by their stacking symmetry. These perfectly commensurate and periodic di-atomic polytypes result in distinct electric potential steps and exclusive ladder-like polarizations owing to their various combinations of broken inversion and mirror symmetries. Our current research focus is mono-atomic polytypes that break both symmetries and offer further fundamental insight into the purely geometric impact of the atomic positions in the unit cell. Our preliminary experiments on graphitic polytypes detect novel internal polarizations, placing us in a great position to explore its interplay with superconductivity and orbital magnetization. The key challenge is to break the polytypes out of their commensurate meta-stable stacking and force the layers to slide at particular interfaces, only along armchair lattice orientation and for discrete inter-atomic distances. We have recently observed that such switching is possible using external electric fields, but only in the case of polar di-atomic bilayers. The swapping involves a thin incommensurate boundary wall encompassing a single stacking fault, which may slide rapidly in a super-lubric manner. Building on our ability to construct and distinguish adjacent polytypes, we aim to develop methods to efficiently switch between many distinctive polytypes and properties. With robust nano-meter and nano-second swapping capabilities, we envision ground-breaking SlideTronic technologies.		moshebs@tauex.tau.ac.il
70	Condensed Matter Physics	3D Cuprate Twistronics as a platform for high temperature topological superconductivity	LEIBNIZ INSTITUT FUR FESTKORPER UND WERKSTOFF ORSCHUNG DRESDEN EV		Superconductivity; 2D materials; Cuprates; Twistronics	2D superconductors can be used to build ultra-clean interfaces for Josephson junctions, the superconducting analog of a transistor. A small twist in the relative crystal orientation of 2D superconductors could become a new platform for topological superconductivity, an exotic state of matter that holds great promise for quantum computing at high temperatures. Based on my methodological developments for the realization of twisted cuprate ultra-clean interfaces, the field is rapidly evolving, and these interfaces are now the leading candidate for the implementation of high-temperature topological superconductivity. However, the combination of well-controlled twisted cuprate heterostructures and complex circuits calls for new experimental methodologies. 3DCuT will develop micro/nanodevices and techniques to fabricate and control cuprate van der Waals twisted heterostructures in three-dimensional nanoarchitectures: 1) We will develop novel fabrication tools to integrate complex thermal and superconducting circuits in fragile twisted cuprate bilayers. We will explore if a topological gap opens near ´magic´ angles in twisted bilayers by studying the Josephson effect. 2) We will fabricate trilayers cuprate heterostructures with different twist angle symmetries, where the topological gap is amplified and time-reversal symmetry broken states appear across a wide range of angles. 3) We will create a heterostructure between a superconducting cuprate twisted heterostructure and a topological insulating crystal, allowing us to create a chiral Majorana edge mode. At the end of this project, we will have provided a brand-new solid-state tool for emerging quantum technologies in computation, metrology, secure communication, single-photon imaging, methodologies for the entire field of 2D materials, and a comprehensive understanding of the governing principles and ingredients for topological superconductivity at high temperatures.	Condensed Matter Physics; Experimental Condensed Matter Physics;	nicola.poccia@unina.it

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71	Condensed Matter Physics	Imaging Ultrafast Single Particle Macromolecular Dynamics with X-ray Lasers	UPPSALA UNIVERSITET	https://cordis.europa.eu/project/id/101088426		Conformational dynamics are crucial for the functioning of most macromolecules and a deeper understanding of these motions holds great promise for future discoveries in biology. But it is difficult to probe the structure of macromolecules away from their most stable conformations, and time-resolved studies remain limited by the available techniques. Today a new generation of XFELs is growing. The extremely short pulse duration, high pulse intensity and repetition rate of these lasers offer new research opportunities in physics, chemistry, and biology. Since the first XFELs were proposed, the idea of obtaining images of individual proteins frozen in time has fascinated and inspired many, and we have been at the forefront of this quest. The combination of advances in XFEL technology with ESI has brought the dream of imaging hydrated single proteins by X-ray diffraction within reach. Currently time-resolved studies in solution in the sub-ms range are done through solution X-ray scattering or spectroscopic methods, but they can only provide limited structural information. XFELs provide a way to dramatically improve our understanding of these time-scales. This proposal aims to develop the science and technology to make ultrafast single-protein imaging a reality, through a three-step approach: (I) develop diagnostics suitable for nanosized samples, (II) enable single protein X-ray diffraction imaging through new sample delivery instrumentation, (III) perform time-resolved single protein imaging experiments using the unexplored tender X-ray energy range. Ultrafast imaging of macromolecules will reveal new horizons. As a single-molecule method with high time-resolution, it enables imaging the structural changes associated with fundamental processes such as enzyme catalysis, allosteric signal transduction or even protein folding. It also opens a way to record molecular movies and mapping the conformational landscape of isolated macromolecules for the first time.		filipe.maia@icm.uu.se
72	Condensed Matter Physics	Understanding, Engineering, and Probing Correlated Many-Body Physics in Superlattices of Graphene and Beyond	UNIVERSITY OF STUTTGART		moiré, superlattices, 2D materials, graphene, machine learning physics, strong correlations, superconductivity	Exploring the plethora of possibilities provided by solid-state systems to realize exotic many-body phases is not only motivated by fundamental questions but also by potential quantum technological applications. In both cases, it is important to have control over the properties of the system in order to engineer the phase of interest, to have a clear theoretical understanding of the microscopic physics, and to be able to probe it. In this regard, superlattice systems have recently brought many exciting results: e.g., the moire lattice that emerges when two layers of graphene are twisted induces correlated phenomena, akin to high-temperature superconductors. Furthermore, artificially arranged atoms on surfaces have become popular tools to design electronic bands. SuperCorr will explore the vast set of possibilities provided by these tunable systems to engineer novel correlated many-body physics, propose ways to probe it, and advance our understanding of the complex phase diagrams of quantum matter. More specifically, we will address key questions related to several different graphene moire systems, such as the origin and form of superconductivity, its relation to the correlated insulator, the interplay of topological obstructions and correlations, and the microscopics of their nematic phases. We will work on the impact of spin-orbit coupling and on a theoretical description of twist-angle disorder, viewing inhomogeneities as a blessing in disguise that can also be used to probe and realize interesting physics. Finally, we will develop a theoretical framework for the design of atom arrangements on the surface of complex host materials, in order to create or simulate a quantum many-body system on demand. To this end, we will employ and further extend a variety of analytical and numerical methods of many-body physics and field theory, and combine it, in some projects, with machine-learning techniques, while keeping a close connection to experiment.		mathias.scheurer@itp3.uni-stuttgart.de

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73	Condensed Matter Physics	Spin-momentum locking and correlated phenomena in chiral topological materials	MAX-PLANCK-GESELLSCHAFT ZUR FORDERUNG DER WISSENSCHAFTEN EV	www.schroeterlab.org	Chirality, Topology, Quantum	Chiral topological semimetals are a new class of quantum materials at the intersection of structural and electronic chirality. We discovered the first example of this material class three years ago and have since demonstrated that they host new fermionic quasiparticles without analogue in high-energy physics, which carry large and controllable topological charges. ChiralTopMat will go beyond these initial works and aims to discover new extraordinary properties that have only been predicted for these materials but for which experimental evidence remains elusive: 1) A new form of isotropic parallel spin-momentum locking that can be considered the natural counterpart of Rashba spin-orbit coupling, 2) new electronic phases that are both correlated and topological, and 3) interface effects with magnetic materials that could be exploited for new energy-efficient information technology applications. We will achieve these research goals by employing spin- and angle-resolved photoelectron spectroscopy on various energy scales, probing these materials' surface, bulk, and interface electronic structures. Whilst the proposed experiments are challenging, our prior work and recent preliminary results have demonstrated their feasibility. If successful, ChiralTopMat will build on these discoveries to search for structure-property relationships that can be used to control these new phenomena by chemical and structural modification. We envision that this new understanding will be the basis for future devices that exploit chiral topological semimetals for energy-efficient magnetic memory devices, which use multifold fermions for field-free switching of magnets with perpendicular magnetic anisotropy.	Chirality, Topology, Quantum	recruitment-schroeterlab@mpi-halle.mpg.de
74	Condensed Matter Physics	A new SUPERconducting LANDscape: using nanoscale inhomogeneity for enhanced superconductivity	UPPSALA UNIVERSITET			Superconductivity is a truly quantum mechanical phenomenon, strongly dependent on the zero-energy density of states (DOS). This project aims to create and enhance superconductivity using nanoscale inhomogeneity to produce large DOS peaks at zero energy, thereby creating an entirely new, spatial and figurative, landscape for superconductivity. One recent example is twisted bilayer graphene, an all-carbon material that becomes superconducting due to a moiré structure producing large zero-energy DOS peaks. In this project we will establish superconductivity driven entirely by nanoscale inhomogeneity generating zero-energy DOS peaks, including in moiré structures. We will also use zero-energy DOS peaks to create a superconducting phase crystal in many different superconductors, generalizing findings from high-temperature cuprate superconductor surfaces. In the project we will continue to develop our state-of-the-art computational tools to self-consistently study superconductivity in large inhomogeneous systems at the atomistic level.		annica.black-schaffer@physics.uu.se

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75	Condensed Matter Physics	Microscopic Active Particles with Embodied Intelligence	GOETEBORGS UNIVERSITET			Over billions of years of evolution, motile organisms have developed complex strategies to survive and thrive. These strategies integrate three components: sensors, actuators, and information processing. In the last two decades, active-matter research has tried to replicate the evolutionary success of microorganisms in artificial systems. Researchers have replicated the actuators by developing artificial active particles that extract energy from their environment to perform mechanical work and, to a lesser extent, the sensors, by making these active particles adjust their motion properties to physical cues. However, these artificial particles are still largely incapable of autonomous information processing, which is limiting the scientific insight and technological applications of active matter. The main challenges are: 1. Make active particles capable of autonomous information processing. 2. Optimize the behavioral strategies of individual active particles. 3. Optimize the interactions between active particles. Drawing inspiration from Nature, this project will take the next steps in the evolution of artificial active matter systems by endowing them with embodied intelligence and autonomous information processing abilities. Specifically, it will: 1. Realize microscopic active particles with embodied intelligence (microbots). 2. Use embodied intelligence to achieve optimal behaviors for the microbots. 3. Use embodied intelligence to engineer interactions between microbots. I will achieve this by combining my background in mesoscopic physics and microfabrication with machine learning, a new research direction that offers radically different and complementary opportunities. This project will provide scientific insight into far-from-equilibrium physics and lay the foundations for ground-breaking applications empowered by microbots that are able to autonomously sense and react to their microscopic environment.		giovanni.volpe@physics.gu.se
76	Physical and Analytical Chemical Sciences	Heat in the driver's seat: unlocking the full potential of pulsed photothermal catalysis	STICHTING VU		Plasmonic nanoparticles, photocatalysis, nanophotonics, photothermal catalysis, metal nitride nanostructures	The climate catastrophe urgently calls for greening and intensifying chemical reactors. Most chemical reactors use catalysts to speed up reactions, but their operation at steady-state temperature impairs rate, selectivity, and energy efficiency. To go beyond these limitations, applying short heat pulses theoretically leads to >100× higher reaction yield, lower energy use, and a controlled product distribution. However, pulsed heating has remained out of reach because it is hard to heat catalysts selectively and fast enough. I break this paradigm and take control of dynamic thermo-catalysis by using light pulses and robust "plasmonic" materials that convert light to heat with nanoscale specificity. HEATPULSE comprises three work packages that tackle three challenges: (1) kinetics: modulate pulse timing for controlling reaction rate and selectivity, (2) localization: confine heat at thermal hotspots to boost energy efficiency, and (3) stability and performance: access high peak reaction rates by developing temperature-stable pulsed photocatalysts. Ground-breaking innovations: (1) Access to a normally unreachable reaction landscape, with dynamic tunability of catalyst activity and selectivity; (2) Thermal hotspots break the limit of nanoscale heating and reach 3× higher peak temperatures with exponentially enhanced rates; (3) Metal nitride nano-arrays integrated with single-atom catalysts grant thermal stability beyond 1000 °C. HEATPULSE represents a revolution in green reactor technology by shifting from burning fossil fuels to heat-pulsing with light, powered by renewables. The project will lead to the new field of "photocatalysis beyond the steady-state" at the crossroads of catalysis, nanophotonics, and materials science. With an accomplished track record in nanoscale light-driven chemistry, and as a pioneer in the field of pulsed catalysis at both experimental and theoretical level, I am uniquely suited to unlock the full potential of pulsed photothermal catal		s.h.c.askes@vu.nl

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77	Physical and Analytical Chemical Sciences	Cargo-towing Highly enantioselective Electro-pumps: unconventional asymmetrlc Readout and transmission of chiral information	UNIVERSITA DEGLI STUDI DI MILANO			Chirality is found throughout nature, but it occupies a special place in chemistry, perhaps for historical reasons, but mainly as a result of the beneficial properties of chiral molecules across a diverse range of areas, from medicine to materials science. The global aim of CHEIR is to achieve with unprecedented efficiency the propagation of chiral information along different length scales, based on the synergy of well-chosen molecular ingredients and physicochemical engineering. The artificial systems here involved can be considered as models for the transmission of chiral information through space. Such ambitious aim could be achieved developing a cargo-towing electro-pump based on chiral conducting polymers for targeted drug-delivery applications. The combination of four main ingredients, electric field and magnetic field (externally applied), electrical conductivity and enantiodiscrimination capability (intrinsic features of the object), makes these innovative miniaturized bipolar soft pumps perfect candidates for a multipurpose asymmetric detection. In such scenario inherent chirality can provide the breakthrough. It implies chirality and key functional properties to originate from the same structural element endowing the selector with extraordinary chirality manifestations that can be propagated from molecular level to the macroscopic one. Unprecedented recognition, in terms of energy differences, was recently observed, implementing inherently chiral materials as enantiopure electrode surfaces. Recently, attractive potentialities of these systems were also exploited in the field of bipolar electrochemistry and in the one of autonomous swimmers allowing to correlate the output signal with the concentration of the enantiomers present in solution. Such striking performance will prepare for the development of innovative systems with high impact in analytical, biological and pharmaceutical fields considering the project interdisciplinarity.		serena.arnaboldi@gmail.com
78	Physical and Analytical Chemical Sciences	Phase Contrast STEM for Cryo-EM	WEIZMANN INSTITUTE OF SCIENCE			Cryo-electron microscopy has revolutionized the field of structural biology, primarily for macromolecular structure but also for cells and tissue sections—achieving resolutions at the limit of physical optics. While wide-field transmission EM (TEM) with phase contrast by defocus is the most commonly used modality in biology, the alternative, scanning transmission EM (STEM), has emerged as the mode of choice for atomic resolution in materials science. Seeking to endow biology with the benefits of STEM, our lab established STEM for cryo-tomography of biological cells and demonstrated its advantages for thick specimens and compositional contrast. We now seek to extend cryo-STEM to high-resolution, with an emphasis on tomography, by means of coherent detection (Obj1). This will be achieved by the method of integrated differential phase contrast (iDPC) using a segmented detector, from which we obtain simultaneously phase and depth contrast in a single scan. The major expected benefits are: 1) minimization of image aberration, especially defocus with its associated complications for image interpretation, 2) reduction of beam-induced radiation damage by means of flexible scan and sampling patterns, and 3) improved reconstruction for tomography based on tailored data acquisition. We will validate the new methods for single particle analysis on standard macromolecular substrates and compare them to current state-of-the-art methods. Further, we will apply the new developments in 3D imaging to explore novel large-scale structures in chromatin we observed recently by whole-cell cryo-STEM tomography using current, low-resolution methods (Obj2). Labelling with halogenated nucleotides will reveal sites of active transcription or DNA synthesis. The proposed approaches' expected broad applicability and STEM's unrealized potential for hardware simplicity should together ensure the wide adoption of cryo-STEM methods in biology, accelerated by our dissemination efforts (Obj3).		Michael.elbaum@weizmann.ac.il

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79	Physical and Analytical Chemical Sciences	Deciphering information encoded on the nanoscale	UNIVERSITAET GRAZ		Single particle anaysis, elemental mass spectrometry, Raman spectroscopy, bottom-up modelling, ICP-MS, nanoparticles, optical traps, optical tweezers	Despite the natural ubiquity of nano- and microparticles and their increasing production and emission in anthropogenic processes, we struggle to understand their direct impact on environment and health. This is anchored in their elusive nature and analytical challenges arising from it. Although current approaches can retrieve some facets, we are blind for a majority of properties or cannot retrieve them coherently. We are in a dire need to decipher basic traits of particles and gain more comprehensive insights in their compositions, size distributions and abundances. Only this way, we can advance on our understanding on origin, implication, and fate of particulate entities. “NanoArchive” will provide new paradigms and innovations to enable the analysis of particles and aims to close a persistent gap in our understanding of the world at the nano- and microscale. The technological innovation is based on the convolution of elemental mass spectrometry, optical traps, and molecular spectroscopy to promote characterisations on a single particle level. The hyphenation of newly emerging technologies goes far beyond the current state-of-the-art but provides new opportunities to gain complementary and comprehensive perspectives on particles. Our aim is the empowerment of non-target particle analyses, the identification of integral molecular and elemental information and the bottom-up modelling of dispersion parameters using single particle data. This way, we will be able to bring particle science to a ground-breaking new level, allowing us to understand particles in our environment. The application potential of “ NanoArchive” will be demonstrated by focussing on glacier ice cores – the ideal archive to investigate natural background as well as the chronological evolution of human emission. However, the full impact of “NanoArchive” goes much beyond, potentially revolutionizing the analytics and understanding of particles in fields like geology, biology, or medicine.	hyphenation of hardware, hyphenation of software, single particle analysis, optics	david.clases@uni-graz.at

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80	Physical and Analytical Chemical Sciences	Predictive computational models for Enzyme Dynamics, Antimicrobial resistance, Catalysis and Thermoadaptation for Evolution and Design	UNIVERSITY OF BRISTOL		Enzyme catalysis, antimicrobial resistance, antibiotic resistance, protein design, enzyme evolution, molecular dynamics simulation, virtual reality, computational modelling, multiscale modelling	Enzymes are superlative catalysts, honed by billions of years of evolution to achieve high specificity and efficiency. Understanding how enzymes function and are adapted to different environments will be essential in developing biocatalysts for the circular economy and in combating drug resistance. Basic principles of catalysis and mechanistic understanding have come from experiments and simulations, and significant progress has been made in designing and evolving de novo protein catalysts. Truly predictive understanding is limited, however. There is a need for models able to predict, e.g. whether an enzyme is able to break down a particular antibiotic and how to inhibit it; temperature dependence of catalysis; how mutations affect activity and temperature optima; to understand how catalytic power evolves and use those principles in the development of new biocatalysts. Theoretical developments, and emerging multiscale methods, provide a route to the predictive understanding required. Fundamentally, protein dynamics are vital, not in ‘driving’ reaction but rather as a fundamental facet of natural enzymes on which evolution acts. PREDACTED will simulate enzyme dynamics and dynamical changes associated with catalysis. We will (1) Investigate the adaptation of enzyme activity using the emerging theoretical framework of macromolecular rate theory, and develop simulation approaches to predict enzyme temperature optima, with relevance e.g. for understanding ecosystem response to climate change, and for the development of biocatalysts for practical industrial applications. (2) Develop predictive simulation models for enzymes responsible for antibiotic resistance, analyse allosteric effects and predict spectrums of activity. (3) Model antibiotic breakdown and inhibition of beta-lactamases (4) Apply the understanding developed in redesigning and engineering natural and artificial enzymes to test the catalytic principles and demonstrate how they can be applied in practice.	Machine learning, artificial intelligence, generative models, human-computer interaction, enzyme design, inhibitor design, software engineering, enzyme engineering, enzyme catalysis, antimicrobial resistance, antibiotic resistance, protein design, enzyme evolution, molecular dynamics simulation, virtual reality, computational modelling	Adrian.Mulholland@bristol.ac.uk

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81	Physical and Analytical Chemical Sciences	In-silico Models for the Design of Mechanochromic Functionalized Polymers	ECOLE NATIONALE SUPERIEURE DE CHIMIE DE PARIS			The MaMa project aims at developing integrated computational approaches enabling to describe and design new mechanochromic materials. In particular, we aim at rationally design technologically consistent commodity polymers with smart and intelligent features such as mechano-responsive elastomeric, thermoplastic and thermoset polymers by the introduction of chromogenic species in the polymeric matrix in the form of mechanophore chromophores. The inter- or intra-molecular interactions ruling the opto-mechanical behaviour of the chromophores within the polymer matrix, and thereby the macroscopically perceived colour, can be tuned by application of an external force and they will be the key issue to control - by suitable design of the chromophores and polymers- and to predict by theoretical tools. In this respect the present project concerns, beside primary fundamental issues, such as the development of theoretical approaches for the description of photophysical processes in complex matrix, the handling, description and prediction of phenomena occurring from molecular to nano-scale in presence of an external stimulus such as pression/shearing or drawing. We will focus on mechanochromic luminogenic materials based on strain-induced modulation of molecular covalent or non-covalent interactions, affecting phenomena like excimer modulation or aggregation-induced emission at the molecular chromogenic scale. The functionalized smart materials designed can find real-life applications ranging from anti-counterfeiting systems for intelligent packaging, smart coatings and textiles, and optical indicators for the detections of cracks and fatigue issues in thermoset polymers. The solid and active collaboration with leading experimental and theoretical chemists will allow for the efficient synthesis and characterization of the most promising demonstrators, to exhaustively validate the computational tools and to further illustrate the technological relevance of these materials.		carlo.adamo@chimieparistech.psl.eu
82	Physical and Analytical Chemical Sciences	Theory and principles of luminescent organic radical materials for OLED and sensor applications	LINKOPINGS UNIVERSITET		luminescence, phosphorescence, solar cells, OLEDs, TADF, perovskite, radicals	Organic luminescent radicals (OLRs) are quite rare emitters demonstrating doublet-doublet fluorescence and having a number of advantages towards practical applications in organic light emitting diodes (OLEDs), ratiometric fluorescence sensors and anti-counterfeiting labelling. The doublet-doublet fluorescence by OLRs is a spin-allowed process similarly to the common singlet-singlet fluorescence. But in contrast to closed-shell molecules for which “bright” excited singlet states are higher in energy than “dark” triplet states, the doublet excited states of OLRs are always lower in energy than the quartet states. That is why the theoretical limit for internal quantum efficiency of OLR-based OLEDs is expected to be 100% and why the quartet excited states in general have not been considered for OLRs. However, recent experimental studies indicate that quartet states of OLR emitters indeed can be populated in OLEDs so reducing their efficiency. Thus, in the current project I aim to develop general theory and principles of OLRs in order to involve quartet states into the emission process and to boost the efficiency of OLEDs beyond state-of-art results. Another challenge for this project is design of OLRs for sensor applications. Most of OLRs possess low-lying first excited doublet state that makes them perfect anti-Kasha emitters for which emission occurs from higher excited states, something that is rare for closed-shell systems but required for ratiometric fluorescence sensors. In this project I aim to extend the principles of anti-Kasha emission for OLRs to make a breakthrough in state-of-art ratiometric detection of radicals. Finally, the special kind of sensing called two-step anti-counterfeiting labelling will be developed in this project based on photoresponsive aromatic carbonyls. These compounds are environment friendly, they can easily generate stable OLRs upon UV irradiation that I will utilize for innovative anti-counterfeiting application.	luminescence, phosphorescence, solar cells, OLEDs, TADF, perovskite, radicals	glib.baryshnikov@liu.se

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83	Physical and Analytical Chemical Sciences	Strain engineering to design functional 4D polymorphism in nanostructured materials	UNIVERSITEIT GENT	https://cordis.europa.eu/project/id/101115787	strain fields, molecular dynamics, phase transformations, metal-organic frameworks, metal halide perovskites, mechanical stability, functional material design, nanostructured materials, electronic structure methods, force field methods, machine learning potentials	It is often easy to observe the ability of polymorphic materials to undergo a phase transition through changes in colour, conductivity, photovoltaic efficiency, or other functional properties. In contrast, it is challenging to control under which external stimuli–stress, temperature, adsorption–these materials switch. Yet, enabling such polymorphic material design would be a game changer for pressing societal challenges, from access to drinkable water to producing green energy. This requires a firm understanding of how changing a material's structure impacts its polymorphism and macroscopic function. In STRAINSWITCH, I aim to transform polymorphic material design by establishing the strain engineering concept. The central characteristic in my in silico approach is strain: the extent to which a material deforms due to external or internal triggers. On the one hand, external stimuli generate strain, even before they activate a phase transition. On the other, spatial disorder in a structure, tuneable from the atom to the device scale, also induces strain that interferes with external strain fields. My key hypothesis is that it is possible to systematically predict which disorder is needed to ensure polymorphism only occurs under well-defined external triggers by balancing these internal and external strain fields. To confirm this hypothesis, I will develop new in silico methods with the goal to: i. understand how disorder induces strain fields in a material that propagate through both space (3D) and time (+1D) to enable 4D design; ii. predict which internal strain fields activate a material's polymorphism under specific external stimuli. In STRAINSWITCH, I will combine both goals to establish fundamental disorder-strain-function relationships that can be validated experimentally for metal-organic frameworks and metal halide perovskites. They will pave the way for 4D polymorphic material design with application in water harvesting, photovoltaic devices, and more.	strain fields, molecular dynamics, phase transformations, metal-organic frameworks, metal halide perovskites, mechanical stability, functional material design, nanostructured materials, electronic structure methods, force field methods, machine learning potentials	sven.rogge@ugent.be

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84	Physical and Analytical Chemical Sciences	Hyperpolarized Magnetic Resonance at the point-of-care	UNIVERSITA DEGLI STUDI DI PADOVA		NMR; hyperpolarization; SABRE; PHIP; DNP	HYPMET proposes a pioneering research methodology for hyperpolarized magnetic resonance for real-time monitoring of upregulated metabolic pathways in cancer cells and in-vivo and for body fluid metabolic analyses with the prospect of revolutionizing the medical approach to personalised treatments. A common analytical method for structural biology, medical imaging, and chemical analysis is nuclear magnetic resonance (NMR), which is flexible but intrinsically insensitive. Even in the most sensitive NMR spectra, many endogenous compounds found in blood, saliva, or urine are currently unresolved. HYPMET will establish a ground-breaking technology enabling the detection of body fluids metabolites below the current limit of NMR detection (~μM) and the real-time monitoring of clinically relevant metabolic pathways in-cells and in-vivo; it will enable NMR metabolomics analyses at the point-of-care and will be fully compatible with personalised medical treatments; it will be compact (less than 10 ×10×30 cm) and will not require superconducting magnets. Emerging methods (e.g. hyperpolarisation methods - HM) can boost the NMR signal intensity. HYPMET will merge two HMs to achieve NMR signal enhancements of several thousand-fold continuously, in the liquid state and at ultra-low-magnetic field (ULF, i.e. <10 mT) for many nuclear isotopes. The two HMs are: Overhauser Dynamic Nuclear Polarization (ODNP) and Signal Amplification By Reversible Exchange (SABRE). The PI unique expertise spans method development on various HMs and development and implementation of a protocol for real-time monitoring of pyruvate to lactate conversions in-cells and in-vivo to probe the state of a tumor in real-time. Success in this multidisciplinary project will pave the way for efficient NMR metabolomics analyses and for better real-time metabolic conversion monitoring directly at the point-of-care. In the future, the technology could be further reduced in size and become a widespread clinical tool.		gabriele.stevanato@unipd.it

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85	Physical and Analytical Chemical Sciences	Imaging Single Glycoconjugates	MAX-PLANCK-GESELLSCHAFT ZUR FORDERUNG DER WISSENSCHAFTEN EV	https://anggara.science/	STM Imaging, Glycan-decorated Proteins, Glycan-decorated Lipids, Electrospray Ion Beam Deposition	GlycoX aims to develop single molecule analytical methods to address the challenge of elucidating glycoconjugate structures. Glycoconjugates are glycans (a.k.a carbohydrates) that are attached to another biomolecules such as proteins or lipids. Glycoconjugates are essential to all living organisms, carrying out key cell-cell communication roles in immune system or in microbial infection. Glycoconjugates are found in all biological systems and yet, when compared to proteins or nucleotides, very little is known about their structures and how they lead to their biochemical properties or how they can be exploited in therapeutics. Efforts to reveal their structures by ensemble averaged approaches, whether primary structures (sequences) or secondary structures (conformations), have been severely hampered by the high complexity and flexibility of glycans. GlycoX addresses this challenge by direct imaging of single glycoconjugate molecules, devoid of any ensemble averaging. To this end, glycoconjugate ions generated from electrospray ionization are soft landed on surface and imaged one-at-a-time by scanning probe microscopy in vacuo. The Project proposes the use of direct imaging (1) to identify the glycoforms of any glycoconjugates (i.e. variants of a specific glyconjugate that possess different glycan primary structures), (2) to sequence any glycan residues in any glycoconjugates, and (3) to determine the conformations of any glycoconjugates. The Project plans to focus on glycoconjugates that are intractable by present analytical methods, many of which are central in immune system, in microbial infection, and in emerging diagnostics, drugs, and vaccines. These works have far reaching impacts: shedding light into the language used by cells to communicate and by pathogens to infect; creating new opportunities in glycan-based therapeutics; as well as opening new frontiers in single molecule analytical chemistry of biomolecules.	Model Building, STM Image Recognition, Parallel Computing, Structural Search, Biophysical Chemistry, Computational Chemistry, Density Functional Theory	k.anggara@fkf.mpg.de
86	Physical and Analytical Chemical Sciences	Designing organic molecules as platforms for reversible charge-to-spin conversion with applications in chromophore optimisation and drug discovery	UNIVERSIDAD DEL PAIS VASCO/ EUSKAL HERRIKO UNIBERTSITATEA	https://cordis.europa.eu/project/id/101116089	Diradicals, Organic Chemistry, Electronic Structure	Chemistry and Biology are governed by molecules and how they interact. Crucially, what glues a molecule together are chemical bonds, made from atoms pairing all their electrons. Although preferred, this is not the only option: in the comparatively rare cases where a molecule presents unpaired electrons, it acquires a fascinating new status that transforms its chemical and biological properties, best described by the acutely apt name of radical. Despite the extraordinary toolset found in radical-bearing molecules, the rather demanding methods to radical formation currently available mean that only very specific molecular architectures can withstand them, inadvertently limiting the scope of their applicability. The aim of this ERC project is to show that reversible diradical formation upon deprotonation is prevalent, and yet unexplored, in general donor-acceptor organic molecules and use this new knowledge to develop novel design criteria in light-emitting molecules and drug discovery. To achieve this unique aim, I will exploit a widespread structural pattern in a novel way, enabling a molecule to reversibly convert its charge and spin and become a diradical. I will first characterise how different molecular constituents (un)favour diradical formation on isolated molecules. I will then establish, for the first time, the role that diradicals play in defining the function of the numerous bioactive molecules sharing the proposed structural pattern. By exposing the overlooked diradical character in general families of deprotonated organic molecules, I will deliver transformative mechanistic understanding on i) the photo physical properties of fluorescent proteins and ii) the reactivity of small molecule drugs, particularly a new class of covalent inhibitors. The field of organic radicals sits at a critical crossroads between Chemistry and Biology, and as such, taking it a step forward has the potential to cross-pollinate research fields and reshape research frontiers.	Spectroscopy, Computational Chemistry, Covalent Inhibitors	Daniel.reta@ehu.eus

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87	Physical and Analytical Chemical Sciences	Turning gold standard quantum chemistry into a routine simulation tool: predictive properties for large molecular systems	BUDAPESTI MUSZAKI ES GAZDASAGTU DOMANYI EGYETEM	http://www.fkt.bme.hu/~theoreticalchem/	development and application of efficient and predictive quantum chemistry methods, computational chemistry, coupled cluster, perturbation and density functional theory methods, computation of reaction mechanisms and molecular interactions, computation of thermochemical, kinetic and spectroscopic molecular properties, parallel and scientific programming, high-performance computing	We propose comprehensive theoretical method development targeting a long-standing dilemma in molecular quantum simulations between controllable predictive power and affordable computational time. While the outstanding reliability of quantum chemistry's gold standard model is repeatedly corroborated against experiments, its traditional form is limited to the size of an amino acid molecule. By exploiting the short-range nature of leading interaction contributions, a handful of groups, including ours, have recently extended the reach of such quantitative energy computations up to a few hundred atoms. However, these state-of-the-art models are still too demanding and are not at all equipped to compute experimentally relevant dynamic, spectroscopic, and thermodynamic molecular properties. Thus, to break down these barriers, we will further accelerate our cutting-edge gold standard methods up to few 1000 atoms via concerted theoretical and algorithmic developments, and high-performance software design. Additionally, we will take into account biochemical, crystal, and solvent environment effects via cost-efficient embedding models. For the first time, we will also derive and implement practical approaches to compute static and dynamic observable properties for large molecules at the gold standard level. The exceptional capabilities of the new methods will enable us to study challenging chemical processes of practical importance which are not accessible with chemical accuracy for any current lower-cost alternative. We aim at modeling and understanding intricate covalent- and non-covalent interactions governing supramolecular and protein-ligand binding as well as the mechanism of organo-, organometallic, surface, and enzyme catalytic reactions. Once successful, this project we will deliver groundbreaking and open access tools for the systematically improvable and predictive quantum simulation of large molecules in realistic conditions and environments.	development and/or scientific programming of electronic structure methods OR ab initio molecular/materials modeling numerical simulations/computational modeling in chemistry/physics/biochemistry/materials science OR applied computational modeling for reaction mechanisms, molecular interactions, thermochemical, kinetic and spectroscopic molecular or material properties OR machine	nagy.peter@vbk.bme.hu

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88	Physical and Analytical Chemical Sciences	Deep multi-scale modelling of electrified metal oxide nanostructures	UPPSALA UNIVERSITET			One promising solution toward a sustainable society and a green economy is to use metal oxide-based materials. Metal oxides are a class of inorganic materials that have various energy and environmental applications such as heterogeneous catalyst, fuel cell, lithium-ion battery, supercapacitor, water treatment and antimicrobial application. Most metal oxides are synthesized as nanostructures which leads to unique properties and reduced economical costs. The very properties that make the metal oxide nanostructures attractive and indispensable in modern science and technology also cause an issue for the environment and human safety. In both the functioning and the degradation of metal oxide nanostructures, aqueous interface plays a vital role. The metal oxide-aqueous solution aqueous interface is electrified in working conditions due to acid-base chemistry and composed of protonic electric double layer. Given the importance of metal oxide surfaces in practical applications, surprisingly little is known about the relation between atomic structure of protonic double layer and the interfacial reactivity. This is largely due to the fact that our knowledge is mostly based on macroscopic observations such as current and concentration in electrochemistry and microscopic information of protonic double layer is difficult to be obtained in experiments. Therefore, developing a novel deep-learning empowered multi-scale modelling framework and providing a revolutionizing understanding at microscopic level of the functioning and degradation of electrified metal oxide nanostructures are the aims of this proposal. The outcome of this project will not only lead to the knowledge discovery about the impact of protonic electric double layer on porous metal oxide-based supercapacitors and on the degradation of metal oxide nanoparticles, but it will also propose useful design principles for synthesis and fabrication.		chao.zhang@kemi.uu.se
89	Synthetic Chemistry and Materials	Receptor Recruitment as an Organizational Principle for Self-Assembling Matter	UNIVERSITEIT TWENTE			Receptor recruitment occurs in biology as a response to binding, for example, by virus particles to a cell membrane. The interactions that underlie the binding process are typically multivalent in nature, in other words, multiple interactions of the same motif occur simultaneously to provide a collective, cooperative effect. This project aims to employ recruitment as a design criterium for self-assembling building blocks into well-defined architectures. Intrinsically weak and dynamic interactions are essential in achieving self-assembly and recruitment. Exquisite control over stoichiometry and structure of the assemblies is achieved by harnessing ground-breaking developments in the understanding of these multivalent interactions. Follow-up fixation processes will be developed to transfer the molecular organization onto stable building blocks and materials. Functional, e.g., fluorescent, groups will be implemented into the systems to provide insight into recruitment and self-assembly processes. These breakthrough insights will be used tackle challenges with the identification, sensing and isolation of biological particles. High-throughput methods will provide technology to screen multiple virus–glycan combinations with the aim of providing ‘fingerprints’ of viruses based on their binding behaviour. Platforms with nanoscale dimensions and molecular functionalities will be prepared, which will be used for single-particle sensing and particle isolation of, for example, virus particles and extracellular vesicles. As such, this proposal takes inspiration from nature, by borrowing recruitment as a concept to build self-assembled materials, and to contribute to a better understanding of living systems using new detection and isolation tools, with application prospects for biomedical platforms and smart materials.	self-assembly, supramolecular interactions, receptor recruitment, multivalent interactions, surface chemistry	j.huskens@utwente.nl

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90	Synthetic Chemistry and Materials	Reversible Heterolytic Mechanophores for Dynamic Bulk Materials	FUNDACIO PRIVADA INSTITUT CATALA D'INVESTIGACIO QUIMICA			Stimuli-responsive polymers adapt their properties in response to external cues. Engineering such “smart” behaviour in artificial systems by molecular design is an exciting fundamental challenge that can lead to technological breakthroughs. Most stimuli-responsive polymers rely on heat and light to trigger changes in materials properties in a predictable fashion. However, limitations intrinsic to these stimuli highlight the necessity of alternative strategies. Naturally evolved systems widely exploit mechanical stimulation to regulate their functions, but recreating such concept in artificial materials has proven extremely challenging thus far. ReHuse proposes a radically new approach that focuses on the application of mechanical force to induce changes in bulk materials properties isothermally and reversibly. The research project aims at pushing the frontiers of covalent mechanochemistry through the development of reversible heterolytic mechanophores –molecular platforms that dynamically generate and recombine two oppositely charged (macro)molecular fragments upon mechanical stimulation. These new motifs will enable dynamic chemistries involving organic ionic species in solid-state systems in two different types of advanced bulk materials. Combining reversible mechanochemistry and dynamic covalent chemistry will lead to dynamic covalent polymers displaying selective mechanoresponsiveness. This concept will be leveraged to create recyclable materials. The reversible generation of charges from the heterolytic scission will enable to modulate hydrophilicity/hydrophobicity dynamically. Such principles will be explored to set the groundwork for mechano-responsive atmospheric water harvesters. This interdisciplinary research project will advance our understanding of mechanochemistry and, more importantly, will usher new avenues for its productive and repeatable use in adaptive materials.		jberrocal@iciq.es
91	Synthetic Chemistry and Materials	Enantioselective screw-dislocation-mediated growth of chiral nanocrystals	BAR ILAN UNIVERSITY		Nanoscale chirality, crystal growth mechanisms, screw dislocations	In many scientific disciplines structural symmetry considerations are key. Specifically, mechanisms by which symmetry translates from atomic and molecular building blocks to crystal structures and shapes attract a great deal of attention. A fascinating aspect of this is related to chirality. Louis Pasteur’s monumental work, reported in 1848, on formation of chiral shapes in crystals made from chiral molecules, led to an intuition that chiral building blocks naturally lead to chiral shapes in crystals. Yet, after countless observations ever since of crystals with chiral shapes, mechanisms of their formation are understood to be often more complex and elusive than first imagined. In work proposed here, nanocrystals will serve as convenient model systems for studies of the interplay between crystallization and chiral shape formation. They are beneficial for this purpose as they can mimic “embryonic” stages of crystal growth, exhibiting structural details that can be retrieved at remarkable resolution, that are often hidden in macroscopic crystals. Specifically, I will focus on a universal mechanism by which crystals grow at low concentrations of building blocks, assisted by a common type of imperfections, namely, screw dislocations. I will tackle key unresolved questions on the interplay between chirality, screw dislocations and crystallization. First, how does screw-dislocation-mediated growth proceed in the presence of chiral additives that can bind to growing crystals, and how do these dislocations even come to be? Second, how general is this mechanism, and how often was it overlooked throughout history? The results obtained in this work, on the one hand, will lead to a general design principle to control nano-scale chirality in many inorganic materials, beneficial for novel applications. On the other hand, they have the potential to elucidate a missing piece of crystal growth theory and lead to a paradigm shift in our understanding of shape chirality in crystals.		assaf.ben-moshe@biu.ac.il

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92	Synthetic Chemistry and Materials	Biological fabrication of cotton fibers with tailored properties	WEIZMANN INSTITUTE OF SCIENCE		cotton, cellulose, fibers, dyeing, biofabrication	Naturally produced fibers have always played central roles in shaping human civilizations. Current hazardous chemical-based manufacturing processes and consumers' preferences for cotton products are putting much strain on the future of cotton's global economy. Thus, it is urgent to seek future sustainable alternatives. What alternatives and tools are available? Which new avenues are waiting to be explored toward this end? Harnessing biological systems is one of humanity's ultimate frontiers. Yet, the intrinsic complexity of higher organisms and the lack of in-depth, comprehensive understanding of the underlying mechanisms and their interactions across a multitude of scales has primarily hindered their use to manufacture bio-based materials with desired properties. This project addresses this lack of knowledge by answering key questions concerning the sugar uptake and upwards transport from the roots and biosynthesis of naturally produced fibers at the level of cotton plants while using this body of information to create a roadmap to produce cotton fibers with tailored properties. Our approach will dive into the exploration of a recent and largely unexplored discovery that cotton plants uptake sugar by the roots, transporting them upwards, reaching as far as the fibers (root-to-fiber). In particular, we will dwell on the dynamics of this process using sugar derivatives. This body of information will set the stage for feeding the roots of whole cotton plants with sugar derivatives carrying specific functionalities to become, ultimately, biologically incorporated into the fibers modifying their end properties, particularly fluoro-sugars to yield fibers with increased hydrophobicity. We will demonstrate the feasibility of biological fabrication and material farming in whole cotton plants as a revolutionizing and sustainable alternative to manufacturing current chemical-based strategies and toward a bio-based global economy.		filipe.natalio@fct.unl.pt
93	Synthetic Chemistry and Materials	Engineered Particles for Chemical Communication	UNIVERSITAT POLITECNICA DE VALENCIA		communication, nanoparticles	This project aims to the development of communication at the nanoscale and to advance in the understanding of how abiotic micro/nanoparticles can communicate between them and how micro/nanoparticles can communicate with living systems. In this context, an approach for establishing communication at the nanometric level is to mimic how nature communicates. Chemical or molecular communication, based on transmitting and receiving information by means of molecules (chemical messengers) is one of the communication forms used by living organisms. Moreover, many swarm systems found in nature communicate by modifying the environment using a concept called stigmergy. The advantages of nanoparticles that communicate each to another are immediately obvious; they constitute the basis of a dynamically interacting network eventually resulting in certain autonomy of the system. If we would be able to raise the bases for communication between micro/nanoparticles and between micro/nanoparticles and cells, the potential future applications in the biomedical field, environmental research and industry technology are almost unlimited. The project will establish firm handholds for the use of nanoparticles able to communicate from one to another and with cells in different applications. The project will trace, optimise and adapt all single steps from the idea to its implementation into applicable final systems with the aim of targeting issues that are difficult to address with conventional single particles. The project is divided into three WPs. The first work package (WP1) will create the basic elements for chemical communication. In a more complex situation, WP2 will use the tools of WP1 to develop systems able to establish communication between nanoparticles and living systems. Finally, WP3 will generate nano-systems integrating gated nanoparticles and up-to-date electronics to develop new communication structures.	supramolecular chemistry, microelectronics, communication.	rmaez@qim.upv.es

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94	Synthetic Chemistry and Materials	Porous poly(ionic liquid)s for CO2 capture and simultaneous conversion under ambient conditions	STOCKHOLMS UNIVERSITET	yuan-group.com	CCS, CCU, porous polymers, porous carbons	CO2 capture, storage and utilization is judged critical to mitigate the rapid rise in the atmospheric CO2 concentration. A key problem is the gigantic mass of CO2 emitted, which asks for robust, efficient and economically viable approaches that are currently missing and limited by the lack of suitable materials. To break through this barrier, I aim to develop metal-free dual-function porous poly(ionic liquid)s (DPPs) to capture and convert CO2 under ambient conditions into cyclic carbonates with high efficiency, and to apply them in model reactors for cost-effective processing of CO2. Poly(ionic liquid)s (PILs) are innovative ionic materials, in which ionic liquids (ILs) are covalently joined by a macromolecular backbone. ILs are known CO2-philes, and IL-derived PILs are naturally in favour of CO2 sorption, while their ions can be tailor-made for catalytic CO2 transformation. Such dual-function as sorbent and catalyst is the intrinsic merit of PILs to address the CO2 challenge, but unfortunately has been long impeded by the mismatched chemical structures in each function. Our preliminary work proved that the newly emerging 1,2,4-triazolium PILs were catalytic active and drastically more CO2-philic than common polyimidazoliums, and are believed as the game-changer materials. We envision that by structuring chemically tailor-made 1,2,4-triazolium PILs into highly porous materials, they will be able to capture and convert CO2 under ambient conditions. This ground-breaking materials concept will circumvent the complicated, harsh conditions for CO2 fixation, and cut the cost to an affordably low level. This project will radically advance scientific knowledge and technology to fixate and convert CO2 at scale into value-added chemicals that further reduces the consumption of fossil resources. Its outcome will expedite the research in PIL and dual-function materials to revolutionize the CCU routes and equip us with powerful materials tools to mitigate the global CO2 rise.	functional polymer and carbon materials	jiayin.yuan@mmk.su.se
95	Synthetic Chemistry and Materials	Glycan foldamers: designing oligosaccharides to build three-dimensional architectures	MAX-PLANCK-GESELLSCHAFT ZUR FORDERUNG DER WISSENSCHAFTEN EV	https://www.mpikg.mpg.de/carbohydrate-materials	glycans, folding, secondary structure	Natural biopolymers have inspired the development of synthetic analogues – i.e. foldamers – capable of adopting defined conformations and forming programmable three-dimensional architectures. These compounds are mainly based on peptides and nucleic acids, that are well understood at the molecular level. The diversity, intrinsic chirality, and ability to generate hierarchical assemblies suggest that carbohydrates hold an even larger potential for the generation of three-dimensional structures. However, the complexity of carbohydrate synthesis and structural analysis have prevented access to synthetic carbohydrates capable of adopting defined geometries. I propose the creation of carbohydrate foldamers capable of 1) adopting rigid secondary structures and 2) assembling into supramolecular architectures. To achieve these goals, we will address fundamental questions related to carbohydrate structure, design new methods to stabilize particular conformations, and we will implement protocols for systematic structural analysis. State-of-the-art synthetic platforms (i.e. automated glycan assembly) and analytical techniques (i.e. NMR spectroscopy, microED, and single molecule imaging) will be the tools to complete this ambitious project. My group has proved to be very successful at gaining a basic understanding of carbohydrate structure and aggregation. Building upon these preliminary results, I aim to develop programmable carbohydrate architectures, which have the potential to open a new field of carbohydrate and supramolecular chemistry. Analogous to the birth of a new field after the discovery of peptide-based foldamers, carbohydrate foldamers could find applications in several areas, including material science, biology, and catalysis. Moreover, carbohydrate foldamers will expand our understanding of carbohydrate structures and interactions, and new analytical protocols will standardize the characterization of carbohydrate materials.		martina.delbianco@mpikg.mpg.de

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96	Synthetic Chemistry and Materials	Tailoring Organic-Inorganic Layered Structures to Build Functional Graded 2D Nanomaterials for Advanced Nanointerfaces	FONDAZIONE ISTITUTO ITALIANO DI TECNOLOGIA		robotic synthesis, organic-inorganic layered structures, graded nanomaterials, optoelectronics, biointerfaces	Advanced functional devices require integration of distinct materials (polymers, ceramics, metals) with different properties to achieve high performance in aerospace, biomedicine, electronic, and automotive. A major structural challenge is associated with localized (mechanical, thermal, electrical) stresses due to property mismatch at different scales, thus causing premature malfunction and failure. Research has focussed on compositional or structural material gradients (in at least one spatial direction) to enable fabrication of “in-one” body parts (mostly inorganics) with exceptional properties. Examples at rather macroscale include AlGaAs with graded bandgap for solar cells, or Al2O3/Ti with graded mechanical stiffness for bioimplants. However, in light of miniaturization technology, there is a need to translate this concept to nanomaterials. The EVA project aims to establish scientific principles to design and fabricate pioneering organic-inorganic 2D layered nanomaterials with functional gradients and continuous interfaces. My approach to designing such innovative nanomaterials is based on their compositional engineering by using correlations to perform an extended mapping of combinations and properties. I will explore self-assembly techniques in solution and translate them into automated processes to hierarchically build robust components with nm-layered thicknesses and mechanical and optoelectronic gradients. EVA will also demonstrate their use as advanced interfaces for soft bio-tissue coupling and flexible lighting nanosystems, providing answers from the nanoscale to key drivers in these fields: reliability, robustness, and durability. Through this interdisciplinary approach (physics, chemistry, mechanics, biology, and materials science), the envisioned atomically designed hybrids will be a hallmark for frontiers in fields such as energy, health, robotics, and digital technologies.		milena.arciniegas@iit.it
97	Synthetic Chemistry and Materials	Clip-off Chemistry: Design and Synthesis of New Materials via Programmable Disassembly of Reticular Materials	FUNDACIO INSTITUT CATALA DE NANOCIENCIA I NANOTECNOLOGIA		Clip-off Chemistry, MOFs, COFs, cages, organic chemistry, supramolecular chemistry, coordination chemistry	Historically, innovations in synthetic methods and reactions have changed the way scientists think about designing and synthesizing materials and molecules. Indeed, novel synthetic methods not only unlock access to previously unattainable structures, but also inspire new concepts as to how we design and build materials to address global social, economic and industrial needs. The project that I propose here, CLIPOFF-CHEM, centers on the demonstration of a novel synthetic methodology that I have named Clip-off Chemistry. Unlike most state-of-the-art synthetic approaches, which use bottom-up strategies to link atoms and molecules through the formation of new bonds, Clip-off Chemistry is based instead on the selective cleavage of existing bonds in reticular materials, providing precise spatial control over bond cleavage. In reticular materials, this cleavage can be programmed to enable the synthesis of limitless materials varying by composition (from organic to metal-organic), dimensionality (from 3-D to 0-D) and size-scale (from macro- to nanoscale). Accordingly, in CLIPOFF-CHEM, I will employ clip-off synthesis to prepare a diverse collection of new materials and molecules, including new 3-D metal-organic frameworks (MOFs), low-dimensional (2-D and 1-D) materials, organic polymers, metal-organic polyhedra (MOPs), complexes and macrocycles. Our work will encompass 1) synthesis of the reticular material precursors (MOFs, COFs and MOPs) that incorporate non-cleavable and cleavable (alkene/alkyne) groups in precise positions of their structures; and 2) cleavage of alkene/alkyne groups through ozonolysis to produce the targeted materials. As the resultant products will be novel, we will also endeavor to identify and characterize any unprecedented structural or functional properties of them. I believe that CLIPOFF-CHEM will provide the global scientific community with an innovative methodology for the design and synthesis of new functional molecules and materials.		daniel.maspoch@icn2.cat

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98	Synthetic Chemistry and Materials	Enabling Noble Metal Reactivity with Earth-Abundant Metals for Selective Bond Functionalization Strategies	TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY		Earth-Abundant Metal Catalysis, Cross-Coupling, Metathesis, C-H bond activation, Iron	The functionalization of C=C and C–X bonds (X = I, Cl, Br, and H) is fundamental in organic chemistry for making carbon-carbon bonds or for introducing molecular complexity. Chemists have traditionally relied on precious metals catalyst such as palladium, platinum, and iridium to facilitate these transformations. Some of these metals, if not all of them, are one of the rarest on earth, leading to increasingly high prices and uncertainty in future supply chains. As their availability continues to decline it is important to address the scarcity of these metals to secure a sustainable future. One solution is to develop new technologies that allow one to substitute the precious metal catalysts for those that are abundantly available (e.g., iron), without sacrificing on performance and selectivity. Because of the fundamental differences between the properties of iron (one-electron chemistry) and the second/third-row transition metals (two-electron chemistry), this approach has shown to be a daunting task. If, however, it could be shown that iron could reliably engage in two-electron chemistry, then the reactivity of precious metals could be unlocked for iron. Through bespoke ligand design we will attempt to unlock this two-electron chemistry and apply it to three of the most common reactions in organic synthesis; (i) cross-coupling, (ii) alkene metathesis, and (iii) C–H bond functionalization. By relying on a distinct two-electron mechanism, a treasure trove of possibilities for selective bond forming reactions is generated. Overall, this work is expected to result in new avenues in earth-abundant metal catalysis and provide new methodologies to construct ever important C-C and C-N that can be used to induce molecular complexity.		graham@technion.ac.il
99	Synthetic Chemistry and Materials	Bringing molecular photomagnets to light - achieving magnets through visible light excitation at room temperature	UNIWERSYTET JAGIELLONSKI	https://photomagnet.chemia.uj.edu.pl		Visible light provided by the Sun is the cleanest energy source one could ever imagine. Harvesting it is crucial for further development of science and technology as well as for reducing the ecological footprint of humanity. The efficient use of the visible spectrum of the Sun can take many forms and the direct photoexcitation of molecules resulting in a dramatic magnetization change - the so called photomagnetic effect - is one of them. In other words, sunlight photons could write, read and erase magnetic states of photomagnets. Photomagnets can be designed and prepared via a bottom-up modular approach using low-energy preparation methods developed by coordination, organometallic chemistry, supramolecular chemistry and crystal engineering with the support from physical and computational sciences. Photomagnets belong to the class of smart multifunctional molecular materials that become paramagnetic, ferromagnetic or simply change their magnetic properties upon illumination - a feature that is hardly accessible in conventional magnetic solids - metal alloys and oxides. Currently known photomagnets are merely laboratory curiosities due to extremely low operation temperatures below the boiling point of nitrogen (-196?C). Hence, the overarching goal of LUX-INVENTA is the discovery of room temperature (RT) photomagnets that would show light-induced ON/OFF ferromagnetic switching under normal conditions. This goal will be pursued alongside the deep understanding of the processes occurring during the absorption of a photon by photomagnetic chromophores - the molecular components responsible for the photomagnetic effect. The proposed research focuses on (i) the design and synthesis of novel photomagnetic chromophores, (ii) investigation of the mechanism of the photomagnetic switching and (iii) preparation of RT photomagnets by a rational incorporation of the photomagnetic chromophores in the structure of coordination polymers and metal-organic frameworks		dawid.pinkowicz@uj.edu.pl

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100	Synthetic Chemistry and Materials	Converting N2 directly into amines through multimetallic catalysis	UNIVERSITEIT UTRECHT		Coordination chemistry, N2-activation, Organometallics	Nitrogen containing molecules (amines) are ubiquitous in our daily lives. The N atoms in these essential compounds originate from dinitrogen (N2), but often undergo a vastly energy inefficient route to be incorporated into molecules. Hence, it has been a long-standing goal to develop catalysts that enable the direct conversion of N2 into amines to provide an efficient and sustainable alternative for amine synthesis. While various metal complexes enable the stoichiometric conversion of N2 into amines, a key problem preventing catalytic conversion lies in the incompatibility of the required harsh reductants with the reagents for making N–C bonds. In this project, I aim to develop well-defined molecular catalysts wherein multiple metals work together to directly convert N2 into amines. To this end, I will develop innovative ligand platforms based on rigid core scaffolds, designed to bind 2, 3 or 4 metal centers in close proximity. In a systematic combined experimental and computational study, I will obtain fundamental understanding on how aspects like metal-metal separation, number of metals, reduction state or accessibility of metal sites, affect the cooperative binding and activation of N2. This will enable me to identify design parameters of multimetallic complexes that enable N–C bond formation at metal-bound N2 without requiring harsh reductants. With this information, I will rationally design multimetallic complexes that enable the direct (electro)catalytic conversion of N2 into amines. My strong background and track record in ligand design, N2 activation, multimetallic coordination chemistry and catalysis puts me in a unique position to realize the highly ambitious goals of this project. The N2-CONVERT project will provide a new paradigm on how we look at N2, from an inert molecule to an abundant, cheap and non-toxic N-atom building block. In the long run, it will lay the foundation for a sustainable alternative to the current wasteful way of making amines.		d.l.j.broere@uu.nl
101	Synthetic Chemistry and Materials	Synthetic Bimodal Photoredox Catalysis: Unlocking New Sustainable Light-Driven Reactivity	UNIVERSITA DEGLI STUDI DI PADOVA	101040025	photocatalysis - organic synthesis - reaction mechanism	Solar light is an inexhaustible, abundant, and free reactant that can promote the construction and transformation of molecules. The chemistry community is particularly interested in photocatalysis, which uses light energy to promote a chemical transformation. Photocatalysts (PCs) play a key role in transformative light-driven processes by donating or receiving electrons to or from the target substrate. The selection and structural refinement of PCs can channel reactivity to diverse mechanistic pathways, but often proceeds via trial and error. Here, I will use structure-property relationships to: 1) define novel bimodal organic PCs able to catalyse thermodynamically demanding and opposite photoredox events exploiting their electronically excited state; 2) explore the PCs reactivity by means of their radical ions, going beyond conventional photoredox approaches; 3) capitalise on the new reactivity and bimodal way of action of the PCs to implement novel selective transformations of biological targets under physiological conditions. These project core concepts will be accomplished by the rational evaluation and optimisation of the PCs physicochemical and structural properties as well as the careful analysis of the mechanistic features subtending the light-driven chemical events. Overall, SYNPHOCAT will deliver new conceptual and experimental tools for the sustainable light-driven construction and functionalisation of biorelevant molecules, opening the way to a new dimension of sustainable light-driven chemistry.	organic synthesis - photochemistry	luca.dellamico@unipd.it

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102	Synthetic Chemistry and Materials	Nanoscale Epitaxial Heterostructures Involving Metal Halides	FONDAZIONE ISTITUTO ITALIANO DI TECNOLOGIA		nanocrystals, nanomaterials, photonics, energy, lighting, catalysis, detection, devices	Building epitaxial interfaces between two materials that match each other with atomic precision is key to control the flow of electrons in many technological devices spanning electronics, optics and catalysis. Today, these interfaces are realized also with colloidal nanocrystals, for example in the strongly light emitting core/shell quantum dots used in TV displays. For nanocrystals, the synthesis of epitaxial interfaces based on traditional semiconductors (metal chalcogenides/pnictides, etc.) is well consolidated, while it has been much more challenging with metal halides (including the popular halide perovskites), for two reasons: (i) the attempt of coupling materials that are structurally very different from each other; (ii) the high reactivity of metal halide nanocrystals that defies conventional approaches to make heterostructures. This is regretful, considering that many applications (in lighting, energy conversion, catalysis, etc.) would greatly benefit from the ability to grow heterostructures, also considering the variety of materials belonging to the metal halide family. In NEHA, I will turn the intrinsic reactivity of metal halide nanocrystals into an opportunity to re-design synthetic strategies of nanoscale epitaxial nano-heterostructures in which at least one component is a metal halide. I will leverage on our recent discovery that these heterostructures can form when there is a continuity of ionic sublattices, ensuring that the local coordination of ions at the interface is similar in both components. My aims are to: i) identify materials that can be coupled to form epitaxial heterostructures; ii) uncover the synthesis conditions to make these nano-heterostructures; iii) study their properties, also with advanced techniques and modelling, and transformative behaviour; iv) exploit them in proof-of-concept applications that will benefit from the presence of metal halide interfaces. These will include photocatalysis, photoharvesting and photonic devices.	nanocrystals, nanomaterials, photonics, energy, lighting, catalysis, detection, devices	liberato.manna@iit.it
103	Computer Science and Informatics	Data-Driven and User-Centered Content Moderation	CONSIGLIO NAZIONALE DELLE RICERCHE	https://doi.org/10.3030/101113826	content moderation, social media, social computing, personalization, artificial intelligence	Online platforms apply moderation interventions (MIs) to mitigate misbehavior. Today, MIs are one-size-fits-all, meaning that each intervention is applied in the same way for all users. However, not all users are the same, as they have diverse demographics, ideologies, and personalities. This naive approach to content moderation is platform-centered and neglects user differences. Moreover, content moderation resembles art more than science. The design of MIs is based on common sense and intuition, and progress is sought via trial-and-error rather than via a rigorous scientific process. The inevitable consequence is that current MIs have variable effectiveness, are highly unreliable, and fall short of the moderation needs. The ambitious goal of DEDUCE is to initiate a paradigm-shift in content moderation, by building the theoretical and methodological foundations to move from intuition-driven approaches enforced via one-size-fits-all MIs, to science-driven strategies grounded on personalized moderation interventions (PMIs). We will develop causal methods and indicators to evaluate the effectiveness and fairness of current content moderation practices. Then, we will study how user characteristics influence the outcomes of moderation. Finally, we will leverage the acquired knowledge to design and evaluate PMIs, a first-of-its-kind endeavor. Our data-driven approach will enable us to evaluate in advance the effects of many MIs (what-if analyses) and to plan ahead their application, rather than to assess and correct afterwards. The high-gain nature of DEDUCE is evident, as it will open new directions of research (e.g., the design of PMIs), while also providing major practical and social benefits. Our results will yield groundbreaking advancements in the theory and practice of content moderation, and will be embodied in (i) practical guidelines for moderators and policymakers and (ii) an open-source proof-of-concept system to support both human and automated moderation.	causal discovery and inference, social computing, generative AI, human-computer interaction	stefano.cresci@iit.cnr.it

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104	Computer Science and Informatics	Evolutionary Cellular Computing for Environmental Synthetic Biology	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS			This project will build living evolutionary cellular computers, and showcase them as intelligent bioremediation agents. Current synthetic genetic networks that perform human-defined computations must remain unchanged—as initially designed—in order to perform well. This is a problem, since biological substrate adapts and evolves, compromising durability, robustness, and computing power. We will exploit the intrinsic dynamic features of living systems. ECCO's biocomputers will be able self-adapt and reconfigure at run-time. They will show unprecedented levels of robustness and efficiency—far beyond current technological limits. To this end, we will tackle intra-cellular evolvability and multi-cellular reconfigurability. At the intra-cellular level, we will upgrade current genetic circuitry with pre-defined mutation, evaluation and selection dynamics. Circuits will optimise themselves. At the multi-cellular level, we will design cellular consortia able to reconfigure its structure—therefore changing its functionality—according to environmental needs, thus adaptive. The ECCO project will integrate theoretical developments with in-vivo experimentation. The soil bacteria Pseudomonas putida will be used as a host to illustrate the capabilities of evolutionary genetic circuits. To demonstrate long-run efficiency, bacteria will be used to colonize the root of the plant Arabidopsis thaliana—a much more complex environment than the pristine laboratory conditions where circuits are often characterized. Reconfigurability will be achieved by building a multicellular computer able to switch between metal and aromatic removal circuits—two important pollutants. Evolution, adaptation and reconfigurability are elusive to conventional computers; conveniently, these are intrinsic properties of living organisms. The ECCO will benefit from this in order to engineer living computers that unlock applications in novel domains—from synthetic agriculture to precision bioremediation.		angel.goni@cnb.csic.es

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105	Computer Science and Informatics	Enabling Homomorphic Encryption of Deep Neural Network Models and Datasets in Production Environments	BARCELONA SUPERCOMPUTING CENTER CENTRO NACIONAL DE SUPERCOMPUTACION		Homomorphically Encrypted Deep Learning Inference; Heterogeneous Memory Systems; High-Performance Computing;	Deep learning (DL) is widely used to solve classification problems previously unchallenged, such as face recognition, and presents clear use cases for privacy requirements. Homomorphic encryption (HE) enables operations upon encrypted data, at the expense of vast data size increase. RAM sizes currently limit the use of HE on DL to severely reduced use cases. Recently emerged persistent memory technology (PMEM) offers larger-than-ever RAM spaces, but its performance is far from that of customary DRAM technologies. This project aims at sparking a new class of system architectures for encrypted DL workloads, by eliminating or dramatically reducing data movements across memory/storage hierarchies and network, supported by PMEM technology, overcoming its current severe performance limitations. HomE intends to be a first-time enabler for the encrypted execution of large models that do not fit in DRAM footprints to execute local to accelerators, hundreds of DL models to run simultaneously, and large datasets to be run at high resolution and accuracy. Targeting these ground-breaking goals, HomE enters into unexplored field resulting from the innovative convergence of several disciplines, where wide-ranging research is required in order to assess current and future feasibility. Its main challenge is to develop methodology capable of breaking through the existing software and hardware limitations. HomE proposes a holistic approach yielding highly impactful outcomes that include novel comprehensive performance characterisation, innovative optimisations upon current technology, and pioneering hardware proposals. HomE can spawn a paradigm shift that will revolutionise the convergence of the machine learning and cryptography disciplines, filling a gap of knowledge and opening new horizons such as DL training on HE, currently too demanding even for DRAM. HomE, based on solid evidence, will unveil the great unknown of whether PMEM is a practical enabler for encrypted DL workloads.		antonio.pena@bsc.es
106	Computer Science and Informatics	Specializing TEmporal Planning using Reinforcement Learning	FONDAZIONE BRUNO KESSLER	https://pso.fbk.eu/articles/step-rl/	Automated Planning, Reinforcement Learning, Domain Specialization	Planning - devising a strategy to achieve a desired objective - is one of the basic forms of intelligence. Temporal planning studies the automated synthesis of strategies when time and temporal constraints matter. Temporal planning is one of the most strategic fields of Artificial Intelligence, with applications in autonomous robotics, logistics, flexible production, and many other fields. Historically, the research on temporal planning follows a general-purpose framework: a generic engine searches for the strategy by reasoning on the problem statement (i.e. the starting condition and the desired objective), as well as on a formal model of the domain (i.e. the possible actions). Despite substantial progress in the recent years, domain-independent temporal planning still suffers from scalability issues, and fails to deal with real-word problems. The alternative is to devise ad-hoc, domain-specific solutions that, although efficient, are costly to develop, rigid to maintain, and often inapplicable in non-nominal situations. STEP-RL will study the foundations of a new approach to Temporal Planning, that is domain-independent and efficient at the same time. The idea is to adopt a framework based on Reinforcement Learning, where a domain-independent temporal planner is specialized with respect to the domain at hand. STEP-RL continuously improves its ability to solve temporal planning problems by learning from experience, thus becoming increasingly efficient by means of self-adaptation. STEP-RL will advance the state of the art in temporal planning beyond the "efficiency vs flexibility" dilemma, that I had to personally face in the many industrial projects I worked on.		amicheli@fbk.eu

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107	Computer Science and Informatics	SecuStack: Securing the Leaky Hardware/Software Boundary	STICHTING VU		Program Verification; Side Channels; Hardware	Problem: Side-channel leaks via timing, cache, and speculation can expose sensitive information across traditional isolation barriers, putting our data at risk. Unfortunately, despite decades-long attempts to eliminate these leaks, new attacks are discovered by the day. Fundamentally, this is due to the following mismatch: Today's hardware is extremely complicated because of its myriad fast paths and performance optimizations, yet, we reason about it based on coarse, implicit, and inaccurate models. This divide between model and reality results in leaks and inefficient systems that fail to keep our data safe. Aim: SecuStack wants to put an end to this seemingly endless cycle of new attacks and defenses through a radically new approach based on the following insight: To effectively secure computer systems against side-channel leaks, we need to know when the hardware leaks, at the level of gates, flip-flops, and wires. Approach: SecuStack will leverage this insight via the following four research tasks. First, the SecuStack team will automatically construct per-processor, ground-truth leakage models at the hardware level (T1). Next, we will use those models to describe leakage at the assembly (ISA) level (T2), which in turn will allow us to synthesize provably correct software defenses (T3). These steps build on research breakthroughs from my recent work. To remain feasible for a small team in a five-year timeframe, SecuStack will not target legacy toolchains but instead aim for a breakthrough in a tightly controlled setting, based on open-source RISC-V processors and a custom compilation toolchain. Finally, we will demonstrate immediate practical impact by implementing two challenging case studies: a silicon root of trust and an enclave monitor (T4). Impact: If successful, this ambitious effort will yield the first provably secure end-to-end timing, cache, and speculation safe systems and pave the way towards secure infrastructure for the future.		Kfl900@vu.nl
108	Computer Science and Informatics	Interactions with Future Reach-Through Volumetric Displays	UNIVERSIDAD PUBLICA DE NAVARRA	www.upnalab.com	Volumetric Display, Direct Interaction, Acoustic Levitation, Holography	Displays in the shape of televisions, computer screens or phones are ever present in our education, work and entertainment. However, they do not take full advantage of our inner spatial abilities that we have to interact with the real world. True 3D displays can provide the same visual clues as the real world without forcing the users to wear devices. However, with State of the art (SoA) displays, the users cannot reach inside the display volume to directly interact with the virtual objects as they would do in real life. We envision a volumetric display capable of projecting true 3D virtual objects in mid-air that can be reached by the users to enable direct interaction, i.e. a reach-through volumetric display (RVD). This vision has been presented in multiple movies and books but there is no realization. Three novel technologies will be developed and combined to create an RVD. 1) fast time-multiplexed acoustic fields will create virtual force fields that give shape to microfabricated light-scaterring particles. 2) Tomographic illumination will shine on the particles as a more scalable alternative to phase-based holographic. 3) Volumetric tracking of the particle distribution will control the previous technologies in a closed-loop manner. Applications will serve as benchmarks to test novel interaction techniques and develop a framework that fills in the knowledge gap for interactions with as yet nonexistent RVDs. The objectives of the project are: O1) find a set of technologies that enables the realization of RVDs, O2) create interaction techniques for RVDs and categorize them using a framework that will be applicable to future displays, our current frameworks for 3d-interactions may not be applicable to RVDs. O3) enhance an RVD with tactile sensations, spatial audio and study its effects on humans. The PI is uniquely qualified with experience in designing mid-air interactions and using levitated particles for displays.	Computer Graphics, Holography, Acoustics, Human-Computer Interaction	asier.marzo@unavarra.es

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109	Computer Science and Informatics	ENabling Self-Driving in Uncertain Real Environments	KOC UNIVERSITY		Computer Vision, Self-Driving	ENSURE addresses the challenge of self-driving in uncertain situations of the real world. Due to the difficulty of reasoning in complex real-world scenarios, self-driving remains one of the most difficult research problems today. For safe navigation, the driving agent needs to be able to anticipate the consequences of its actions. Current solutions are reactive without any planning for what might happen in the future. This poses major safety issues and delays the deployment of self-driving vehicles. Without a change in our approach to self-driving, we risk not only realizing fully autonomous driving but also half-baked solutions that endanger lives in uncertain situations. The future is inherently uncertain due to some scene structures such as intersections and the unknown intentions of the other agents. The errors in the perception of the scene and the prediction of the future cause another type of uncertainty. Furthermore, there are rarely encountered situations that might require passing the control to the human driver such as an unknown object on the road. As a way of managing uncertainties in the real world, ENSURE proposes a world model to predict the future with different types of uncertainty in a compact bird's eye view representation. To realize the potential of the world model, ENSURE will put it into action first online in simulation and push its performance to the limit under a controlled setting. The most ambitious goal of ENSURE is to learn to drive in an offline manner from already collected real driving data based on the predictions of the world model. The different types of uncertainties will be used to safeguard against the model's expected failures in the offline setting. Every step of ENSURE will build towards enabling end-to-end driving in the real world and its success in achieving this goal will allow similar success stories in other domains that require reasoning under uncertainty.		fguney@ku.edu.tr
110	Computer Science and Informatics	Entropy for Quantum Information Science	RHEINISCH-WESTFAELISCHE TECHNISCHE HOCHSCHULE AACHEN		Quantum Information Theory	Entropy for quantum systems is the fundamental, interdisciplinary concept to quantify the advantage of quantum technologies for processing of information. It is well-established that the quantum advantage originates from the strong correlations found in the entanglement spectrum of multipartite quantum states, as exactly characterised by the information-theoretic tool quantum entropy. Contrary to the case of classical systems, however, our knowledge about the mathematics of quantum entropy is much more limited. Nonetheless, special entropy inequalities that are known to hold in the quantum case, such as the strong sub-additivity of quantum entropy, give crucial insights into the entanglement structure of multipartite quantum states. In this project, I will focus on understanding multipartite entropic constraints, which will lead to tight characterisations of the ultimate, physical limits of quantum information processing. My recent mathematical works in quantum information led to operational extensions of the concept of strong sub-additivity from the seventies. Starting from that, I propose a research program that will lead to an understanding of quantum entropy that is on the same level as for the classical, commutative case. In the first part of my project, I will establish techniques in matrix analysis and optimisation theory to understand the interplay of arbitrarily many non-commuting operators. This mathematical framework will allow to prove novel quantum entropy inequalities that lead to refined approximations on the entanglement structure of multipartite quantum states. Second, I will employ the newly obtained entropic constraints to derive approximation algorithms for a plethora of fundamental problems in quantum information science. This includes schemes for achieving the physical limits of cryptography, resolving entropic additivity questions in information theory, and providing algorithms for the description of strongly interacting many body systems.	Mathematical Physics, Quantum Shannon Theory	berta@physik.rwth-aachen.de

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111	Computer Science and Informatics	New Frontiers in Information-Theoretic Secure Computation	TEL AVIV UNIVERSITY		Cryptography, Secure Computation, Computational Complexity, Secret Sharing	Information-theoretic secure computation is a general-purpose technique for processing sensitive data without compromising its confidentiality or integrity even in the presence of a computationally-unbounded all-powerful adversary. This notion plays an important role in cryptography, both as a stand-alone object and as a tool for computational constructs. Despite its increasing importance, we have a very limited understanding of the *intrinsic complexity* of information-theoretic security, and some of the most central feasibility questions in this area have remained open for more than three decades. In this proposal, we aim to decipher the power and limitations of this notion. We will focus on three main objectives. First, we aim to improve the complexity of general *secret sharing schemes* and exploit such improvements towards realizing highly-efficient general-purpose zero-knowledge proofs. The second objective is to explore the complexity of Secure Non-Interactive Reductions and Multiparty Randomized Encoding -- a powerful generalization of information-theoretic garbled circuits that was recently presented by the PI. The third objective is to expand our theoretical understanding of constant-round information-theoretic protocols, optimize their round complexity, and study their concrete and asymptotic computational complexity. Being part of several recent exciting developments in these areas, we believe that it is now possible to make progress in some of these basic open problems. The suggested research will bridge across different regions of computer science such as coding theory, cryptography, and computational complexity. It is expected to impact central problems in cryptography, while enriching the general landscape of theoretical computer science.	Strong publication record in leading venues in cryptography or closely related areas.	ionas@tauex.tau.ac.il.
112	Computer Science and Informatics	Exact and Approximate Computation of Tensors and Polynomials	TEL AVIV UNIVERSITY		Algebraic complexity, theoretical computer science, Algebraic geometry	This research proposal will address fundamental problems concerning the complexity of computing and manipulating polynomials. For example, consider the following questions: 1. What is the complexity of computing the total weight of perfect matchings of a weighted graph? 2. Is there an efficient deterministic parallel algorithm that determines whether a graph has a perfect matching? 3. Is approximation much easier than exact computation? 4. How many EPR pairs can we distill from a given quantum state? These seemingly unrelated questions represent some of the most important and challenging open problems in theoretical computer science: the first is the algebraic analog of the famous P vs. NP problem. The second question amounts to asking whether a symbolic matrix associated with the graph has full rank. Parallel randomized algorithms for computing this rank are known, but not deterministic ones. This is an instance of the polynomial identity testing (PIT) problem, the most fundamental algebraic derandomization problem. The third question asks about the relation between a complexity class and its closure, which lies at the heart of the Geometric Complexity Theory (GCT) program. The last question concerns the subrank of a tensor representing the given quantum state. Problems related to rank of tensors are at the heart of both algebraic complexity and quantum information theory. Recent years have seen tremendous advance in our understanding of algebraic computations with new lower bounds, new PIT algorithms and with increasing connections to other branches of computer science and mathematics discovered. Results proved by the PI play an important role in all of these advances. This project aims to study these and related problems and to develop new methods for solving them. Making progress on any of these problems will constitute a significant breakthrough.	Algebraic complexity, theoretical computer science, Algebraic geometry	shpilka@tauex.tau.ac.il

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113	Computer Science and Informatics	Inference in High Dimensions: Light-speed Algorithms and Information Limits	INSTITUTE OF SCIENCE AND TECHNOLOGY AUSTRIA		Theory of Machine Learning, Information Theory, High-dimensional Statistics, Genome-Wide Association Studies (GWAS), Approximate Message Passing (AMP), Spectral Estimators, Neural Networks, Mean-field Analysis	Extracting information from data is the key challenge of our time, and in many applications (e.g., genome-wide association studies, data compression, and virtual assistants such as ChatGPT) both the data and the machine learning model used to extract information are increasingly high-dimensional. As traditional statistical theory is ill-equipped to face this explosion in the dimensionality of the problem, machine learning is now predominantly experimental. However, empirical approaches come with huge costs affordable only to large companies, and they lack interpretability, which is especially troublesome in medical applications. To address these issues, the INF^2 project develops information-theoretically principled methods for high-dimensional inference in machine learning and data science. The key insight is that, via a “mean-field” approach, high-dimensional quantities are well approximated by low-dimensional ones and then characterized exactly. Leveraging this characterization, we will (i) establish the fundamental limits of inference, i.e., the minimal amount of data necessary to solve the problem, and (ii) design efficient algorithms requiring only the minimal amount of data. The challenge we tackle is to apply this paradigm to practical settings, in which data are structured and heterogeneous (as in genome-wide association studies), and models consist of complex architectures tailored to applications (auto-encoders for data compression, and transformers for ChatGPT). Through a novel analysis of spectral methods, approximate message passing and gradient descent, INF^2 builds a theoretical framework having conceptual impact, as well as vast applicability, in machine learning and information theory. This framework is then brought to the real world via applications in genome-wide association studies. Broadly, our results enable the principled design of machine learning algorithms and models, drastically reducing costs and providing interpretable solutions.		marco.mondelli@ist.ac.at
114	Systems and Communication Engineering	Learning to Control - Smart and Data-Driven Formal Methods for Cyber-Physical Systems control	UNIVERSITE CATHOLIQUE DE LOUVAIN	https://perso.uclouvain.be/raphael.jungers/		The engineered systems surrounding us are increasingly hard to control. Not only the complicated interaction of the physical processes with the machines that control them, but also specifications (cyber-security, safety, privacy, resilience, resource-efficiency, decentralization) are more and more complex, and critical. Last but not least, in an increasing number of situations, no model of the system is available (or the model is too complex), and one needs to ‘learn’ the optimal way of controlling the system by the mere observation of data. Our technological world is living a paradigm shift, which is often coined as the Cyber-Physical Revolution, or the Industry 4.0. In view of these specificities, the only sensible way of controlling these complex systems is often by discretizing the different variables, thus transforming the model into a simple combinatorial problem on a finite-state automaton, called an abstraction of this system. Until now, this approach has not been proved useful beyond academic, small examples, as it scales very poorly. The goal of L2C is to transform this approach into an effective, scalable, cutting-edge technology that will address the CPS challenges and unlock their potential. This ambitious goal will be achieved by leveraging powerful tools from Mathematical Engineering. Out of this research, a state-of-the-art software platform will promote our results and translate them into directly usable solutions for the scientific and industrial communities. L2C is a pluridisciplinary project at the frontier between Control Engineering, Computer Science and Applied Mathematics. It bridges the gap between rich innovative techniques and emerging challenges in Control. It impacts both fundamental Science and Engineering, as the theoretical research is driven and fostered by cutting edge technological challenges.		raphael.jungers@uclouvain.be

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115	Systems and Communication Engineering	Non-invasive patterned electrical neurostimulation of the retina	TEL AVIV UNIVERSITY	https://www.yaelhanein.sites.tau.ac.il/projects-6	Neurotechnology	Retinal implants remain one of the most demanding technologies in brain-machine interfacing. State of the art devices have yet to reach the needed performances. Main barriers are sub-optimal stimulation parameters and long development and testing procedures. While invasive approaches, have yet to achieve the resolution performances needed by million of patients blinded by retinal degenerative diseases, non-invasive approaches in the form of trans-orbital stimulation have received no attention, yet they offer potentially dramatically cheaper and easy to adapt and optimize technology. The main goal of this project is to advance the field of retina neurostimulation by developing new tools for the study and interfacing with the retina. In particular: (1) Bi-directional electrophysiological interface which can record and stimulate the intact retina (in the eye) and (2) soft multi-electrode arrays for non-invasive stimulation of the retina (soft trans-orbital electrodes) will be explored. We will use these tools to study the retina in its intact form (in animal models) and we will implement the gained know-how in humans to study non-invasive stimulation. In this project we will establish a new platform for bi-directional electrophysiological interfacing with the intact retina and we will use it to study the retina in its intact form. Such investigations have ground breaking nature as they can advance both the fundamental understanding of the retina and improve the manner by which we stimulate the retina to generate artificial vision: Specifically, we aim to record spontaneous waves activity and light sensitive ganglion cells, optimize electrical stimulation parameters in the intact retina, and ultimately to measure retina responses to trans-orbit stimulation. As the ultimate goal of the project, we aim to establish the foundation of trans-orbital stimulation as a new non-invasive paradigm for functional vision in patient suffering from retina degenerative diseases.		yaelha@tauex.tau.ac.il
116	Systems and Communication Engineering	All-optical photoacoustic imaging for neurobiology	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS		photoacoustic imaging - optical sensing of ultrasound - calcium imaging	Measuring the electrical activity of neurons in vivo is of paramount importance to understand the underlying principles of the brain. Current imaging techniques fail to capture this activity across the entire brain with sufficient spatial or temporal resolutions, while leaving brain tissue intact. Non-linear fluorescence microscopy, the most widespread optical imaging modality in system neurobiology, provides optical diffraction limited resolution and high frame rate, but is limited to shallow depth due to light scattering in tissue. Single-neuron activity in brain regions deeper than one millimeter can therefore not be probed. Combining widefield optical excitation and ultrasonic detection, photoacoustic imaging has emerged in the last decades as a powerful technique to image of optically contrasted objects embedded deep inside biological tissue. It relies on the emission of ultrasound waves upon the absorption of a light pulse. As ultrasound are only weakly scattered when propagating in soft tissue, optically absorbing structures can be reconstructed from the sole measurement of the ultrasound field at the tissue surface. The highest spatial resolution is currently achieved using optical sensors of pressure waves, which exhibit a better sensitivity to high ultrasound frequencies compared to conventional piezoelectric detectors. However, single-cell resolution is still beyond the reach of such sensors, and the underlying sequential acquisition process prevent from imaging at sufficient frame rate. To address this challenge, I will develop new sensors and associated interrogation techniques with 1) high acquisition speed and 2) high sensitivity at high acoustic frequencies, to resolve temporally and spatially the activity of single neurons. This will enable to 3) image non-invasively neuronal activity at unprecedented depth of several millimeters in vivo in the mouse brain.	experimentalist in optics - expert in multiphysics modelling - expert in thin film fabrication techniques (polymer, optical) - ultrasound characterization of materials	thomas.chaigne@fresnel.fr

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117	Systems and Communication Engineering	Integrated Mechanistic Modelling and Analysis of Large-scale Biomedical Data	RHEINISCHE FRIEDRICH-WILHELMS-UNIVERSITAT BONN			Modern cancer therapeutics target signalling processes within the cancer cells and the interaction of cancer and immune cells. A comprehensive understanding of these signalling processes is therefore essential to identify drug targets, plan clinical trials, and to select suitable drugs, drug combinations and drug dosages for a specific patient. Yet, most of the available mathematical models capture only a small number of molecular species and pathways, thereby ignoring important crosstalk and feedback loops. Furthermore, these models are usually based on experimental data for cell lines, which behave differently from complex cancer tissues. In INTEGRATE, I will develop computational methods for the full process of data-driven modelling of signalling processes in cancer, ranging from model development to parameterisation all the way to uncertainty analysis. To this end, I will combine methods from the fields of mathematical modelling, machine learning, and signal processing with established approaches in systems biology. The model development will employ natural language processing and an automatic testing framework. For federated model inference, I will develop scalable mini-batch optimisation and marginalisation based uncertainty quantification. To refine models, I will exploit tools from signal processing, such as blind identification of latent variables. I will apply the developed scalable mechanistic modelling approach to integrate large-scale biomedical data for molecular phenotyping studies and clinical trials across sites. This will provide mechanistic models reconciling the available data. The study will, for the first time, combine mechanistic modelling and machine learning for the integrated analysis of patient-derived omics and phenotypic data. By linking these data sources, INTEGRATE will deepen our understanding of biological signal processing and provide the basis for the development of digital twins.	Cancer, cancer signalling, tumour micro environment, mathematical modelling, simulation, parameter estimation, machine learning	jan.hasenauer@uni-bonn.de
118	Systems and Communication Engineering	Smart E-skins for Life-like Soft Robot Perception	THE UNIVERSITY OF EDINBURGH		Soft sensors, robotics, machine learning	Nature, through millennia of evolution, has endowed living organisms with unmatched sensory adaptability. As robotics weave more deeply into the fabric of human society, a compelling challenge emerges: mimicking the sensory intelligence intrinsic to these life forms. The intricate synergy between the organism’s skin and brain, delivering unrivalled sensory insight and data interpretation, epitomises a domain in robotics still uncharted. Cultivating such perceptive sense in robots is crucial; it heralds a future with enhanced safety and adaptability in human-robot interactions, revealing new horizons for innovative applications. SELECT aims to bridge this perception gap in soft robotics – a rapidly evolving robotic field inspired by the softness of living beings. At the heart of SELECT lies the ambition to pioneer smart electronic skins (e-skins) that resonate with the sensory capability of organisms. SELECT's objectives include: 1. Develop multi-modal e-skins for holistic perception. 2. Build models to simulate the integration of e-skins and robots. 3. Explore automated, adaptive e-skin designs. 4. Advance learning algorithms to decode e-skin data. 5. Streamline e-skin deployment and training. SELECT's outcomes promise to redefine soft robot perception, synergising e-skin sensory attributes with state-of-the-art machine learning. Beyond advancing robotics, SELECT envisions reshaping our interaction dynamics with intelligent systems, championing a new epoch of human-machine symbiosis.	soft robotics, soft electronics	y.yang@ed.ac.uk

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119	Systems and Communication Engineering	Extracting the Human Motor Null Space from Muscles - A new framework to measure human neural activity	UNIVERSIDAD DE ZARAGOZA		Movement Neuroscience; Motor neuron; Neural signal processing; Brain Rhythms	By contracting our muscles, we move and interact with the world. In turn, the activated muscles act as signal repeaters of the neural inputs they receive. Muscles do not only receive inputs determining how they need to contract (and thereby how we move), but they also receive a rich set of neural information originating in the central nervous system and traveling through nerves and muscles without directly altering motor commands. This 'motor null space' in the muscles may represent a unique opportunity to explore the human central nervous system in an unobtrusive, spatially selective, and robust way, thereby overcoming the most critical inherent limitations of currently available non-invasive neuroimaging technologies. To test this novel concept, fundamental research is needed to develop methods to extract, separate, and interpret the non-motor neural projections to human muscles. ECHOES will capitalize on recent breakthroughs in decoding the spinal outputs to muscles to develop a theoretical and experimental framework to unveil the 'motor null space' in human muscles. The project will then demonstrate the potential benefits of the extracted neural information in three scientific fields with growing societal and clinical impact: human-machine interfaces, targeted brain neuromodulation, and diagnosis of movement disorders. I expect that the project's multidisciplinary research program will further our understanding of the origin and relevance of neural signals generated by the human brain and spinal cord. This will markedly improve future research aimed to understand, use, and modulate human neural activity by providing a first-of-its-kind, minimally invasive, and robust neuroimaging technology with unprecedented spatio-temporal resolution. By achieving these goals, ECHOES technology will enable the development of new applications for the clinical and industry fields.		jibanez@unizar.es
120	Systems and Communication Engineering	From single cells to microbial consortia: bridging the gaps between synthetic circuit design and emerging dynamics of heterogeneous populations	INSTITUT NATIONAL DE RECHERCHE EN INFORMATIQUE ET AUTOMATIQUE		stochastic processes in biology	A key turning point in the evolution of life was the transition from single-cell to multicellular organisms and the optimization of fitness via division of labour and specialization. Similarly, microorganisms have evolved equivalent strategies by forming communities or consortia. Division of labour in isogenic microbial populations is often implemented by mechanisms that create or act upon population heterogeneity to diversify functionality. Rational design in synthetic biology, on the other hand, is focused on the engineering of gene circuits with deterministically predictable functionality within single cells. While synthetic biology has certainly come a long way, predictable functionality of circuits in growing microbial populations still remains elusive or limited to tightly constrained operating conditions. We will develop novel mathematical methods to characterize and control the dynamics of synthetic gene circuits within growing microbial populations. We will develop a modelling framework and novel computational methods that take both stochasticity of single-cell processes and consequences of heterogeneity for population dynamics into account. On the mathematical side, this necessitates coupling single-cell stochastic processes to state dependent population processes such as growth or selection. We will develop methods for parameter inference, experimental design and control for such models. This will enable the construction of models that can be used to design synthetic circuits that function as specified within growing populations and that can be deployed to regulate single-cell processes such that desirable dynamics emerge at the scale of populations and consortia. We will apply the methodology for bioproduction problems in which proteins that are hard to fold need to be produced. Overproducing such proteins impairs cellular growth, which creates couplings between single-cell and population processes and raises the need to feedback control production.		jakob.ruess@inria.fr

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121	Systems and Communication Engineering	Correlated Ion elecTRonfOr Nanoscience	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	https://cordis.europa.eu/project/id/101055250	Atomic and molecular physics, Rydberg atoms, ion beam, electron beam, electron microscopy, focused ion beam, charged particles optics, time and position sensitive detectors	Electron and Ion beams have become indispensable tools in surface and materials science. Many applications rely on extreme miniaturization, like in nanostructuring and doping, which imposes to control the energy, the number and the locations of electrons or ions at the nanometric level. The CITRON project aims at achieving breakthroughs in focused ion and electron beams, exploiting monochromaticity in the low-energy domain (eV-keV) to reach such a fine level of control of the sources of charged particles. In contrast with standard tools, the proposed developments rely on the ionization of a neutral atomic species and on the simultaneous production, detection and control of both the ion and the electron. Such a detection in coincidence yields correlated information on both particles that can be used to improve the beam properties, like the deterministic knowledge of the creation of the charged particles, and the correction of their trajectories in real time. Using this novel technique, which I have recently demonstrated the feasibility with my group, I propose to develop three innovative prototypes: • 1) A focused ion beam using feedback control with unprecedented focused properties. I will used it to realize semiconductor circuit-editing at the (sub-)nm scale. • 2) A deterministic source of (potentially) any type of ion for controlled implantation at the nm level. I will use it for on-demand doping of quantum devices. • 3) A high-resolution electron-energy-loss microscope with precise knowledge of the electron energy and the position on the sample. I will use it to realize both imaging and vibrational spectroscopy for surface analysis. The synergy between the three prototypes is based on atomic beam laser excitation to create a monoenergetic beam of charged particles, with energy and position controlled by correlation between oppositely charged particles. All will require dedicated optical columns designs and fast time and position sensitive detectors.		daniel.comparat@cnrs.fr
122	Systems and Communication Engineering	Terahertz Ultra Strong Coupling for mAcromolecules structure aNalYse & control	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	https://www.tuscany-erc.fr/	Terahertz, Spectroscopy, protein, strong coupling	MacroMolecules (e.g Proteins, DNA) carry out most of the functions of the living and these functions come from their 3D-structure. For instance, foldopathy like Alzheimer's and Parkinson's disease are caused by misfolding of proteins. Modifying this structure non-invasively is consequently a tremendous challenge for both microbiology research and applications. Besides, light-Matter strong coupling (SC) occurs when a material is located at a high density of state of a photonic mode resonant with one of its transitions. Extensively studied in optics and quantum physics, SC recently gave exciting results in chemistry with the demonstration of its ability to change the product ratio of several chemical reactions. Experimental and theoretical results unveil that macromolecules have delocalized vibrations over their whole 3D-structure in the Terahertz (THz) range. Therefore, one can ask if the functions of macromolecules can be modified by implementing strong coupling on the vibration of macromolecules in the THz. In Tuscany, I will develop µ/nano THz photonics devices and experiments to establish reliable methods for macromolecules THz spectroscopy from cryogenic to body temperatures on samples from the single macromolecules to the cell culture. Then, I will demonstrate vibrational SC in the THz on these samples. Finally, I will demonstrate that the function of macromolecules, including catalysis and macromolecules assembly can be modified by selectively coupling individual vibrational modes from the single macromolecules up to in vivo experiments with prion propagation and viral capsid assembly. My overall aim is to understand in detail the vibrational strong coupling in the THz range for macromolecules and make it a useful tool for biochemists and biophysicists. In the longer term, I hope this knowledge will seed the design of new approaches in µbiology leading to medical treatments impeding the proteins aggregation and ultimately the evolution of the foldopathies.	photonics, terahertz, light matter interaction	romain.peretti@cnrs.fr

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123	Systems and Communication Engineering	Lensless label-free nanoscopy	POLITECHNIKA WARSZAWSKA	https://qcilab.mchtr.pw.edu.pl/	computational imaging, digital holography, lensless microscopy, biophotonics	Optical nanoscopy has changed the “seeing is believing” paradigm. This was achieved within a limited field of view (FOV~100µm2) and required fluorescent markers. Large-FOV high-throughput live unimpaired cell imaging is crucial for biology and biomedicine. Hence, improving the space bandwidth product (SBP) using time-consuming scanning stitching is not a good solution. Lensless holographic microscopy (LHM) inherently bypasses FOV limitations by using full sensor-size hologram reconstruction for label-free object information retrieval. Its major limitation, not yet addressed, is its low lateral (~1µm) and axial (~3µm) resolution. I will overcome this fundamental problem by pioneering deep UV (DUV) lensless holotomographic nanoscopy (LHN) as a simple and compact device easily operated inside the cell chamber or outside the laboratory (in contrast to lens-based systems). Owing to DNA damage, DUV is used to sterilize and never image bio-samples. This paradigm will be shifted to provide a breakthrough 10 giga pixel SBP via a low-dose DUV optical-elements-free (no cost, no radiation loss) lensless setup with a worlds-first full-angle tomographic scenario, numerical aperture > 1, and a new class of reconstruction algorithms to decrease the effective pixel (to 100 nm) and remove background noise. I will use LHN to enable the discovery of a new mechanistic understanding of extracellular vesicles expression and intake within large live cell cultures with single-vesicle resolution. EVs, nanosized lipid spheres released by virtually every cell type, are currently emerging as novel disease biomarkers and drug nanovehicles. LHN is a new research field that inherently makes this a high-risk project, but the potential gains are also high as a new era of simple ultrahigh SBP nanoimaging might be opened. The proposed multidisciplinary project calls for near-unique expertise in computational microscopy and digital holography, which I acquired in cooperation with international leaders.		maciej.trusiak@pw.edu.pl
124	Systems and Communication Engineering	Chip-based room-temperature terahertz frequency comb spectrometers	POLITECHNIKA WROCLAWSKA	https://sterczewski.com/	THz radiation, chip-scale, semiconductor laser, far-infrared	Although visual perception of humans is limited to a fraction of wavelengths spanning the electromagnetic spectrum, technological advances enable us to see in other spectral regions by providing suitable sources and detectors. Of particular interest for many applications is the ability to probe objects in the terahertz (THz) range, which bridges the microwave and infrared domains. THz radiation offers unique opportunities for imaging or sensing due to its high transmission by optically-opaque materials like paper, textiles, ceramics or plastics, while for gas sensing it enables identification of structurally-complex molecules. Unfortunately, access to this region is difficult due to limitations of conventional electronics and photonics, and often involves cryogenic operation. Even the most mature systems operating at room temperature, despite years of advances, still struggle to provide chip-scale miniaturization of the source and detector, and moving-parts-free acquisition of a broadband THz spectrum. Here, to fill this niche and address the critical demand for broadband, chip-based THz spectroscopy without any moving parts, we propose to leverage mid-infrared (3-5 um) semiconductor laser frequency combs based on interband cascade lasers (ICL). We postulate that nonlinear frequency conversion due to the recently discovered second order susceptibility of the ICL medium can be used to obtain microwatt to sub-milliwatt level of THz power at a battery-compatible bias. A complementary mid-infrared photomixer technology envisioned in this proposal will additionally enable coherent detection of broadband THz comb radiation at room temperature. Although the project is inherently risky due to uncertainties in the ultrafast dynamics of semiconductor structures, losses in the terahertz range, and fabrication complexity, it is timely and strongly demanded by the community. It will unlock new opportunities across many disciplines ranging from chemistry to 6G telecommunications.	semiconductor laser modeling, nonlinear frequency conversion	lukasz.sterczewski@pwr.edu.pl

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125	Systems and Communication Engineering	Transmission over Channels with Insertions and Deletions	BILKENT UNIVERSITESI VAKIF		information theory, coding, insertion/deletion, DNA storage	Insertions and deletions represent perhaps the most challenging impairments exhibited by communication channels in a wide range of applications from recording systems and covert communications to DNA storage. While tremendous progress has been made in determining the ultimate limits of communication using information-theoretic tools as well as in designing and implementing signaling solutions for various channel models with practical significance; for the case of insertion/deletion channels, even the simple scenarios are not fully understood. For instance, we do even not know the capacity of the basic independent and identically distributed binary deletion channel. TRANCIDS will take on the monumental challenge of conquering the insertions and deletions by developing precise theoretical limits of communication and by designing explicit and implementable coding solutions approaching these limits. Specifically, TRANCIDS will 1) establish with precision the capacity of basic deletion/insertion channels, and obtain tight upper and lower bounds on the capacities of more sophisticated channel models encountered in practice (including the effects of noise and interference); 2) formulate and explore wireless communication problems with insertions and deletions (including multi-input and multi-output systems as well as different multi-user communications settings); 3) develop explicit and implementable channel coding solutions for a variety of channel models with insertions and deletions of practical importance; 4) address the channel capacity and code design problems for channels with additional impairments such as permutations as motivated by in-vivo DNA storage applications. TRANCIDS will highly impact different emerging applications such as DNA storage and beyond 5G wireless communications. Furthermore, the findings will help facilitate the development of DNA computing technologies of the future.		duman@ee.bilkent.edu.tr
126	Systems and Communication Engineering	Micro-Macro Secure Control of Infinite-Dimensional Transport Systems	POLYTECHNEIO KRITIS	https://c-nora.tuc.gr/	Control Theory, Partial Differential Equations, Blood Flow, Epidemics Spreading	Although "transport" may imply different notions for different scientific fields, the feature of incorporation of interacting system components through which "information" is propagated remains invariant. Biological transport systems is an example whose significance has become evident with the recent outbreak of COVID-19 spreading. Blood transport in cardiovascular systems falls also under this category. The urgent need of design of efficient/safe, epidemics spreading suppression and congested blood transport monitoring, strategies is apparent, considering the potential, significant socioeconomic impact. However, the continuum, spatiotemporally-varying nature of such interconnected systems, in addition to dynamic complexity and limited available control authority, hamper development of systematic feedback control design and analysis methodologies. C-NORA aims at introduction of a pioneering holistic framework for systematic, computationally tractable control design and analysis of large-scale, interacting, distributed parameter transport systems, which i) harmonizes control at micro-macro levels, ii) accounts in design for all essential dynamic phenomena, iii) compensates adverse effects of limited control authority in design, and iv) develops ad hoc tools for system-specific analysis. C-NORA new control design and analysis tools will be demonstrated in distributed parameter, epidemiological/cardiovascular transport systems and will be validated in numerical simulation. C-NORA high risk lies in unification and complexity of heterogenous, unexplored infinite-dimensional systems, whose treatment requires rethinking of fundamental control-theoretic tools. C-NORA high scientific gain lies in that, on the way of executing its key ideas, novel, interdisciplinary concepts and groundbreaking control/analysis methodologies will be introduced, while unprecedented research arenas will open for systems and control, transport, mathematicians, and systems biologists.	Control Theory, Partial Differential Equations, Blood Flow, Epidemics Spreading	nlimperis@tuc.gr

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127	Systems and Communication Engineering	Memristive Neurons and Synapses for Neuromorphic Edge Computing	NAMLAB GGMBH			In recent years, Artificial Intelligence has shifted towards collaborative learning paradigms, where multiple systems acquire and elaborate data in real-time and share their experience to improve their performance. MEMRINESS will generate new fundamental computing primitives that will overcome the current challenges for the deployment of intelligent systems on the edge. The requirements of a system operating on the edge are very tight: power efficiency, low area occupation, fast response times, and online learning. Brain-inspired architectures such as Spiking Neural Networks (SNNs) use artificial neurons and synapses that perform low-latency computation and internal-state storage simultaneously with very low power consumption, but at present they mainly rely on standard technologies, which make SNNs unfit to meet the above-mentioned constraints. Indeed, the dream of compact and efficient neurons and synapses, able to work at different time scales to match real-time constants and to retain memory of their state even in the absence of a power supply, cannot be realised without flanking standard technologies with emerging ones. In this respect, memristive technology has shown promising results, due to its ability to support non-volatile storage of the SNN parameters. Yet so far, research has prioritised the non-volatile properties of the devices rather than focusing additionally on the reproduction of multi-temporal synaptic and neural dynamics. To solve this problem, I will develop neurons and synapses that exploit the intrinsic physical characteristics and dynamics of volatile and non-volatile memristive devices to enable the design of compact, power efficient SNNs with multi timescale dynamics. I will use a holistic approach and co-develop every aspect, from the devices to the circuits, to the learning algorithms. I will use the results to design a SNN and demonstrate its collaborative and online learning capabilities in three scenarios of increasing complexity.		e.covi@rug.nl
128	Systems and Communication Engineering	Wireless Networks within Next-Generation Computing Systems	UNIVERSITAT POLITECNICA DE CATALUNYA	https://winc-project.eu/	Wireless Interconnects, Computer Architecture, Quantum Computing	Computing systems are ubiquitous in our daily life and have transformed the way we learn, work, or communicate with each other, to the point that progress is intimately tied to the improvements brought by new generations of the processors that lie at the heart of these systems. A common trait of current computing systems is that their internal data communication has become a fundamental bottleneck. The anticipated death of Moore's Law has forced computer scientists and architects to find new ways to build faster processors, which include massive parallelization, specialized accelerator design, and disruptive technologies such as quantum computing. These trends cause an exponential increase in the volume and variability of data transfers within computing systems, rendering traditional interconnects insufficient and threatening to halt progress unless fast and versatile communication alternatives are developed. In this context, the WINC project envisions a revolution in computer architecture enabled by the integration of wireless networks within computing systems. The main hypothesis is that wireless terahertz technology will lead to at least a tenfold improvement in the speed, efficiency, and scalability of both non-quantum and quantum systems. With a cross-cutting approach, WINC aims to validate the hypothesis by (i) revealing the fundamental limits of wireless communications within computing packages, (ii) developing antennas and protocols that operate close to those limits while complying with the stringent constraints of the scenario, and (iii) developing radically novel architectures that translate the unique benefits of the wireless vision into order-of-magnitude improvements at the system level. If successful, WINC will be the seed of a new generation of non-quantum and quantum systems and foster progress in the computing field for the decades to come.		abadal@ac.upc.edu

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129	Systems and Communication Engineering	Towards no-drift sensors with on-chip self-calibration	BILKENT UNIVERSITESI VAKIF	https://erc-hotcores.univ-lille.fr/	MEMS, inertial sensors, stress sensors, sensor calibration, sensor interfaces	Sensor drift is a major problem for inertial sensors and limits their usage in autonomous navigation applications. Inertial sensor data is integrated to find the position and drift leads to error accumulation. A common drift suppression approach is temperature calibration, but ovenized state of the art sensors still exhibit drift. Instead of using temperature as a drift indicator, I have pursued a non-conventional approach and measured on-chip stress that directly correlates with drift. The device interacts with its surroundings through the anchors and on-chip stress accurately estimates drift. I am the leading researcher in the stress compensation field, and I have recently demonstrated that MEMS gyroscope drift could be eliminated with stress compensation. My long-term stability results at 2 days of averaging are unrivaled, but the calibration algorithm is not practical. Different from temperature calibration, stress calibrating a device is difficult. I propose a sensor system that would convert my proof of concept work into a practical 0-drift sensor with self-calibration. The proposed system consists of a circular MEMS sensor with multiple (~100) distributed stress sensors and piezoelectric stress transducers, a machine learning supported analytical calibration model, a custom ASIC for superior noise, and an FPGA for system control and self-calibration. If successful, the proposed approach would improve the MEMS gyroscope stability by >100X to the levels of 10-4 – 10-5°/h, enabling error-free, only gravity-referenced inertial navigation. Unlike GPS or camera, inertial navigation works under all weather, light, and location conditions providing a stable reference to navigation algorithms. With further miniaturization, 0-drift sensors could fit into smartphones, and reliable indoor navigation would become a reality. The compact, low-cost sensor could also disrupt the precision inertial market dominated by bulky and expensive fiber-optic and laser sensors.		etatar@ee.bilkent.edu.tr
130	Products and Processes Engineering	Aluminum STEAM combustion for clean energy	TECHNISCHE UNIVERSITAT DARMSTADT	https://www.asteam.tu-darmstadt.de/	combustion, metal fuels, aluminum, renewable energy, hydrogen production	Metal fuels are emerging as a zero-carbon, high-energy density replacement for fossil fuels due to their availability and recyclability using renewable energy. Aluminum (Al) powder has been investigated mostly in air/O2 as an additive in solid rocket engines. Recently, Al continuous pressurized combustion in steam has attracted considerable interest for on-demand co-production of high-temperature heat and H2. Combustion in pressurized steam lowers flame temperatures and minimizes emissions of undesirable and hard-to-collect Al2O3 nanoparticles. Quantitative understanding of the dynamics of multi-phase and multi-scale Al-steam flames, driven by microscopic transport processes, phase changes, as well as homogeneous and heterogeneous chemical reactions at the particle level, is largely lacking. A-STEAM will unravel the fundamental properties of pressurized Al-steam flames for the entire scientific chain, from single particles to turbulent flames with millions of particles, through a well-orchestrated combination of high-fidelity simulations, advanced modeling, and tailored experiments. We will combine and develop our unique computational capabilities in fully resolved direct numerical simulations (FR-DNS) at the particle level, novel particle-in-cell (PIC) models considering particle-attached/particle-detached flames and Al2O3 nanoparticle formation, carrier-phase DNS (CP-DNS), and large eddy simulations (LES) of turbulent confined flames. The unique combination of numerical studies and tailored experiments will lead to a substantial breakthrough in knowledge by quantifying physicochemical processes in Al-steam combustion, bridging the gap between single particles and turbulent flames. Our numerical-experimental database of reference Al-steam flames, together with science-based best practice guidelines for future Al burners, will also empower the broader metal fuel research community and guide future system design and implementation of this carbon-free technology.	metal particle combustion, high temperature oxidation of aluminum	hasse@stfs.tu-darmstadt.de

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131	Products and Processes Engineering	Towards Future Interfaces With Tuneable Adhesion By Dynamic Excitation	POLITECNICO DI BARI	https://tribodynamicslab.poliba.it/	adhesion, viscoelasticity, soft material, polymers, contact mechanics	Macroscopic adhesion is of utmost importance in key technologies such as soft and climbing robots, aerospace grasping technologies, human-robot interactions, pick-and-place manipulators. Commonly, bioinspired adhesives interfaces have been characterized from a quasi-static perspective, neglecting the effect of dynamic excitations. Nevertheless, recent observations suggest that added micro-vibrations may be exploited to strongly enhance and rapidly tune macroscopic adhesion. By exploiting the multiplicative coupling between geometric- and viscoelastic vibration-induced enhancements of macroscopic adhesion, SURFACE aims at designing future soft interfaces with unprecedented and tuneable adhesion strength. To this end, I aim to: (i) develop highly efficient numerical tools for studying adhesion of patterned soft surfaces under micro-vibration excitation, (ii) unveil the coupling effect between topography and viscoelasticity that determine the interfacial strength and toughness (iii) design optimal surface topography and excitation for macroscopic adhesion tuning, by exploiting artificial intelligence models to unveil new mechanisms for adhesion enhancement, (iv) prove the adhesive performance reached, by experimentally testing high-resolution 3D printed interfaces with the desired topography and superposed micro-vibrations. So far, the adhesive performance of bioinspired patterned interfaces has been limited by manufacturing capabilities at the micro/nanoscale. SURFACE ground-breaking approach aims at exploiting dynamics excitation to outperform state-of-the-art adhesive interfaces. By exploiting artificial intelligence models, SURFACE aims at revealing new mechanisms for adhesion enhancement, which lay beyond our intuition. Rapidly tuneable strong adhesive interfaces have the potential to revolutionize cutting-edge technologies based on soft adhesive interfaces that require to move and place objects quickly and with accuracy.	phd student, post.doc, senior researcher	antonio.papangelo@poliba.it
132	Products and Processes Engineering	Modelling transient granular flow	UNIVERSITAET FUER BODENKULTUR WIEN		granular material, granular flow	Granular materials are omnipresent in our daily life. The same granular material can behave like solid and fluid, which poses a formidable challenge to the constitutive models and numerical methods. Traditionally, constitutive models for the solid- and fluid-like behaviour have been developed for the respective flow regimes in different engineering/scientific disciplines with hardly any intersections. A single constitutive model capable of describing the transient behaviour during phase transitions in both solid-like and fluid-like regimes is a challenging task with enormous application potential. MOTRAN takes on this challenge with a simple yet efficient ansatz by decomposing the stress rate into a frictional and collisional part, which gives rise to an unconventional constitutive model with the 2nd order strain rate similar to the acceleration of motion. It serves as an excellent classifier for steady and transient motions. This constitutive model is then augmented to include a length scale in micropolar continuum for multiscale analysis. Based on the mixture theory, the field equations are established in rate form for the first time and discretised by a multi-layer SPH model. For polydisperse granular flow with individual large particles, the SPH model is coupled with own developed Surface Mesh Represented DEM to simulate particles of arbitrary shapes. Advanced solution techniques are developed based on multi-GPU acceleration for high fidelity simulation of large-scale problems. The constitutive model is calibrated by laboratory experiments on natural granular materials and their transparent surrogate. The numerical model is validated by scaled model tests under elevated acceleration in centrifuge as well as real-world cases of our database. MOTRAN is an exciting endeavour with the potential to create a new paradigm that will revolutionise the way how transient granular flow is to be modelled.	granular material, numerical simulation	wei.wu@boku.ac.at

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133	Products and Processes Engineering	Generative Understanding of Ultrafast Fluid Dynamics	TECHNISCHE UNIVERSITAET MUENCHEN			Fluids are fundamental to a wide spectrum of natural phenomena and technological applications. Spectacular manifestations of patterns and order arise at small spatiotemporal scales from ultra-fast fluid dynamics (UFD). Initiated by focused deposition of high thermal energy, causing local disruption of equilibrium, violent competing fluid dynamics with extreme local state variations characterize the subsequent relaxation. UFD offer a unique potential for exploration in micro-manufacturing and energy conversion. How can this potential be leveraged/harnessed? What mechanisms and inherent properties determine UFD in complex manufacturing environments? How can UFD be controlled to deliver nanoparticles or micro-structured surfaces with predictable properties? What is the potential of employing UFD to control breakup of phase interfaces? Our objective is to answer these questions by decisive advances in generative computational predictions and high-fidelity numerical experiments. Data-driven multi-fidelity models break the curse-of-dimensionality barrier. Identification of interpretable low-dimensional manifolds of UFD dynamics generates understanding from data. Transformer models produce UFD realizations without solving equations. Harnessing efficient sampling from these methodologies enables us to optimize UFD processes, targeting applications in precision engineering. Developed paradigms, methodologies, and computational tools will be delivered to the scientific and engineering community. Our group has strong foundations in complex-fluid physics and advanced computational methods, and a strong record of successfully integrating fundamental research and technical applications. Our goal is to provide unprecedented insight into UFD in complex environments and to unravel the path to technical solutions. Leveraging the hidden potential of UFD gives access to breakthrough innovations and high-impact technologies in micro-manufacturing and energy conversion.		aerodynamik@tum.de
134	Products and Processes Engineering	Engineered Porous Electrodes to Unlock Ultra-low Cost Fe-Air Redox Flow Batteries	TECHNISCHE UNIVERSITEIT EINDHOVEN	www.fornercuencaresearch.com	porous electrodes, iron-air batteries, electrochemical energy storage	This proposal will develop a game-changing paradigm to design, synthesize, and functionalize porous electrode materials with far-reaching consequences in electrochemical science and engineering. Focusing on the Fe-air redox flow battery (FAIR-RFB), which holds promise for low-cost, long duration energy storage, I will employ an interdisciplinary approach bridging (electro)chemical engineering, materials science, and computational design to address the following fundamental challenges: (1) I will elucidate the role of the porous electrode microstructure. I will introduce a new methodology that couples evolutionary algorithms with microstructure-informed simulations to predict ideal electrode geometries. A versatile synthetic platform, non-solvent induced phase separation, will be leveraged to synthesize highly controlled 3D microstructures and train neural networks to accelerate the discovery of optimal geometries. (2) I will determine to what extent surface moieties of the porous electrode influence transport phenomena, kinetics, and durability. I will employ electrografting of select molecules to functionalize porous electrodes and impart functional properties (wettability, activity, stability). I will perform nanoelectrochemical imaging to elucidate the role of electrode-coating-electrolyte phenomena. (3) I will develop a novel electrochemical reactor architecture for high-power Fe-air RFBs. Building upon the two previous developments, I will synthesize tailored iron and air electrodes and leverage polymeric bipolar membranes to realize a high voltage and low resistance electrochemical cell. Advanced imaging techniques, i.e. energy- and wavelength-selective neutron imaging, will be employed to visualize reactive transport phenomena during operation, thus helping to address these questions. The novel approaches developed in FAIR-RFB will enable breakthroughs in performance and durability of large-scale electrochemical energy storage systems.		a.forner.cuenca@tue.nl

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135	Products and Processes Engineering	Models for Lignocellulose Thermochemical Conversion	THE PROVOST, FELLOWS, FOUNDATION SCHOLARS & THE OTHER MEMBERS OF BOARD, OF THE COLLEGE OF THE HOLY & UNDIVIDED TRINITY OF QUEEN ELIZABETH NEAR DUBLIN		Biomass, Lignocellulose, Pyrolysis, Reaction Kinetics, Multiscale Modelling	Chemicals, fuels and energy must be produced from lignocellulosic plant-matter if global economies are to decarbonise. To be successful, these lignocellulose-derived products must compete in technical quality and price with fossil derived products. Thus, we must understand what lignocellulose is, and how its chemical structures react in thermochemical processing technologies, such as pyrolysis. Pyrolysis is a promising method to produce valuable products from lignocellulose and the basic fundamental process of more complex thermochemical technologies, such as catalysis. Mod-L-T deciphers the elementary reaction mechanism and kinetics of lignocellulose pyrolysis. Relative to cellulose, the reaction kinetics of hemicellulose and lignin are less studied, and thus the focus of Mod-L-T. Mod-L-T creates the first detailed, elementary, mass- and energy-conserved chemical reaction model for lignocellulose pyrolysis. A compositional characterisation and modelling procedure utilising Nuclear Magnetic Resonance spectroscopy identifies what molecular structures comprise, and best represent actual lignocelluloses. The mechanism and kinetics of the pyrolysis reaction of the identified hemicellulose and lignin functionalities are then rigorously and systematically determined by the study of model molecules of incrementally increasing structural complexity, up to actual hemicellulose and lignin structures. Experimental and theoretical means are coordinated; A Thin Film Reactor obtains kinetically limited isothermal reaction rate and time-resolved evolved species information. Potential Energy Surfaces are determined by the M06-2X/6-311++G(d, p) methodology. This new fundamental knowledge is assimilated by the construction of detailed reaction kinetic models for hemicellulose, lignin and lignocellulose pyrolysis. The knowledge is disseminated for application in optimized and reduced models, envisaging their coupling to process and fluid dynamic engineering modelling tools.	Chemical engineering, Biomass, Lignocellulose, Biorefining	stephen.dooley@tcd.ie
136	Products and Processes Engineering	Icevoltaics: from the Workman-Reynolds Freezing Potentials to Electrical Energy	NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU			Water and aqueous solutions release a huge amount of thermal energy during freezing. Accessing energy utilizing the freezing process has never been attempted until today. It is known that orderly freezing of dilute aqueous solutions can result in electrical potentials as great as 230 volts at the ice-solution interface, namely the Workman-Reynolds freezing potential (WRFP), and a maximal electrical current of 1 μA. Based on our newly published results of counter ion separation during icing growth in ionic liquids, this project aims to combine high-throughput computing and nanotechnology for probing the approach of controlling and utilizing stable WRFPs and for the first time to enable energy exploration in the freezing process of aqueous solutions. Specifically, ionic liquids will be screened for maximizing WRFP and electrical energy output via atomistic modeling and multiscale experiments. Critical parameters for WRFP, including ion concentration, temperature and freezing rate, will be investigated for their effects in electrical energy generation. Novel electrical energy output based on WRFP will be constructed and tested, which will seed an entirely new green energy acquisition research and application field. The project, termed Icevoltaics, explores an un-touched energy source and provides highly innovative solutions of the future and clean energy.		senbo.xiao@ntnu.no

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137	Products and Processes Engineering	Data-Driven Bioinspired Design of Fatigue Super-Resistant Structures: learning by Nature and Flying into the future	UNIVERSITA DEGLI STUDI DI ROMA LA SAPIENZA			Biological material science is a new research topic at the interface of biology and physical science, having a common ground in chemistry, physics, mechanics and engineering. During their evolution, biological materials have developed a unique combination of properties to fulfil specific functions through a series of ingenious and distinctive design elements, evident in different systems created by nature. As an example, butterfly wings have an extraordinary combination of lightness, durability and iridescence. We have merely scratched the surface of this knowledge. Exploring the basis of the unique performance of natural and biological materials, a material science perspective has been widely adopted. However, the study of natural systems considering a structural perspective is still at its early stage and, up to now, we have not fully taken advantage of this potentially unique and immense source of design inspiration, especially in the field of structural integrity and fatigue design. ButterFly is aimed to fill this gap in knowledge making a ground-breaking jump towards bioinspired fatigue design. Fatigue is in fact the most ubiquitous mode of fracture accounting for more than 80% of all in service failures in structural components; however, available design approaches are still deterministic and uselessly repetitive. ButterFly will, for the first time, develop a novel and reliable mechanistic approach able to capture the salient design principles allowing long-term durability of natural systems and will transfer this new fundamental knowledge to design fatigue super-resistant structures. Building upon promising results from my research group, I am convinced that ButterFly will induce an utterly new paradigm-shift in fatigue design inspired by Nature with a considerable impact on industrial design practice, paving the way to a new era of smart and fully optimized fatigue design.		filippo.berto@uniroma1.it
138	Products and Processes Engineering	Providing Computational Insights into Cardiac Xenotransplantation	UNIVERSITY COLLEGE DUBLIN, NATIONAL UNIVERSITY OF IRELAND, DUBLIN		finite volume method; fluid solid interaction; cardiovascular simulation; higher order	We are at the dawn of a new age in medicine, marked by the first pig-to-human heart transplant. Xenotransplantation has long been a dream for clinicians and now, due to rapid progress in gene editing, is becoming a reality. To overcome immediate rejection, barriers of immunity and infection have to be overcome, however, achieving long-term success requires a deep understanding of the physiological and mechanical challenges introduced by the anatomically dissimilar xenotransplants. XENOSIM aims to address these challenges by providing fundamental clinical insights into the nascent field of cardiac xenotransplantation through the development and application of novel high-resolution, higher-order, multiphysics simulation methods. Tremendous progress has been made in biomedical imaging, nonetheless, a multitude of physical phenomena relevant to xenotransplantation are not available for experimental observation. In silico studies are uniquely placed to provide insights into the haemodynamic disruption caused by replacing a human heart with an anatomically dissimilar one. XENOSIM is targeting the establishment of the first family of porcine cardiac xenotransplant models that can provide clinically significant insights into the haemodynamic compatibility of porcine donor hearts, the impact of surgical approach, and the consequence of pathologies. To provide these novel insights requires new coupled simulation approaches. Accordingly, the second goal of XENOSIM is to create a new class of monolithic finite volume fluid-electro-solid interaction methods, which can provide predictions in clinically relevant timescales through the exploitation of hybrid CPU-GPU systems. XENOSIM will establish the new field of computational cardiac xenotransplantation. Furthermore, the novel numerical methods established by XENOSIM are expected to impact a broad range of fields well beyond the project end.	finite volume method; fluid solid interaction; cardiovascular simulation; higher order	philip.cardiff@ucd.ie

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139	Products and Processes Engineering	Tellurium-free Thermoelectric Technology for Near-room-temperature Applications	LEIBNIZ INSTITUT FUR FESTKORPER UND WERKSTOFF ORSCHUNG DRESDEN EV			Thermoelectric (TE) technology – whereby heat is converted to electrical power and vice versa – holds great potential for cooling and power generation in many applications because its unique solid-state nature enables TE devices to be free from emissions and maintenance; thus providing extraordinary reliability. Realizing this potential requires developing modules that have high performance at around room temperature (-70 ˚C to 300 ˚C). Currently, almost all commercial modules are based on bismuth telluride (Bi2Te3) because of their until now unparalleled performance. However, Bi2Te3 cannot meet the rapidly increasing demand of TE technology, because tellurium (Te) is very scarce, with the Earth's crust having a concentration of <0.001 ppm. Therefore, it is vital to develop a next-generation technology to mitigate the potential bottleneck in raw materials supply for a sustainable future. Here I propose to develop, on Mg-based compounds, a new TE paradigm completely free from Te with groundbreaking performances that transcend the record of state-of-the-art (S.O.A.) Bi2Te3. To that end, I will bring together interdisciplinary know-how with unique technical capabilities to enable a full-chain development to 1) innovate synthesis methods to produce superior materials, 2) establish contact materials and methods to optimize TE modules, 3) develop methods for scale-up production of materials and module sizes, 4) enhance and secure the modules' robustness, 5) assemble device prototypes use the obtained modules. I aim to realize conversion efficiency of ~12% in the temperature range from 30 ˚C to 300 ˚C (S.O.A. is 3-6%), and cooling ΔT of ~90 ˚C (S.O.A. is 70-75 ˚C). These proof-of-principle demonstrations will pave the way for large-scale, high-performance, robust, and sustainable solid-state power generation and cooling for numerous applications, ranging from geothermal power generation to cold-chain boxes for medical storage and transportation including mRNA vaccines.		r.he@ifw-dresden.de
140	Products and Processes Engineering	Building a space Revolution: Electric Air-breathing Technology for High-atmosphere Exploration	SCUOLA SUPERIORE DI STUDI UNIVERSITARI E DI PERFEZIONAMENTO S ANNA	https://www.santannapisa.it/en/institute/mechanical-intelligence/breathe	air-breathing, electric propulsion, space propulsion	Airflight and spaceflight gave mankind different perspectives and opened new paths for communication. A gap remains, between 50 km and 250 km of altitude, where the rarefied atmosphere makes it hardly viable to operate with either spacecraft or planes. Air-breathing Electric Rockets (AERs) will allow to close this gap, lowering the altitude of spacecraft operations below 250 km, in the so-called Very Low Earth Orbits (VLEOs). Operations in VLEOs will give radical advantages in terms of orbit accessibility, payload performance, protection from radiations, and end-of-life disposal. AERs combine an intake to collect the residual atmosphere in front of the spacecraft and an electric thruster to ionize and accelerate the atmospheric particles. Such residual gas can be exploited as renewable resource not only to keep the spacecraft on a VLEO, but also to remove the main limiting factor of spacecraft lifetime, i.e., the amount of stored propellant. Several realizations of the AER concept have been proposed, but limited evidence of the concept feasibility is available. The few end-to-end experimental campaigns highlighted the need to improve the AER functional design and the representativeness of simulated atmospheric flows. The difficulty in recreating the VLEO environment in a laboratory limits the data available to validate scaling laws and modelling efforts. The objective of BREATHE is to increase the understanding of air-breathing electric propulsion and to pave the way toward the in-orbit demonstration of the AER concept. With this aim, project activities will focus on: 1) Developing theoretical models and simulation tools, to characterize atmospheric flows and low-temperature plasmas; 2) Merging on-ground testing and virtual simulations, to provide a controlled environment for the characterization of prototypes and the extrapolation to flight conditions; 3) Identifying the main scaling laws governing AERs and, thus, the optimal operating principle and design.		tommaso.andreussi@santannapisa.it

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141	Products and Processes Engineering	Understanding the Effect of Non-natural Fluid Environments on Enzyme Stability	DANMARKS TEKNISKE UNIVERSITET		Biocatalysis, Scale-down, Oxidation, Gas-liquid interface, Liquid-liquid interface	Enzymes are the protein-based catalysts found throughout nature and are of immense scientific importance, and of great practical value in medicine, chemistry and biotechnology. In most practical applications (such as industrial biocatalysis), enzymes are exposed to non-natural conditions, resulting in a loss of stability. Our understanding of what leads to a loss in enzyme stability under these conditions is very poor and therefore the aim of this project is to obtain such understanding. Current studies on enzyme stability mostly measure thermodynamic stability, and in some more limited cases operational stability, after exposure to different conditions (such as different temperatures and pH values). However, they overlook the effect of mixing, exposure to high concentrations of reactant and product as well as to dynamic fluid-fluid interfaces, all of which are common in a most practical applications. This project aims to understand the effect on enzyme stability of exposure to such non-natural conditions, using designed experiments in novel apparatus (mimicking industrial conditions), complemented by a suite of analytical characterization tools. The result of such studies will firstly enable the re-design of suitable equipment for industrial biocatalysis, which is of increasing interest as an alternative catalytic method for the synthesis and production of a vast array of valuable products. Secondly, the knowledge gained will be of great importance for protein engineering, providing the basis for pre-screening of enzymes on the basis of stability. Finally, the results will also have implications for other areas of bioprocessing, including microbial fermentation for the extracellular to produce enzymes and cell culture to produce therapeutic proteins.	Experimental characterization of enzymes and proteins	jw@kt.dtu.dk
142	Products and Processes Engineering	Perovskite Spiking Neurons for Intelligent Networks	UNIVERSITAT POLITECNICA DE VALENCIA		Neuromorphic system, Spiking Neural Networks (SNNs), Metal halide perovskites, Bio-inspired computation, neuromorphic devices, Materials for neural networks,Hysteresis and memory effects	A brain is a complex structure where computing and memory are tightly intertwined at very low power cost of operation, by analog signals across vast quantities of synapse-connected spiking neurons. Animal brains react intelligently to environmental events and perceptions. By developing similar Spiking Neural Networks (SNN) we can realize neuromorphic computation systems excellent for dealing with large amounts of noisy data and stimuli and very well suited for perception, cognition and motor tasks. But the current CMOS technologies perform very poorly for emulating the biological brains and their power consumption is large. Currently we cannot replicate biological neurons behaviours with existing design and manufacturing technology. This project aims to develop compact miniature material elements that will emulate closely the complex dynamic behaviour of neurons and synapses, to form SNNs with substantial reduction in footprint, complexity and energy cost for perception, learning and computation. We investigate the properties of metal halide perovskite that have produced excellent photovoltaic devices in the last decade. These perovskites have ionic/electronic conduction, hysteresis, memory effect and switchable and nonlinear behaviour, that make them ideally suited for the realization of devices in close fidelity to biological electrochemically gated membranes in neurons, and information-tracking synapses. We will use the methodology of impedance spectroscopy and equivalent circuit analysis to fabricate devices with dynamic responses emulating the natural neuronal coupling and synchronization. This method will produce the hardware that we need for a preferred spiking computational model, incorporating time, analog physical elements and dynamical complexity as computational tools. As illustration we will show visual object recognition from spiking data provided by a spiking retina by advanced neuristors and dynamic synapses.	Spiking Neural Networks (SNNs), Memristors, Impedance spectroscopy, Metal halide perovskites, Dynamic synapses, Equivalent circuit analysis, neuronal devices, Hysteresis and memory effects	jbisquer@itq.upv.es

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143	Products and Processes Engineering	A breakthrough in the two-way coupling within a wave-current-atmosphere system	UNIVERSITETET I BERGEN	https://cordis.europa.eu/project/id/101164343		The Wave-Current-Atmosphere (WCA) system in the upper ocean is an air-sea interface that drives the physical, chemical, and biological processes crucial to our global climate and environment. Observations and simulations over the last two decades have revolutionized our picture of the roles of small-scale wave processes in the large-scale oceanic circulations controlled by the WCA system, offering a promising direction to correcting long-standing biases and errors in key indicators in climate models, such as sea surface temperature and the mixed depth of vertical mixing. The key to correcting such biases and errors is to physically resolve the surface waves processes in the WCA system. OceanCoupling will effect a paradigm shift towards two-way coupled modeling of the system using a novel approach which removes a bottleneck caused by two main challenges: (i) multi-scale dependent physical processes and (ii) the air-sea interface - known for its dynamics and complexity. This approach harnesses both the analytical features of multi-scales quantities and the rapid development in computing power to greatly increase numerical efficiency, at no cost of accuracy. OceanCoupling will explain, for the first time, how the surface waves processes control the essential exchange of mass, momentum, and energy between the atmosphere and ocean. The outcome of OceanCoupling will provide timely links to recent and future ocean surface remote sensing products that monitor the ocean surface and will equip us with a feasible tool to tackle the ever-increasing wave extremes due to climate changes and innovative technologies for renewable energy. OceanCoupling initiates a new way of efficiently modeling complex systems with multiple scales, enabling breakthroughs in similar physical systems; technically, the main outcomes, e.g., theoretical framework and numerical solver with open access, will create opportunities for novel insights due to their wide applicability in fluid dynamics.		yan.li@uib.no

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144	Products and Processes Engineering	Crystal Engineering the New Generation of Sustainable, Biocompatible and Stimuli Responsive Formulations for the Delivery of Active Ingredients	POLITECNICO DI TORINO	https://cryform.polito.it/		CryForm aims at progressing our fundamental knowledge in organic materials crystallization and crystal engineering by: (1) gleaning a mechanistic understanding of the relationship between crystal structure and surface properties; (2) uncovering the thermodynamic and kinetic mechanisms of crystal nucleation and growth at liquid/liquid and liquid/gas interfaces; (3) understanding the role of large biomolecules in the modification of crystal growth and nucleation kinetics. This knowledge will enable the design of novel sustainable, biocompatible and stimuli responsive multiphase formulations (e.g., emulsions, foams) for the encapsulation and controlled release of active ingredients. Developing formulations with enhanced dissolution rate and bioavailability is critical for many industrial sectors: about 40% of the active pharmaceutical ingredients on the market and 60% of the ones in development are poorly soluble or scarcely bioavailable. Agrochemicals and food nutraceuticals present similar problems. Currently, synthetic excipients, surfactants and specialty polymers are used to create formulations with enhanced properties. However, these compounds are derived from non-renewable resources through some of the most greenhouse gas-intensive manufacturing processes. The production and incineration of polymeric materials will produce, in 2019, more than 850 million metric tons of greenhouse gases. Furthermore, the chemical synthesis of many polymers involves highly toxic, flammable and polluting reagents such as ethylene oxide, responsible for the 2004 explosion at Sterigenics International in California. It is clearly necessary to move away from polymer-based formulations and find more sustainable and safer alternatives. CryForm proposes a unique approach whereby synthetic additives will be replaced with natural crystals specifically engineered to enable controlled release of active ingredients via a unique mechanism based on stimuli-triggered solid form transformations.		elena.simone@polito.it
145	Products and Processes Engineering	MOdeling and Reduction of Aeroacoustics Sources of Interaction Noise in Aviation	TECHNISCHE UNIVERSITEIT DELFT			The target of climate-neutral aviation has led to a strong increase in the size of new propulsion systems, resulting in their lowered distance to the airframe components. This causes new aerodynamic interactions with heavy distortion of the turbulent flow, determining unpredictable sources of noise. Mitigating this interaction noise would allow to deploy radically new aircraft configurations capable of reducing up to 20% of the current aviation emissions. While studies from literature have tried to correct discrepancies larger than 10 dB from acoustic predictions by a-posteriori tuning the models to very specific flow patterns, recent results from my team have shed light on the physics behind the unpredictability of these noise sources. Results hinted that the geometrical deformation of the turbulent flow from its original pattern might explain the origin of interaction noise. To solve this puzzle, with MORASINA I aim at first understanding how the flow and the turbulence are distorted in archetypal interactions between rotating and stationary aerodynamic objects. My objective is to discover the unknown mathematical formulation to model this distortion mechanism and to use it to create the first holistic acoustic model for predictions of interaction noise. By innovatively describing the interaction mechanisms with mathematical functions related to the geometrical distortion of the flow, I will find an answer to whether different flow fields can be assimilated in a unique fundamental flow pattern. With this knowledge, I will create the first acoustic model based on a mathematical “ flow twin” to accurately predict interaction noise. For maximum impact on the society, I will extend the model to equipollent interaction mechanisms with a neural network approach trained on the results, allowing the use of the prediction framework for reducing interaction noise in the design of the next generation of zero-emission and silent aircraft.		d.ragni@tudelft.nl

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146	Products and Processes Engineering	Unraveling the impact of turbulence in Mixed-phase Clouds	CHALMERS TEKNISKA HOGSKOLA AB			Mixed-phase clouds—atmospheric complex three-phase systems containing suspended ice particles, supercooled water droplets, and water vapor—are responsible for most of the precipitations reaching the Earth's surface. In addition, these clouds play a primary role in the planet's radiative energy budget and the water cycle. Despite their relevance, there is a lack of a basic understanding of the complex hydrodynamics, heat, and mass transfer between the different water components with numerous scientific open questions. In the last decades, many scientific works have shown a significant impact of turbulence in "warm" (ice-free) clouds and "warm" rain formation in enhancing condensation/evaporation of rain droplets and promoting collisions. On the other hand, the role of turbulence in mixed-phase clouds has never been properly quantified; consequently, up to now, this topic has been nearly exclusively a subject pertaining to atmospheric physics rather than fluid dynamics. I want to change this perspective and analyze the rich dynamics of mixed-phase clouds using a combination of theoretical and numerical tools developed for general multiphase flows. MixClouds is a multidisciplinary project aiming to: i) understand the impact of turbulence in mixed-phase cloud microphysics of water hydrometeors, ii) quantify this impact by determining typical ice and water droplet size distributions at given temperature, humidity, and turbulence levels, iii) developing the next generation of numerical tools to couple multiphase turbulent dynamics at different scales, iv) developing novel sub-grid models to parametrize mixed-phase cloud microphysics and test against known atmospheric observations. The final results can potentially generate a ground-breaking impact not only in the areas of turbulent multiphase flows and cloud physics but also in climatology and in all environmental and industrial applications involving suspensions of three-phase flows in the presence of phase changes.		sardina@chalmers.se
147	Products and Processes Engineering	Engineering light induced phase change for emerging nanoscale processes	TECHNISCHE UNIVERSITAET MUENCHEN	https://www.epc.ed.tum.de/td/forschung/forschungsberiche/nano-energy-engineering/nanolpc/	Phase change, heat transfer, nanobubble, multiscale simulation	Light-induced phase change (LPC) is the unifying theme underpinning many apparently non-related processes in i) additive manufacturing (AM) for metals where laser induced vaporisation and the formation of keyhole porosity is a major limiting factor for 3D printing, ii) nanomedicine (NM) where laser induced nanobubble dynamics and associated shockwave effect is powerful for malicious cell destruction, and iii) solar energy (EN) where direct steam /vapor production from bulk and surface fluid is a promising technology for power and clean water solutions. In addition to the challenging multiscale nature of phase change, LPC add further complexities by introducing the multiphysics nature due to strong light-absorber interactions. We will tackle the fundamental challenge of the formation and control of LPC and develop a physics-based platform, supported by multiscale experimentation and multiscale simulation, as the tool to design and engineer LPC as innovative mechanism for in situ process steering and control. Five work programs are designed focusing on two complementary paradigms: i) fundamental studies for enhancing LPC mechanism understanding via developing physics-informed multiscale modelling validated by dedicated nanoscale experiments, and ii) application studies for engineering LPC for designed functions towards EN, NM and AM respectively. Many breakthroughs beyond state-of-art work are expected, such as i) the establishment of a unique multi-physics and multiscale LPC simulation platform; ii) the revelation of LPC mechanisms by sub 100 nm experiments with localized temperature and nanobubble dynamics measurement; and iii) the reverse engineering of LPC to maximize solar vapor production, inhibit keyhole pore formation and control nanobubble shockwave effects. The project will not only advance LPC understanding in the domain of Thermodynamics and Heat Transfer, but also transfer the developed expertise into emerging applications.		d.wen@tum.de

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148	Products and Processes Engineering	Minimisation of the offshore wind and tidal turbine acoustic footprint on marine life	UNIVERSIDAD POLITECNICA DE MADRID		wind turbine, acoustics, aeroacoustics, control, numerical simulation	For renewable energies to be sustainable in the future, their impact and harmful effects on the environment should be minimum. Recent evidences suggest that offshore wind and tidal turbines can have an acoustic damaging impact on marine life, due to the sustained generation of noise, which propagates very efficiently underwater. Off-coustics combines numerical simulations and experiments to provide insights into the physics governing the aero/hydro-acoustic generation and propagation for offshore wind and tidal farms. Control of these physics will enable the design of silent offshore farms enabling renewable energy with zero acoustic impact. First, I propose to develop a novel aero/hydro-acoustic solver, blending advanced high order numerical techniques through machine learning and trained with experiments, to simulate flow-acoustic signatures for wind and tidal turbines, in realistic offshore environments (including bathymetry, air-water surface, etc.). Second, an experimental campaign will generate aero/hydro-acoustic data for scaled turbines and farms to help elucidate the physics governing offshore acoustics and to guide/validate the flow-acoustic simulator. Third, simulations and experiments will be combined to characterise turbines in complex offshore environments and to develop physic-informed surrogate models. Fourth, using the developed surrogate models and optimisation, Off-coustics will propose new designs of silent farms that minimise the acoustic impact while ensuring energy production. Major advances in multidisciplinary aspects are expected, including fluid mechanics, numerical simulations, optimisation, experimental acoustics, aero/hydro-acoustics and offshore wind and tidal turbine physics.	wind turbine, acoustics, aeroacoustics,	esteban.ferrer@upm.es
149	Products and Processes Engineering	Single-Atom Catalysts for a New Generation of Chemical Processes: from Fundamental Understanding to Interface Engineering	POLITECNICO DI MILANO	https://vile-researchgroup.com/		The grand challenge for the chemical industries of the 21st century is the transition to more sustainable manufacturing processes that efficiently use raw materials and eliminate waste. Catalysis engineering is the key enabling technology to drive this transition, and single-atom catalysis is an emerging new approach to catalyst design. However, major questions concerning the local structure of these systems, their reactivity, and their evolution when prepared and structurally integrated into chemical devices are elusive. This project will address these important scientific gaps, laying the foundation for a new generation of catalysts for CO2 conversion. To unveil their microscale functioning, I will study for the first time the charge transfer taking place before, during, and after reactant adsorption and surface reactivity. This will be done combining synthesis, operando characterizations, microkinetics, and theoretical methods. Then, merging microreactor technology and process intensification, I will manufacture single-atom catalysts in powder and as miniaturized thin films or foams, using new, scalable and greener methods. This will bypass current limitations in terms of efficiency and metal dispersion, and close the gap on challenges related to catalyst-reactor integration, bridging chemical and device engineering. The materials will be validated in the valorization of CO2 to derive structure-function relationships and prove major catalytic improvements under realistic conditions. Overall, this is a fundamental and interdisciplinary project with ambitious objectives and high-risk/high-gain potential, that will go beyond the traditional pillars of catalysis. The scientific outcomes will provide new perspectives in catalysis and open paths in other fields, such as materials chemistry, green synthesis, and purification science. My pioneering contributions in this field and new proof-of-concept data place me in a unique position to undertake this fundamental study.		gianvito.vile@polimi.it

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150	Products and Processes Engineering	A dandelion-inspired drone for swarm sensing	THE UNIVERSITY OF EDINBURGH	https://voilab.eng.ed.ac.uk/dandidrone	Unsteady Aerodynamics, Drones, Plant Seed Dispersal, Dandelion, Microtechnology, Lightweight Sensing and Communications	In the next decade, distributed sensor network systems made of small flying sensors, from dust-scale to insect-scale, will enable a step change in monitoring natural disasters and remote areas. They will contribute to protecting the environment by providing data on the contamination of physical and biological systems and on the impact of human activities. To date, a key limitation of this technology is that small sensors can remain airborne only for a few tens of minutes. By contrast, some natural flyers such as the dandelion fruit, travel unpowered for days and hundreds of kilometres. Recent work led by Viola and published in Nature1, reveals that the dandelion adopts a highly porous wing to forms a new fluid vortex that has never been observed before, and to increase its aerodynamic efficiency by an order of magnitude. Furthermore, the dandelion's unique shape enables to exploit horizontal wind gusts to re-gain altitude and remain airborne for days. This latter mechanism has never been studied, nor artificially replicated, and could lead to a ground-breaking discovery on how to sustain the unpowered flight of small manmade flyers. Fundamental bio-inspired fluid mechanics research will be undertaken with high-fidelity computational fluid dynamics (work packages WP1-2) and will inform the design of a dandelion-inspired drone, the DANDIDRONE. This will be the first unpowered insect-scale flyer capable to sustain hover in wind gusts. A steering system to control the swarm dispersal in the atmosphere will be developed in WP3; a prototype will be manufactured in WP4 and it will be demonstrated with wind tunnel tests in WP5. A first-of-its-kind wind tunnel for low Reynolds number gust encounter research will be developed. Finally, the impact of this project will be maximised in WP6 by engaging with key stakeholders and by paving the way to the development of a new class of distributed sensor network systems with unprecedented endurance.	Unsteady Aerodynamics, Drones, Plant Seed Dispersal, Dandelion, Microtechnology, Lightweight Sensing and Communications	i.m.viola@ed.ac.uk
151	Universe Sciences	Extreme time and angular resolution in the optical with Cherenkov telescopes	CENTRO DE INVESTIGACIONES ENERGETICAS MEDIOAMBIENTALES Y TECNOLOGICAS		Cherenkov telescopes, intensity interferometry, stellar astrophysics, sub-km Kuiper Belt Objects	The universe in the visible wavelength remains largely unexplored in the sub-second time regime and sub-milliarcsecond scale, primarily due to instrumental limitations. Overcoming these impediments would bring a breakthrough in our knowledge of stellar physics, evolution and modelling by imaging the stars and their surroundings as well as unravel the history of the Solar System. MicroStars will demonstrate the viability of a cost-effective and novel solution to enhance the capabilities of Imaging Atmospheric Cherenkov Telescopes (IACTs) to perform ultra-fast optical measurements. Such an upgrade allows two novel applications of these telescopes in the visible range: their use as Stellar Intensity Interferometers and as high-time-resolution, fast, high-precision photometers. MicroStars will allow to expand the limiting time and angular resolution of current optical observatories by at least an order of magnitude. By upgrading the capabilities of next-generation IACTs, MicroStars has the potential of creating a host of scientific breakthroughs, answering fundamental questions regarding stellar physics, magnetic activity and modelling, exoplanet properties and the Solar System planetary formation. The interdisciplinary and field-transforming nature of MicroStars, merging astroparticle physics instrumentation with optical astronomy, will extend the scientific life of current IACT experiments, and greatly expand the scientific impact of the next generation: the Cherenkov Telescope Array. Bringing this proposal to life is only possible with an ambitious funding scheme, willing to finance the major equipment needed, and support a research team with the required multidisciplinary skills to expand the state of the art with novel instrumentation and methodologies.	OB stellar astrophysics, optical interferometry, Solar System concessional history simulation	tarek.hassan@ciemat.es

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152	Universe Sciences	StarDance: the non-canonical evolution of stars in clusters	ISTITUTO NAZIONALE DI ASTROFISICA	https://stardance.inaf.it/	Stars – stellar physics, stellar systems	Thanks to their ubiquity, brightness, and the fact that they are made of stars with similar properties, star clusters have been used as astrophysical laboratories or test particles in an impressive range of research domains. However, we still do not understand fundamental details of their formation and evolution. In spite of recent technological progress, a list of unsolved problems and apparently isolated mysteries has been accumulating over time, some standing since decades. Among them, the existence of multiple stellar populations in globular clusters, with different chemistry, has challenged generations of researchers. They are not the result of classical galactic chemical evolution, mostly mediated by supernovae, and they jeopardize the use of clusters as simple stellar population templates for extragalactic studies. Given the mounting problems faced by the most favored scenarios to explain multiple populations, I think it is now time to revisit the foundations of our current thinking. New results by my team and by others show that: (i) the peculiarities in the chemistry of multiple populations are not limited to the oldest globular clusters; (ii) they can be transient in the evolution of individual cluster stars; and most importantly (iii) binary interactions and fast stellar rotation cannot be neglected in the study of star clusters and do have the capability to produce the observed chemistry. With StarDance I will test a very different scenario, based on a new hypothesis: that multiple stellar populations and five other non-canonical stellar populations (extreme horizontal branch stars and hot sub-dwarfs; extended main sequence turn-offs; red stragglers and sub-subgiants; lithium rich- stars; and blue stragglers) are caused by the interplay between stellar rotation and binary interactions, that are greatly enhanced in the special environment of star cluster, with spectacular results.	stellar abundances, binary stars, fast rotating stars, star clusters, stellar dynamics	elena.pancino@inaf.it
153	Universe Sciences	Speedmeter: Quantum back-action noise-free interferometry for improving the science capabilities of future gravitational wave observatories	UNIVERSITEIT MAASTRICHT	www.etpathfinder.eu	Quantum measurements, squeezed light, gravitational wave detection, laser interferometry	The discoveries enabled by observations of gravitational waves (GW) from merging black holes and neutron stars provided us with a stunning glimpse of the immense potential of GW multi-messenger astronomy and cosmology. In order to discover new phenomena and better understand the constituents of the Universe and the forces driving it, it is vital to improve the sensitivity of future GW observatories. Indeed, to maximise the observation capacity of future GW observatories such as the Einstein Telescope (ET) it is imperative to go beyond the current quantum noise limit imposed by the uncertainty relation originating from a continuous position measurement of the interferometer mirrors, i.e. $[x(t),x(t')]\neq 0$. Quantum mechanics provides speedmeter interferometers (SMI) as a more elegant approach: measuring momentum (speed) of the test masses evades the uncertainty limit, i.e. $[p(t),p(t')]=0$. However, though SMI have been shown theoretically to offer superior sensitivity compared to currently used Michelson interferometers with squeezed light injection, the SMI concept lags behind in technical readiness and hence is currently not yet considered mature enough to build the baseline for ET. This grant will enable me to change this. In particular I will focus on two novel SMI concepts, we invented and which (in contrast to earlier SMI concepts) are easily implementable into current long-baseline interferometers. The main objectives of this proposal are: 1) development of the required new optical components and quantum noise analysis tools; 2) experimental demonstration, initially in proof-of-concept table-top experiments, followed by implementation in ETpathfinder, a unique cryogenic interferometer test facility; 3) verification of the SMI concept with complementary quantum technologies such as squeezed light; 4) development of a detailed SMI practical design for ET including a science case detailing possible improvements in astrophysics, cosmology and fundamental physics.		Stefan.hild@maastrichtuniversity.nl

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154	Universe Sciences	Open Superior Efficient Solar Atmosphere Model Extension	KATHOLIEKE UNIVERSITEIT LEUVEN		solar atmosphere modelling, multi-fluid, higher-order methods	The goal is to develop a time evolving model for the entire solar atmosphere, including the chromosphere and transition region, based on a multi-fluid description. At present, models are steady, rely on a single-fluid description and include only the corona due to computational challenges. We plan to use time-evolving ion-neutral and ion-neutral-electron models. The multi-fluid approach will enable us to describe the intricate physics in the partially ionized chromosphere and quantize the transfer of momentum and energy between the atmospheric layers. The questions where the solar wind originates and solar flares and coronal mass ejections are driven have both fundamental scientific importance and substantial socio-economic impact. Indeed, the solar atmospheric model is the crucial missing link in the Sun-to-Earth model chain to predict the arrival and impact of CMEs at Earth. What makes this goal now possible is the combination of our implicit solver with a high-order flux-reconstruction (FR) method. The implicit solver avoids the numerical instabilities that lead to strict time step limitations on explicit schemes. The high-order FR method enables high-fidelity simulations on very coarse grids even in zones of high gradients. We will start from this new development and introduce three critical innovations. First, we will combine high-order FR with physics-based r-adaptive (moving) unstructured grids redistributing grid points to regions with high gradients. Second, we will implement CPU-GPU algorithms for the new heterogeneous supercomputers advanced by HPC-Europa. Third, we will implement AI generated magnetograms to make the model respond to the time-varying photospheric magnetic field which is crucial for understanding important properties. We will thus develop a first-in-its-kind high-order GPU-enabled 3D time-accurate solver for multi-fluid plasmas. If successful, we will have the most advanced solar atmosphere model implemented in an operational environment.	solar atmosphere modelling, multi-fluid, higher-order methods	Stefaan.Poedts@kuleuven.be
155	Universe Sciences	Waves in the Inner Magnetosphere and their Effects on Radiation Belt Electrons	HELMHOLTZ ZENTRUM POTSDAM DEUTSCHES GEOFORSCHUNGSZENTRUM GFZ	https://www.gfz-potsdam.de/en/press/news/details/prestigious-eu-research-award-for-dedong-wang-1	magnetosphere, electromagnetic waves, wave-particle interactions, radiation belts	The magnetosphere is a natural plasma laboratory. Radiation belts in the magnetosphere are full of high energy particles. The energetic electrons in the Earth's radiation belts can be hazardous to Earth-orbiting satellites and astronauts in space. Many of the space systems on which modern human society depends operate in this region. The fluxes of radiation belt electrons are very dynamic, which is not fully understood due to the delicate balance between various acceleration and loss processes. Wave-particle interactions are believed to play a crucial role in the acceleration and loss of these particles. To quantify the effect of different waves on the dynamics of radiation belt electrons, comprehensive wave models are needed. Currently, there are some wave models based on satellite measurements. However, the space coverage of these wave models is not sufficient due to the orbit limit of satellites. In this project, combining state-of-the-art measurements from multiple satellites, comprehensive wave models will be developed. We will improve our sophisticated physics-based radiation belt dynamic model by using the wave models developed in this project and calculate diffusion coefficients using more realistic background magnetic field and plasma density models for the first time. Furthermore, fundamental acceleration and loss of energetic electrons caused by different waves in the Earth's radiation belts will be quantified. We will systematically validate simulation results against satellite measurements to understand the competition between acceleration and loss caused by various mechanisms. All these improvements will be critically important for answering the overarching scientific question: Why do the Earth's radiation belts respond differently to geomagnetic storms which have approximately the same intensity? The knowledge gained in this project can be useful for basics plasma physics and astronomy physics because the similar fundamental processes exist.	magnetosphere, electromagnetic waves, wave-particle interactions, radiation belts	dedong@gfz.de, dedong@gfz-potsdam.de

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156	Universe Sciences	Gravitational-wave data mining	UNIVERSITA' DEGLI STUDI DI MILANO-BICOCCA	davidegerosa.com/group	black holes, gravitational waves, machine learning	Gravitational-wave astronomy is entering its large-statistics regime. Catalogs with thousands of gravitational-wave events will soon be available, providing a wealth of information on the most compact objects in the Universe --black holes and neutron stars. These new datasets need new tools to be exploited effectively in order to maximize their scientific impact. GWmining is an ambitious program to explore upcoming gravitational-wave catalogs with data-mining techniques. We will develop a complete framework to analyze gravitational-wave data in light of astrophysical predictions. Going beyond phenomenological models, we will train machine-learning algorithms directly on large banks of population-synthesis simulations and post-Newtonian integrations. The development of these astrophysical predictions requires new modeling strategies to accurately capture all the gravitational-wave observables, notably spins and eccentricities. Combined with a hierarchical Bayesian analysis, our neural network will deliver the most stringent measurements to date on elusive phenomena influencing the lives of massive stars. We will constrain phenomena such as binary common envelope, supernova kicks, stellar winds, tidal interactions, etc. Besides harnessing the catalog in its entirety, our complete framework will put us at the forefront to analyze outliers --golden events with favorable properties of one or more parameters. We will design a complete strategy to exploit the strongest signals to infer exquisite details of the relativistic dynamics of their sources. GWmining is a unique project strategically placed at the intersection of astronomy, data analysis, and relativity. As the large-statistics revolution of gravitational-wave astronomy unfolds, GWmining will pioneer the application of data-mining techniques in gravitational-wave population studies, setting the foundations of this booming field for decades.		davide.gerosa@unimib.it
157	Earth System Science	How do diazotrophs shape the ocean biological carbon pump? A global approach, from the single cell to the ecosystem	INSTITUT DE RECHERCHE POUR LE DEVELOPPEMENT	https://www.linkedin.com/in/sophie-bonnet-1b1513214/?originalSubdomain=nc	Marine carbon cycle, ocean, phytoplankton, biological carbon pump, diazotrophs, smart buoy, innovation	Diazotrophs regulate marine productivity in 60% of our oceans by alleviating nitrogen limitation, contributing to carbon (C) sequestration through the N2-primed Prokaryotic C Pump (PCP). Yet we don't know how much diazotroph-derived organic C (OC) is exported to the deep ocean, which prevents robust predictions of how the ocean contributes to CO2 sequestration and climate change mitigation. This knowledge gap is due to the multiple and complex pathways by which diazotrophs are exported to the deep ocean, which quantification and drivers of variability are impossible to capture with current methods. HOPE will bridge this gap thanks to a new isotopic technique I developed and to a coupling between lab and in situ approaches examining processes occurring at different spatiotemporal scales, and capable of capturing both transient and seasonal features of the PCP. HOPE will: 1.Determine how various diazotrophs aggregate, sink and are remineralized by using an automated experimental water column I designed for this proposal 2.Decipher by which pathways diazotroph-derived OC is exported to the deep ocean thanks to a pioneer approach combining single-cell isotopic analyses, in-depth microbiological characterization of sinking particles and geochemical budgets 3.Investigate how environmental drivers control the whole process, from the surface diazotroph community up to their eventual export to the deep ocean, by deploying a cutting-edge autonomous platform, unique as it performs synoptic measurements both in and below the euphotic zone at high resolution (hourly/daily). In its final stage, HOPE will use the generated data to provide global, spatially resolved estimates of the contribution of diazotrophs to overall OC export. Based on my expertise at the interface between microbial oceanography and geochemistry, HOPE has the potential to deliver a multidisciplinary and ground-breaking knowledge leading to potential scientific-based recommendations to fight climate change.		sophie.bonnet@ird.fr

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158	Earth System Science	Resilient northern overturning in a warming climate	UNIVERSITETET I BERGEN	https://www.uib.no/fg/fysos/164420/rover	Nordic Seas; overturning circulation; water mass transformation; physical oceanography	A vigorous Atlantic Meridional Overturning Circulation (AMOC) is crucial for the mild northern European climate; it brings warm water northward near the surface and returns cold, dense water at depth. In a warming climate the AMOC is projected to weaken – or even approach a tipping point. Contrary to this established view, I hypothesize that an overlooked, climate-change induced mechanism may impart resilience to the overturning: As the sea ice recedes, increasing stretches of the boundary current system around the Nordic Seas and Arctic Ocean become exposed to the atmosphere. The resulting increased ocean heat loss in winter further densifies the water in the boundary current, which is a direct pathway supplying the lower limb of the AMOC. Enhanced dense-water formation is counter-intuitive in a warming climate and not represented by current climate models, but has the potential to safeguard the northern overturning and maintain a steady supply of dense water to the AMOC. Sparse observations and preliminary results from a 1D model indicate that water mass transformation occurs in the increasingly ice-free boundary current, but its extent, importance, and future development are unknown. In ROVER, I will explore this concept through an extensive field campaign, which includes a mooring array across the boundary current and an unprecedented wintertime survey of this severely under-sampled area. Combined with targeted high-resolution modeling, I will use the comprehensive data set to document the occurrence of this process, understand its dynamics, quantify its extent, and assess its climatic importance. Dense-water formation in the boundary current system that may safeguard the northern overturning would represent a paradigm shift for water mass transformation at high latitudes and the stability of the overturning circulation. As such, ROVER is timely and will have a substantial and significant impact on the science of climate change and climate impact assessment.	Physical oceanographer; high latitude; water mass transformation; air-sea-ice interactions	kjetil.vage@uib.no
159	Earth System Science	Deciphering the Oxidizing Capacity of the PAST atmosphere	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS		polar regions, clumped isotopes, ice cores, atmospheric chemistry, paleoclimate	Atmospheric chemistry is an essential component of the functioning of the Earth's climate. It determines the atmospheric lifetime of most climatic agents, impacting the nature and concentrations of aerosols, greenhouse gases, cloud formations. Determining how this chemical reactivity has evolved in the past is essential, both for evaluating chemistry-climate models (CCM) and for establishing future climate trajectories. The chemical activity of the atmosphere is driven by highly reactive atmospheric compounds that have a very short lifetime in the atmosphere. Because of this ephemeral nature, they are not archived in the paleoclimate record. Reconstructing this chemical activity over time remains a difficult exercise that has not been successful to date. Using ice cores, the multidisciplinary DOC-PAST project proposes to develop new tracers of this chemical activity by taking advantage of the revolution introduced by clumps and isotopic anomalies. The aim is to use a variety of ice cores covering all latitudes to highlight key elements of the chemical reactivity of the atmosphere. This will be done by 1-determining in the laboratory the isotopic characteristics of key oxidation reactions of atmospheric of compounds preserved in the ice, 2-documenting in the ice archives these isotopic compositions and deducing the associated chemical reactivity of the atmosphere 3-incorporating in the CCM LMDz-INCA these changes and measuring their impacts on climate. These new isotopic proxies will require the development of new analytical approaches based on the retargeting of an orbitrap towards isotopic measurements and the construction of a very high sensitivity infrared spectrometer, paving the way for the use of clumped isotope in broad disciplinary fields using stable isotopes. DOC-PAST will provide for the first time in situ “ chirurgical-level” of how atmospheric species are made with unparalleled mechanistic details and set new standards in geochemistry and spectroscopy.	post doc, PhD, young researcher	joel.savarino@cnrs.fr

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160	Earth System Science	Protocells in the Archaean Rock Record: Implications for the Origin of Life and Detection of Biosignatures	DUBLIN CITY UNIVERSITY	https://sites.google.com/view/protosignslab/home?authuser=2	geobiology; astrobiology; protocells; origin of life; palaeontology; biomorphs; biosignatures; Mars; Archean	Fossilised remains of protocells transitioning towards the first living organisms may be observable in the early rock record distorting our interpretation of biosignatures. Protocells – cellular structures existing prior to the emergence of life – would have comprised simple membranes and molecular machinery. The formation of complex protocells is poorly understood. The interpretation of fossilised microorganisms in the early rock record is steeped in controversy. The potential for abiotic microstructures to further complicate this interpretation has long been recognised but has not been systematically tested. Evidence suggests that prebiotic structures are very difficult to distinguish from microfossils. However, little is known about the chemical and physical characteristics of these 'biomorphs' that may enable us to tell the difference. This project will use a novel microfluidic approach to expand the experimental scope for formation of protocells of increasing complexity. Resulting microstructures will undergo silicification and diagenesis, the principal preservation pathway for early Archean microfossils. State-of-the-art analytical techniques will be used to characterise biomorphs, providing the first rigorous investigation of the feasibility of protocell preservation and how this might express in the geological record. These data combined with a predictive model and biological controls will allow for identification of key observables that will act as biogenicity indicators. Purported microfossils will then be examined and reinterpreted using the novel biosignatures. This project has the capacity to represent a paradigm shift in our fundamental understanding of the origin and evolution of life on Earth and possibly elsewhere in the Solar System. Collectively this will represent a major advance in our understanding of the geological record, providing the first comprehensive methodology to distinguish between abiotic, prebiotic, and biological microstructures.	micropalaeontology; microscopy; microfluidics; geochemist; organic geochemist; microbiology; biosignatures; bioinformatics; computational chemistry; computational biology; Mars; Archean	sean.jordan@dcu.ie
161	Earth System Science	Forecasting climate surprises on longer timescales	ALFRED-WEGENER-INSTITUT HELMHOLTZ-ZENTRUM FUR POLAR- UND MEERESFORSCHUNG		Ice sheets, Earth System Modeling, Tipping points	The Greenland and Antarctic ice sheets (GrIS and AIS, respectively) and the Atlantic Meridional Overturning Circulation (AMOC) are prominent examples of tipping elements in the Earth system that have the potential to respond nonlinearly to small changes in forcing. Tipping elements can thus give rise to climate surprises, i.e., low-probability, high-impact events that may be triggered earlier than expected. Simulating such climate surprises and their impacts, on the relevant multi-centennial timescales and beyond, is particularly challenging. Today, the right methods are not available, resulting in deep uncertainty in future projections. Here I aim to develop a novel, probabilistic methodology to robustly forecast climate surprises such as ice-sheet and AMOC collapse on long timescales. This requires simultaneous advances beyond the state of the art on two fronts. First, a new generation Fast Earth System Model (FESM) will leverage the latest advances in our understanding of key processes to represent the GrIS, AIS and AMOC realistically, in a coupled framework and on long timescales. Critically, this will be the first comprehensive model fast enough to run the large ensembles of simulations needed to quantify the uncertainty associated with deeply uncertain processes. Second, a highly novel and generalized probabilistic approach will be developed, to constrain the FESM to be consistent with output from the latest generation of Earth System Models. FORCLIMA will generate probabilistic estimates of climate surprises for the medium-term future (centuries to millennia) with much higher confidence than we have today, and inform about interactions between key tipping elements in the climate system. This project will therefore greatly advance the state of the art in coupled climate – ice-sheet modeling, and lead to an unparalleled understanding of the long-term impacts of climate change on the Earth system.		alexander.robinson@awi.de

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162	Earth System Science	Universal Model of the Density of Deep Silicate Melts	HELMHOLTZ ZENTRUM POTSDAM DEUTSCHES GEOFORSCH UNGSZENTR UM GFZ		glass; melt; high pressure; refractive index; density; mantle; silicate	The starting conditions for the Earth's evolution were set by gravitational differentiation in the solidifying magma ocean. Yet, a thorough understanding of the magma ocean dynamics and thus of the primordial Earth is lacking. One key unknown is the density of silicate melts at high pressure, which determines whether the crystallizing phases rise or sink. Magma density also governs the storage, spatial distribution, and migration of melts in the present-day Earth. Densities of silicate liquids at mantle pressures and temperatures are extremely difficult to measure because of the tiny sample size, melt chemical reactivity, and its lack of crystalline structure. The use of glasses as proxies of melts lifts some but not all of these challenges. Albeit needed for a holistic picture of planet Earth, no density systematics exists for glasses or melts across the pressure range of the entire mantle. Glass2Melt will employ and further a novel class of fast white laser spectroscopy methods to measure the density of multicomponent synthetic silicate glasses and melts at mantle pressure-temperature conditions. Our approach is ground-breaking because it allows to thoroughly explore a large compositional space and determine the density of any deep silicate melt. Our results will (i) parametrize a universal silicate melt density model applicable to the entire mantle, and (ii) quantify solid-liquid buoyancy throughout the whole crystallizing magma ocean. Glass2Melt will have a broad, lasting impact on our understanding of the Earth's interior and its evolution over geologic time. The new density model will provide critical input for future numerical simulations assessing fundamental questions about the solidification of the primordial magma ocean, as well as the initiation and development of physical and chemical heterogeneity in the mantle. It will also be crucial for deciphering deep low seismic velocity structures, and to modeling magma dynamics in the present-day Earth.	glass; optical properties; high pressure	slobanov@gfz-potsdam.de
163	Earth System Science	Spontaneous interfacial oxidant formation as a key driver for aerosol oxidation	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQU E CNRS			Aerosols and clouds are key players in tropospheric chemistry. These tiny particles suspended in the air, with a radius ranging from a few nanometres to tens of micrometres, impact atmospheric composition, represent one of the largest uncertainties in climatic projections and cause millions of deaths worldwide every year. Hence, they have enormous societal and economic consequences. Nonetheless, there is still a knowledge gap preventing us from describing the chemical evolution of aerosols and clouds during their atmospheric lifetime. Supported by preliminary experiments, I therefore propose to unravel the impact of the spontaneous oxidant formation at the air/liquid interface as a key driver for multiphase oxidation processes. Water molecules in bulk liquid are stable and inert under ambient conditions. In sharp contrast, it was very recently shown that the local orientation of water molecules at an air/water interface induces an electric field that generates spontaneous radicals in micron-sized droplets. This production does not involve any catalysts such as light or heat. It is an intrinsic property of the air/water interface, and therefore potentially ubiquitous in the troposphere. This spontaneous interfacial oxidant formation has never been explored for its atmospheric significance. Therefore, the SOFA project aims to unravel the atmospheric importance of this interfacial (dark) chemistry. If oxidants (including OH radicals) are in fact spontaneously produced at the air-water interface, under atmospherically relevant concentrations, this would profoundly challenge our understanding and description of atmospheric multiphase chemistry. SOFA will develop a novel strategy, scaling up from laboratory-based measurements to fieldwork and modelling to assess the importance of this interfacial chemistry. SOFA will advance an entirely new perspective on how to address the multiphase oxidation capacity of the troposphere, and will therefore have a wide impact.		christian.george@ircelyon.univ-lyon1.fr

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164	Earth System Science	Fire in the land of ice: Climatic drivers and feedbacks	STICHTING VU	https://sites.google.com/view/climateco/projects?authuser=0	Fire, permafrost, lightning, boreal, Arctic, remote sensing	2019 was the largest fire year since at least 1997 within the Arctic Circle, largely driven by Siberian fires. The arctic-boreal region stores about two atmospheres worth of soil carbon with 90 % currently locked in permafrost soils, or perennially frozen ground. Fire releases parts of this carbon stock, which may induce a vigorous climate warming feedback. FireIce will investigate feedbacks between climate warming and arctic-boreal fires by studying direct and longer-term carbon emissions from fires. FireIce will acquire highly needed observations of carbon emissions from Siberian forest and tundra fires. On top of the direct fire emissions, fires accelerate permafrost degradation, which leads to greenhouse gas emissions for several decades. Their sum may be substantially larger than the direct emissions, yet is largely unknown. In addition, FireIce will investigate the relative contribution of CH4 from smoldering fires to fire emissions. CH4 emissions represent a small, yet not well known, fraction of carbon emissions from fires, but CH4 is a more potent greenhouse gas than CO2. FireIce will investigate feedbacks between climate warming and arctic-boreal fires by studying controls on fire size and ignition. Fire growth can be limited because of fuel or fire weather limitations. The fire weather control is sensitive to warming, which may lead to larger future fires. Lightning ignition is the main source of burned area in arctic-boreal regions, and more lightning is expected in the future. By combining contemporary controls on fire size and ignition, and future predictions of climate and lightning, FireIce will assess the vulnerability of arctic-boreal permafrost and soil carbon to increases in fire. FireIce's results will be relevant to evidence-based policy. FireIce's innovations are conceptual, i.e. unstudied aspects of an emerging warming feedback loop, methodological, e.g. inclusion of novel spaceborne data, and geographical, i.e. a focus on Siberia.	Fire, permafrost, lightning, boreal, Arctic, remote sensing	s.s.n.veraverbeke@vu.nl
165	Earth System Science	Global reanalysis for a forest carbon sink in flux	LUNDS UNIVERSITET		Forest dynamics, carbon cycling, modelling, forest inventory	Three trillion trees lie behind a carbon sink that has taken up about 30% of humanity's carbon emissions over recent decades. Yet whether we can continue to rely on this huge natural subsidy is highly uncertain. The sink emerges from systematic perturbations in the dynamics of growth, death and establishment of individual trees. Taken together across the forest, these lead to the net uptake or release of carbon. Both theory and recent observations point towards profound changes in these dynamics of the world's forests being underway, potentially causing the sink to saturate and decline. But our ability to accurately assess and quantify such on-going changes worldwide is severely limited. The reasons for this are twofold: a lack of standardised measurements of the sink and the dynamics that cause it across the world, and the difficulty of modelling the dynamics of trillions of trees. Tree2Globe solves both of these limitations, using a novel model-data assimilation approach to consistently integrate the dynamics of millions of observations of individual trees collected under disparate protocols worldwide and link together this information in space and time based on physically-consistent principles. The resulting global forest reanalysis system will (a) provide a step-change in capability to make accurate and timely assessment of the rates of tree growth, death and establishment globally and (b) quantify how these combine with the legacies of past land-use and disturbance to explain the size, location and trajectory of the global carbon sink in trees over the period 1990-2027. This will enable us to make a definitive assessment of whether hypothesised changes in forest dynamics and the resulting carbon sink are coming to pass. This unique insight into how the world's forests and their contribution to climate change mitigation are changing will provide key information to help guide the world to meet its net zero emissions policy commitments.		thomas.pugh@nateko.lu.se

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166	Earth System Science	High Temperature Dynamics of Metals and the Earth's Solid Inner Core	UNIVERSITE DE LILLE	https://erc-hotcores.univ-lille.fr/	High pressure, metals, Earth's core, mechanical friction, XFEL, diffraction	The Earth's inner-core (IC) is 1220 km radius planet within the Earth, made of solid iron (Fe) crystallizing from the outer core (OC) as the Earth cools down. The IC affects our life at the surface; its growth provides a major source of energy for maintaining the Earth's magnetic field. One may view the IC as a freezing ball of Fe floating at the center of the OC, but seismic exploration reveal structures of increasing complexity, raising fundamental questions on the history and internal dynamics of the IC. Geophysical observations unearth the IC as it is today. Understanding the history of the IC and the effect of the IC on the global Earth dynamics, however, requires a reconstruction based on today's observations and knowledge of the physical properties of the IC Fe alloy, how they could affect IC dynamics, and their relation with present-day geophysical observables. There are significant knowledge gaps and outdated principles regarding the underlying physical properties of the IC Fe alloy. The IC temperature is close to melting, and the IC might even be partially molten. How does temperature affect of the mechanical properties of the IC Fe alloy? What is the effect of temperature and partial melting on seismic observables such as wave travel time and attenuation? This is poorly known and it hinders our interpretation capability of the ever-growing body of geophysical observations. In HotCores, advanced high pressure and/or high temperature experiments will be performed on Fe alloys and analogues. I propose to reenact key events of the history of the IC in the laboratory, as Fe crystallizes at the inner-outer-core boundary, as the IC grows and dynamically evolves to its present state, and as we see it today through the lenses of geophysical exploration. What is the structure and dynamics of the IC? How will the IC evolve in the future? HotCores aims at providing the mineralogical foundation that will help solving these mysteries.		sebastien.merkel@univ-lille.fr
167	Materials Engineering	Sustainable light-emitting devices through control of dynamic doping	UMEA UNIVERSITET	https://opeg-umu.com/	Light-emitting electrochemical cell; electrochemical doping, inkjet printing; control and tuning of doping structures	Artificial illumination is fundamental and ubiquitous in modern society, and the cuArtificial illumination is fundamental and ubiquitous in modern society, and the current large-scale commercialization of more efficient and practical technologies, in the form of LEDs and OLEDs, is therefore important. This development is not only resulting in improved luminaires and displays, but also paving the way for a wide range of applications in, e.g., medtech, security, and communication. However, a growing concern is related to that the fabrication of LEDs and OLEDs consumes large amounts of critical raw materials (CRMs) and energy, and that their recycling is poorly developed and difficult. A novel illumination technology, the light-emitting electrochemical cell (LEC), is in this context interesting, and we and others have recently developed concepts for its material- and energy-efficient and CRM-free printing fabrication and its delivery of efficient emission (although not yet on par with LED/OLED). These combined achievements now pave the way for a timely and important challenge: can the LEC become the first emissive technology that is truly sustainable through its entire lifecycle? We boldly argue that this vision can turn true if we can take control of the defining LEC feature, viz. the dynamic formation of a p-n junction by electrochemical doping. It was recently shown that current LECs suffer from severe quenching of the excitons (the photon precursors formed in the p-n junction) by too-nearby dopants, and we here introduce new insights and methodologies that address this setback through rational design and careful development of new materials. A key task is to tune the mobility of the electronic charge carriers and excitons, through guidelines established by modeling, for the attainment of a sharp p-n junction boundary. We emphasize that our proposed path to high-efficiency LECs does not depend on energy-intense processes or the use of toxic or CRM-based materials.	Solution-processable emitters; solution-processable electrode materials; inkjet printing	ludvig.edman@umu.se

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168	Materials Engineering	Molecular Design of Electrically Conductive Covalent Organic Frameworks as Efficient Electrodes for Lithium-Ion Batteries	UNIVERSIDAD DE SANTIAGO DE COMPOSTELA	https://electromolmat.com/electrocofs/	Organic battery, covalent organic frameworks	A major breakthrough in chemistry and materials science has been the development of Lithium-Ion Batteries (LIBs), which show great potential for storing energy from renewable sources and as the power sources for electric cars. However, commercially available LIBs are based on transition metal oxide cathodes, presenting limited energy density and raising relevant environmental concerns. Organic materials have received much attention as alternative electrodes because of their high theoretical capacity, resources availability and sustainability. In particular, Covalent Organic Frameworks (COFs) have emerged in the past few years as promising organic electrode materials due to their high stability, high ionic conductivity and outstanding chemical and structural versatility. Low electrical conductivity remains the main bottleneck for real applications of COFs as electrode materials, usually addressed by adding in large amounts of conductive carbon additives that decrease the energy density of the battery. The overarching objective of this project is to design and synthesize new conductive redox-active COFs as cathode materials to enhance LIBs electrochemical performance. The specific goals are: a) To design a new family of stable redox-active COFs built from unexplored building blocks to achieve an optimal balance between capacity, electrical conductivity and porosity. b) To investigate the role of the linkages, building blocks, doping, pressure, anisotropy and morphology on the electrical conductivity, unravelling the fundamental mechanisms of charge transport in COFs. c) To manufacture and test lithium batteries using conductive COFs cathode materials, assessing the influence of the processing techniques on the electrochemical performance.		manuel.souto.salom@usc.es
169	Materials Engineering	Controlling Electrodeposition Processes at the Nanoscale with Well-Ordered Nano-Structured Electrolytes	THE HEBREW UNIVERSITY OF JERUSALEM		Electrochemistery, Electrodeposition, Nanofabrication	Even though electrodeposition processes have been used since the nineteenth century, it is remarkably challenging to control their behaviour on the nanoscale. To the naked eye, deposited metal surface appears homogeneous, yet their morphology at the nanoscale is anything but smooth, with ramified metal structures (dendrites) forming on their surface. The utility of electrodeposition for advanced technologies such as NextGen high-energy metal batteries is proportional to our ability to control metal growth at the nanoscale. In theory, this requirement may be accomplished through nanoscale control over ionic processes. Due to lack of appropriate material systems, it appears that examining and validating this hypothesis, much less meeting its requirements, is currently beyond reach. NanoDep envisions a future in which these requirements are met by the development of nano-structured electrolyte systems with well-ordered conductive and nonconductive nanodomains. Our early results suggest that we may be able to completely prevent uncontrolled dendritic formation by designing structured electrolytes that allow nanoscale regulation over local ionic transport processes. The goals of NanoDep are to (1) uncover the behaviour of uncontrolled nanoscale electrodeposition processes within nano-structured electrolytes, (2) prevent them, and (3) apply these newly acquired insights to the construction of a "real-world" system. To accomplish these goals, we will develop a novel in-situ electrochemical platform for investigating the spatiotemporal electrodeposition behaviour in well-ordered nano-structured model electrolytes. The model system insights and guidelines will be translated into "real-world" macroscale batteries using advanced molecular engineering and self-assembly methods. The successful development of well-ordered nano-structured electrolytes represents an important step toward NextGen high-energy metal batteries based on fully regulated electrodeposition processes.		daniel.sharon@mail.huji.ac.il

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170	Materials Engineering	Engineering of Photo-rechargeable Nanoswimmers using Multicomponent Heterojunctions	FUNDACIO PRIVADA INSTITUT CATALA D'INVESTIGACIO QUIMICA		Nanomotors, nanoswimmers, photocatalysis, active matter, photo-rechargeable materials	The realization of smart nanoswimmers capable of moving and performing desired tasks in an aqueous environment is a technological challenge due to the viscous and thermal forces exerted upon them. While various types of external stimulus can be used to activate their autonomous motion, light is the easiest to operate and most flexible, due to the opportunities that it offers for motion modulation through intensity, wavelength, and direction. However, such optical control is affected by the properties of the aqueous media, limiting the applicability of light-driven nanoswimmers to non-scattering environments. The novel approach of this project (PhotoSwim) is the design of hybrid nanoswimmers that consist not only of photocatalytic but also persistent luminescent materials in order to provide triple light-responsive, light-storage, and light-emissive properties at the material level. This project will explore the potential of these innovative photoactivated swimmers to: (1) store and emit sufficient light energy to maintain motion in the absence of external irradiation, (2) exhibit long-term luminescence for tracking purposes, (3) move and interact with their surroundings at high speeds due to efficient charge pair separation and (4) achieve a major control over their motion by wavelength tunability. The knowledge obtained will then be used to expand the applicability of these hybrid nanoswimmers in scenarios of limited light penetrability. Specifically, their capabilities to maintain their photoactivity in the presence of chemical and biological interferences, along with real-time monitoring of their location by the emitted luminescence, will be tested. In this way, the potential of advanced multi-functioning nanoswimmers to keep moving and interacting with the surroundings in scenarios where the light supply is not fully available will be demonstrated.		kvilla@iciq.es
171	Materials Engineering	Nanohelicoid metamaterials templated by cellulose nanocrystals with end-tethered polymers	UNIVERSITAT POLITECNICA DE CATALUNYA	https://ercceli coids.upc.edu /en	colloidal liquid crystals, polymer science, circular dichroism spectroscopy, metamaterials, chiral plasmonics, self-assembly	Chirality plays a fundamental role in natural sciences and pharmacology. The ability to detect chiral molecules relies heavily on inherently weak circularly polarized light-matter interactions. Such interactions are enhanced in the presence of chiral metamaterials, which exhibit extraordinary electromagnetic properties not observed in nature. To date, large and broadband circular dichroism in the UV-visible spectrum requires arrays of metallic nanohelices in order to combine internal and Bragg resonances. However, their fabrication relies on costly electron/ion beam lithography or physical vapor deposition, in which it is difficult and time-consuming to control nanoscale morphology over large areas. New types of helix metamaterials and engineering processes based on self-assembly concepts are absolutely necessary in order to be viable for future technologies. Nevertheless, self-assembled metamaterials with large, broadband and tunable chiroptical responses in the UV-visible region is a great challenge due to the required subwavelength feature sizes. To this end, the helicoidal morphologies of chiral liquid crystals provide the ideal platform for maximizing chiral light-matter interactions. The objective of CELICOIDS is to investigate the use of the chiral liquid crystal phases of cellulose nanocrystals with end-tethered polyoxyethylene analogues as templates for the fabrication of a new class of metamaterial, solid metallic nanohelicoids. A recent breakthrough that now makes this project possible is the discovery that such cellulose nanocrystal hybrids form chiral liquid crystal phases. As one of the very few researchers in the world with the combined expertise in cellulose chemistry, polymer grafting and colloidal assembly, I am the ideal candidate to achieve success. New functionalities are envisioned thereafter, applicable to future devices for invisibility cloaking, super-resolution imaging and chiral sensing, prompting a change in paradigm in metamaterials.	Colloid chemist, polymer scientist, analytical spectroscopist, materials scientist	justin.zoppe@upc.edu

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172	Materials Engineering	Unveiling atomic-scale elemental distribution of electrode/electrolyte interfaces and interphase in batteries	RUHR-UNIVERSITAET BOCHUM			Developing high-energy-density rechargeable battery technologies is essential to solve energy and environmental problems. However, its development is currently impeded by a poor understanding of elementary processes occurring at electrode/electrolyte interfaces. Several long-standing issues such as short cycle life, low Coulombic efficiency and hazardous dendrite formation in batteries cannot be fundamentally solved due to the knowledge gap. The bottleneck is that interfacial chemistry on the atomic-scale is as yet unresolved, owing to the lack of sufficiently suitable analytical capabilities. I will address this gap using atom probe tomography, coupled with a highly innovative cryogenic sample preparation and transfer platform, to provide atomic-scale insights into solid electrolyte interphase (SEI) formed at the electrode/electrolyte interface. The key open questions to answer are: i) what is the composition and elemental distribution in a stable SEI? ii) how do ions in the electrolytes affect SEI formation? iii) how does stable SEI inhibit dendrite formation? My goal is to advance fundamental understanding of SEI formation, establish its structure-property relationships, and elucidate its interplay with other elementary processes occurring at electrode/electrolyte interfaces in a lithium metal battery model system. I will i) reveal elemental distribution and compositional details of SEI in/under different electrolytes and working conditions; ii) unveil compositional evolution of SEI and the electrolytes during charging and discharging; and iii) interrogate their roles in dendrite formation in a half and full battery cell, respectively. These unique data will shed atomistic insights into how to tailor SEI and electrode/electrolyte interfaces to mitigate long-standing issues. Furthermore, the novel cryogenic platform is not system-specific and will be applicable for studying other liquid- or solid-state-electrolyte battery technologies.		tong.li@rub.de
173	Materials Engineering	Engineering of bacteria to see light	POLITECNICO DI MILANO		biohybrid living materials, organic phototransducers, bacteria photostimulation, photodriven bacteria microswimmers	EOS wants to create a new class of biohybrid living materials capable to perceive light and perform tasks remotely (i.e. drug delivery in hard-to-reach body locations). I propose to achieve this by inducing light sensitivity into non-photosynthetic motile bacteria at minimum invasiveness and complexity. Based on the notion that the active manipulation of the bacteria membrane potential allows controlling bacterial functions, including motion, EOS challenge is how to trigger effectively a membrane potential dynamics. EOS will employ a materials-based approach that I call “optobacterial-stimulation” and is composed by two key ingredients: i. light as a spatiotemporal precise tool that can control bacteria remotely; ii. phototransducing organic materials that associate spontaneously with bacterial cells without the need for neither covalent attachment nor genetic modification. The phototransducing mechanism stems from the “cross-talking” between molecular excitations and the polarization state of cells. The photoinduced membrane potential dynamics is ultimately linked to ion motive force, and thus to the bacterial flagellar motor. All these abovementioned elements have in common the study of light-matter interaction, which represents my main research interest in the last decade. Using optobacterial-stimulation I will answer to three outstanding questions that are related to each other and shape EOS objectives: i. can we engineer bacteria to perceive light through exogenous phototransducers? ii. are bacteria able to perceive different photostimulation approaches, as dictated by molecular excited states, in terms of membrane potential dynamics and motion? iii. can we understand the relationship between the fate of excited states and bacterial function? In the case study, I will demonstrate phototactic guidance of “eyeless” bacteria that are competent to swim in the gastrointestinal tract, with the view to develop intrinsically bio-compatible microswimmers.		giuseppemaria.paterno@polimi.it

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174	Materials Engineering	Mechanics-tailored Functional Ceramics via Dislocations	KARLSRUHER INSTITUT FUER TECHNOLOGIE			Advanced functional ceramics play an indispensable role in our modern society and they are typically engineered by point defects or interfaces. The potential of dislocations (one-dimensional atomic distortions) in functional ceramics has been greatly underestimated until most recently. Exciting proofs-of-concept have been demonstrated for dislocation-tuned functionality such as electrical conductivity, superconductivity, and ferroelectric properties, revealing a new horizon of dislocation technology in ceramics for a wide range of next-generation applications from sensors, actuators to energy converters. However, it is widely known that ceramics are hard (difficult to deform) and brittle (easy to fracture), making it a great challenge to tailor dislocations in ceramics. This pressing bottleneck hinders the dislocation-tuned functionality and the true realization of dislocation technology. To break through this bottleneck, MECERDIS employs mechanics-guided design coupled with external fields (thermal, light illumination, electric field) to manipulate the 3 most fundamental factors of dislocation mechanics: nucleation, multiplication, and motion. These external fields greatly impact the charged dislocation cores in ceramics and open new routes for mechanical tuning. With these novel approaches, MECERDIS aims to generate, control, and stabilize dislocations in large plastic volumes up to mm-size with high density up to 10^15/m^2 to allow large-scale preparation for functionality assessment. Another essential benefit is, dislocations are an effective tool to combat the brittleness of ceramics by improving the damage tolerance and fracture toughness. MECERDIS will not only fulfil the key prerequisite of dislocation-tuned functionality but also secure the mechanical integrity and operational stability of future dislocation-based devices. With its success, MECERDIS will define a new paradigm of engineering functional ceramics using mechanics and dislocations.		xufei.fang@kit.edu
175	Materials Engineering	Electrical Modulation of Elastic Moduli	CHALMERS TEKNISKA HOGSKOLA AB	https://www.chalmers.se/en/persons/cmuller/	conjugated polymer, OECT, mechanical properties, electrochemistry, doping	How could a textile change its feel upon the push of a button? While we are accustomed to visual displays and loudspeakers, interactive tactile perception largely eludes our experience. Textiles that change their pliability and texture would allow for communication using our sense of touch. Potential applications abound, from human-machine interfaces for robotics to new forms of virtual reality. To facilitate such a tuneable mechanical response, materials are needed whose stiffness can be altered. This project will use conjugated polymers to realise stimuli-responsive materials. The developed materials will be spun into fibres and yarns, which will be integrated into prototype textile devices that can undergo a reversible change in pliability and texture. The explored materials science concepts will open up a new line of research in the blossoming field of organic electronics, while the application-oriented part of the project opens new horizons for the interdisciplinary field of wearable electronics.	organic electronics, electrochemistry, OECT, doping, conjugated polymer	christian.muller@chalmers.se

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176	Materials Engineering	Universal processing route for high-performance nanostructured yarns	FUNDACION IMDEA MATERIALES		nanowire, synthesis, CVD, fibre, electrode	Yarns are a natural architecture to assemble small building blocks into macroscopic objects and are thus woven in our history, from fabrics of natural fibres in ancient times to fibres of synthetic polymers developed in the 20th century for lightweight applications. Humankind's new building blocks are nanomaterials, with superlative properties in all areas (optoelectronic, catalytic, transport, structural) relevant for global challenges related to energy use, storage and conversion. UNIYARNS proposes a new universal route for gas-phase assembly of one-dimensional nanomaterials into kilometric yarns, applicable to materials central to energy applications (metal oxides, semiconductors and semi-metals), and reaching high volume fractions without use of processing solvents or polymers. The strategy is to grow ultra-long nanomaterials by atmospheric-pressure floating catalyst chemical vapour deposition (FCCVD) at sufficiently high concentration for them to entangle and form aerogels suspended in the gas phase that can then be directly drawn as continuous, macroscopic yarns. The first objective of the project is to demonstrate the generality of the FCCVD synthesis process, with a particular focus on metal oxide nanowires. A further objective is to study the kinetics and reaction paths in 1D nanomaterials synthesis with floating catalyst in order to understand the exceptionally fast growth rate inherent to this synthesis mode and to explore its boundaries of selectivity and conversion. The next objective is to describe aerogel formation by determining factors at the aerogel network level and at the molecular-scale level that govern gas-phase assembly. The final objective is to establish clear structure-property relations for nanostructured yarn systems to overcome the current envelope of materials properties through the low charge transport resistance and high toughness of their network structure.		juanjose.vilatela@imdea.org
177	Individuals, Markets and Organisations	Media, Economics and Geopolitics	Rheinische Friedrich-Wilhelms-Universitat Bonn			Research in political economy has documented a vast number of different " media effects" suggesting that the media can have a profound impact on a range of economically & politically relevant outcomes. Yet, the existing empirical work is significantly skewed towards a few countries, raising concerns about the generalizability & broader cross context relevance of the empirical findings. Further, given the predominant focus on individual countries and its politics, this implies limited attention is devoted to the frictions between national media, national politics and transnational policy making in the myriad of areas that require collective and coordinated global action. To what extent the primarily national media has concrete effects undermining global policy making across a broad range of areas - or on the specific issue of climate change - is an important empirical question that requires both suitable data and suitable research designs. MEGEO will deliver on both dimensions and in the process catalyse research across multiple disciplines. The overarching objectives of MEGEO are: 1) To develop & make available a comprehensive and consistent novel data resource measuring what national media reports on and how and to what extent other countries are represented in each other's media 2) To characterize the extent to which national media may affect policy making in domains with clear transnational relevance that has previously been mostly ignored 3) To quantify the extent to which skewed reporting on foreign countries may have tangible economic & political impacts The work is organized across three work packages that will provide a systematic "Topology of Media Focus" across countries; answer the question of "What, where and why does news spread to?; study "(How) Does National Media Shape Transnational Politics?"; and explore "(How) Does National Media Affect Cross Border Economic Activity?" using a range of novel applications and leveraging proprietary secondary data.		t.fetzer@warwick.ac.uk

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178	Institutions, Governance and Legal Systems	How European Big Cities and Legal Systems Trigger Urban Inequality: An Inquiry into Law and Economics	UNIVERSITA DEGLI STUDI DI GENOVA	https://cordis.europa.eu/project/id/101076616	Urban inequalities; Econometrics; Applied Economics; EU Cities; GIS; Causal Inference	HABITAT is based on a groundbreaking research hypothesis (GbRH): socioeconomic inequality in major European cities is largely due to a history of regulatory failures of urban legal systems. Urban legal systems have played a central causal role in concentrating wealth and, conversely, they have failed as much as the economic system in protecting vulnerable residents from growing socioeconomic inequality in major EU cities. To test this GbRH, the Principal Investigator (PI) and his team address the main forms of urban inequality from a law and economics perspective. HABITAT measures the impact of laws and judicial decisions that, by hypothesis, have triggered urban inequalities. European urban legal systems made middle and bottom deciles, underprivileged minorities, migrants, and women worse. HABITAT tests this GbRH through a case study approach, considering Berlin, London, Milan, and Paris. The PI proposes unprecedented and unique legal research, grounded on rigorous data analysis and a robust, cutting-edge methodology that combines: a) the evolutionary analysis of legal orders, with a focus on the legal determinants of the built environment; b) the comparative analysis of the common core of urban legal systems; c) a regulatory impact assessment through econometrics, statistics, and data analysis; d) an evidence- and process- based normative model, for the design of just cities from a legal and conceptual perspective, tested through scenario analysis.	Policy impact assessment; econometrics; data analysis; machine learning; NLP; economics; applied economics	alessio.sardo@unige.it
179	Institutions, Governance and Legal Systems	Synchronised Politics: Multiple Times and Political Power	LUDWIG-MAXIMILIANS-UNIVERSITAET MUENCHEN	https://politicalsystems.org/erc-advanced-grant-syncpol-synchronized-politics-multiple-times-and-political-powerproject-detail/	time; synchronisation; temporal structuring; European Union; asylum and migration policy	Democratic policy-makers in Europe's multi-level system grapple with multiple times, since different levels of government, parliaments and administrative agencies follow distinct time rules and time preferences. Time clashes are an ever-present threat. Synchronisation is, therefore, a critical, but very little understood dimension of public policy-making. It is designed to avoid systematic time clashes by structuring the timing, speed, frequencies, sequences, durations and time horizons in policy-making. Over the past decade, simultaneous demands for "faster action", "more time" and "extended time horizons" have pushed multi-level synchronisation in opposing directions. In light of major contestation around synchronisation, SYNCPOL asks: 1) What happens when political demands for "faster action", "more time" and "extended time horizons" challenge synchronisation arrangements in multi-level policy domains? 2) How does the reshaping of synchronisation arrangements alter the vertical and horizontal distribution of political power amongst governments, parliaments and administrative agencies and the types of power in Europe's multi-level system? Drawing on institutionalist theory, SYNCPOL conceptualises synchronisation arrangements as a critical variable that is fundamental to the distribution of political power amongst policy-makers. It rigorously probes hypotheses on this crucial connection employing a mixed-methods design that combines document analysis, interviews, a major survey, dictionary-based text analysis and process tracing. The project examines synchronisation across EU, national and subnational governments, parliaments and administrative agencies, with a focus on six multi-level democracies: Austria, Belgium, France, Germany, Italy, Spain. The analysis covers two policy domains - migration-asylum and public health policy – since the early 2010s. SYNCPOL will generate fundamentally new insights into how time shapes democratic multi-level politics and policy.		goetz.lmu@gmail.com

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180	Institutions, Governance and Legal Systems	A New Labour Law for Supply Chain Capitalism	TEL AVIV UNIVERSITY		Supply Chains, Workers Rights, Transnational Solidarity, Labor Law, Global Value Chains	Labour law gradually protects fewer of the worlds' workers. Changes in work and capital structure, new technologies and evolving modes of supply and production (together: 'supply chain capitalism'), lead to an incongruence between the distribution of market power and the premises and tools of labour law, creating barriers to workers' organization and agency. This incongruence stems from the fact that labour law developed in industrial economies to respond to the power disparities between capital and labour, and is therefore tied to a dyadic employer-employee paradigm in which labour law seeks to empower workers vis-à-vis employers, the presumed owners of capital. Yet this is no longer the case in the era of supply chain capitalism, where the direct employer is often a supplier in a Global Value Chain (GVC), whose economic calculus is dependent on corporations in higher tiers of the chain. Given the crises of both labour law and GVC governance, this project offers a path to restructure labour law to fit new patterns of supply chain capitalism. The project includes three main components: 1) Theoretical: The project intervenes in existing literature and theory on GVC governance and on labour law to propose a new analytical framework for reconceptualizing the role of workers and of labour law in GVC governance. 2) Empirical: Current initiatives to improve workers' rights in GVCs worldwide are based mostly on voluntary schemes, often perceived as 'private' or rooted in ' soft-law'. The project will closely study existing initiatives and holistically analyse the studies development and examine whether and how labour law can be restructured to support existing successful initiatives and produce new sustainable paths to strengthen worker power in GVCs. 3) Normative: Based on the two preceding parts, the project will create a blueprint for a new, and overdue, labour law for supply chain capitalism.		hshamir@tauex.tau.ac.il
181	Institutions, Governance and Legal Systems	Towards an evidence-based model for big data policing: Evaluating the statistical-methodological, criminological and legal and ethical conditions	UNIVERSITEIT GENT	https://bigdatpol.com/	Big data, crime, police, AI, statistics	Big data policing is an innovative strategy that uses historical data to forecast when and where there is a high risk of new crime events in order to use police resources more efficiently and proactively, and ultimately reduce crime rates. Big data policing models can consist of variables based on crime data available in police databases (e.g. previous crime events), socio-economic data (e.g. poverty index, residential mobility), opportunity characteristics (e.g. the presence of shops, distance to nearest highway), data from new technologies (e.g. intelligent cameras) and other known predictors of crime (e.g. police patrol intensity). However, there are several research gaps that need to be addressed. First, knowledge about and expertise in big data policing in Europe is currently fragmented. Second, there is a lack of interdisciplinarity with regard to big data policing studies, and yet the involvement of several disciplines is required when studying the issue. Third, there is a lack of scientific evaluations of big data policing models. The overarching objective of this ERC project is to unite and integrate the statistical-methodological, criminological, legal and ethical dimensions of big data policing in an evidence-based model that will be tested by different randomized controlled trials and built on the principles of an international (i.e. European) and interdisciplinary approach. The latter aim should be enabled by incorporating and conducting different PhD tracks focusing on these specific dimensions, which should allow better knowledge, insights and understanding of big data policing to be developed. This approach is innovative and radically different from the existing commercial and economic initiatives, which lack transparency on their predictive reliability and validity, effectiveness and legal and ethical safeguards.	big data analytics, AI	bigdatpol@ugent.be

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182	The Social World and Its Diversity	Implications of Gender-Affirming Hormone Therapy for Psychosocial Functioning and Social Relationships of Transgender People	STICHTING AMSTERDAM UMC	www.affirmrelationships.com	trans, social health, gender, hormones, biopsychosocial	Transgender health is an area of increasing focus for researchers and medical practitioners across Europe, in part due to rapidly escalating numbers of people identifying as transgender. A crucial oversight in this area is that very little research has examined how gender-affirming hormone therapy, the most common form of medical intervention for transgender people, shapes psychosocial functioning and ultimately social relationship experiences. Given the paramount importance of social relationships to health and well-being, evidence for psychosocial effects of gender-affirming hormone therapy is vital to ensuring health equity for transgender people, who suffer from alarmingly high rates of social disruption and suicide risk. I draw together independent strands of research on biological effects of hormones from social neuroendocrinology and health influences of psychological and sociocultural factors from social psychology and epidemiology to propose a novel biopsychosocial model linking gender-affirming hormone therapy to psychosocial functioning in transgender people. Drawing upon this model, I propose a programme of research involving four complementary work packages, triangulating across a variety of novel and cutting-edge research methods. This work will be guided by three key aims: A) to isolate causal pathways from a biopsychosocial model linking gender-affirming hormone therapy to psychosocial functioning, B) to empower transgender people to give voice to their own personal and relational experiences in the context of gender-affirming hormone therapy, and, C) to guide policy and practice for gender identity services in line with the informed consent model, directing focus to the improvement of psychosocial functioning and social relationship outcomes. This interdisciplinary programme of research will sit at the forefront of gender-affirming healthcare and treatment for transgender people.		d.m.doyle@amsterdamumc.nl
183	The Social World and Its Diversity	Digitizing Other Economies: A Comparative Approach	WAGENINGEN UNIVERSITY		Anthropology of Technology; Digitization; Horticulturalists; Hunter-Gatherers; Pastoralists; Non-Industrial Agriculturalists; Smartphones; Economic Anthropology; Digital Anthropology	How do longstanding, primarily non-industrial, non-capitalist societies adopt and adapt digital technologies in their daily practices and systems of values? Classical anthropological theory once arranged basic economic types on an evolutionary ladder ranging from hunter-gatherers, horticulturalists, pastoralists, and agriculturalists to industrialists. Today, the existence of these economies other than industrialism are correctly approached not as anachronisms but as contemporaneous to (post-)industrial life. Still, research on digitization has largely taken place in (post-) industrial contexts, meaning we know next to nothing about how different types of longstanding economies adopt and adapt digital technologies. At the same time, researchers have stipulated that digitization threatens global economic diversity. By comparing digitization to processes of colonization, they have argued that digital technologies facilitate assimilation into (post-)industrial economic systems and their often capitalist values by virtue of their technological design. This project empirically investigates these claims through in-depth ethnographic research among hunter-gatherers (Brazilian Amazon), pastoralists (Kyrgyz Republic), horticulturalists (Solomon Islands) and indigenous agriculturalists (India) who have long resisted assimilation into industrial-capitalism. Additional ethnological comparison of the four sites will offer unique macro-level insights into the possibilities for economic diversity in the digital age. Finally, the project advances a novel theoretical and methodological approach that advances both ethnographic research and ethnological comparison. This approach recognizes the significance of both technological design and contextual adaptations and provides tools for new research agendas not just on digital industrial-capitalism but on diverse economic systems and values.		geoffrey.hobbis@wur.nl

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184	The Social World and Its Diversity	A Middle Way? Probing Sufficiency through Meat and Milk in China	NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU	https://erc-midway.eu/	sufficiency; agri-food systems; China; sustainability; health; STS	About one-fifth of the world's greenhouse gas emissions come from agriculture. Much of this relates to livestock used for animal-based foods. Rather than arguing for increased efficiency, MidWay probes the concept of sufficiency to explore its potential for reducing human impacts on Earth's biosphere while preserving overall welfare, i.e., its potential for defining a 'middle way' between 'too little' and 'too much'. To do this, MidWay studies the cases of meat and milk in China. While meat was always a high-status product, milk was historically considered a 'barbarian' food, and most Chinese were intolerant to it. Both products were scarcely consumed in Chinese history but have boomed in popularity over the past 40 years. While often thought about as a change of consumer preferences, it has taken a concerted effort by the Chinese government and domestic and international actors to make both products integral to Chinese food practices. Seeing China as a strategic research site to ask questions about the supply and demand of animal foods, the MidWay project hypothesises that what has made meat and milk integral to Chinese food practices might also be 'otherwise', i.e., opening up a possibility for a future disembedding of meat and milk from food practices. Thus, using a constructivist inspired lens, MidWay makes use of practice theory and 'systems of provision' to study the normalisation of animal foods in China, particularly since 1978, with China's opening up. The ultimate objective is to probe the concept of sufficiency as a useful organising principle to achieve reduced consumption - highlighted through the sub-objectives of understanding how meat and milk have been rendered desirable in China. Perspectives that show how food is connected to social, technical and cultural variables, and the system that provides food, are lacking internationally and could lead to changes through facilitating a multifaceted policy response.		marius.korsnes@ntnu.no
185	The Human Mind and Its Complexity	Mental Files: New Foundations	COLLEGE DE FRANCE			This project is about the representation of particular objects in language and thought, a topic which has been at the forefront of philosophical attention for more than a century. About fifty years ago, ‘descriptivism’ was demoted from its dominant position in philosophy in favour of the theory of ‘direct reference’. A similar shift away from descriptivism has been a noticeable feature of work on the representation of objects in cognitive science, where the notion of an ‘object file’ has made it possible to unify research on perception and on infant cognition. The object file construct is in many respects similar to the philosophical idea of direct (non-descriptive) grounding for thoughts about particulars, and this has given rise to a new research program: the generalization of the file idea from perception to thought. Thus the last decade has seen the development of the mental file framework, according to which nondescriptive thoughts about particulars (so-called ‘singular thoughts’), whether or not they are based on perception, involve mental files whose 'reference' does not depend on category information to be found in the file but on certain relations to the object the obtaining of which triggers the opening of the file. The mental file framework has attracted considerable attention not only in philosophy, but also in psychology (Perner) and linguistics (Kamp). It has also inspired work in aesthetics and the philosophy of fiction. Successful though it is, the mental file framework currently faces what may be described as a foundational crisis. According to a recurrent piece of criticism, it fails to provide appropriate identity and persistence conditions for mental files. This threatens the credibility of the framework, reduced to a convenient metaphor, and puts it at risk despite its high promises and considerable appeal. The aim of this philosophical project is to end the crisis by entirely rethinking the foundations of the framework.		mentalfileserc@gmail.com

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186	The Human Mind and Its Complexity	Uncovering the human subcortical pathway for auditory threat detection	UNIVERSITAT DE BARCELONA			Fast detection of threats is one of the most important abilities for survival, as it allows efficiently responding to potential harms. In humans, such advantage extends well into other cognitive domains, including social communication. Threat detection is paramount in all sensory modalities, but is probably most adaptive in audition. However, research on the neural substrates of fast threat detection in humans has been almost exclusively dedicated to vision. The key neural pathway for visual fast threat detection is the so-called subcortical route for emotion. Having pulled through millions of years of evolution, this shortcut conveys crude direct sensory inputs from the thalamus to the amygdala, facilitating a prompt emotional response. In the auditory domain, evidence from non-human animals suggests that a similar fast route may exist, but it has never been described in humans. Here, I aim at testing the hypothesis that this auditory subcortical route indeed exists in our species, with neuroanatomical and functional properties that support an optimal response to threat. Using state-of-the-art electrophysiological and neuroimaging techniques (scalp and intracranial electroencephalography, functional magnetic resonance and diffusion-weighted imaging), I will identify a pathway compatible with this route and test its functional and temporal dynamics, relative to a cortical route. Each technique will provide essential information for thoroughly depicting the route. Beyond its function, I will examine its link to traits associated to psychiatric conditions. Then, to confirm its anatomical existence in humans, I will microscopically track its connections directly in postmortem brains. HumanSUBthreat will restructure current dominant models of human affective neuroscience, strongly biased towards vision, and provide a novel view towards the understanding of disorders associated to amygdala dysfunction.		jdominguez@ub.edu
187	The Human Mind and Its Complexity	Computational Mechanisms of Social Media Use in Youth	UNIVERSITEIT VAN AMSTERDAM	connectedmindslab.net	social media, reinforcement learning, youth, adolescence	We have an urgent need to better understand the social media engagement of youth. Social media supports the specific developmental needs of youth, such as those for social connection. However, the increased sensitivity of the developing brain to social rewards may place youth especially at risk. In addition, youth's sensitivity to social influence exposes another potential vulnerability, given that not all information is trustworthy. Understandably, there have been widespread fears about the impact of social media on youth. However, currently little is known about what drives youth to engage with social media or how they are impacted by it. Recent meta-analyses and reviews have identified that the field is hampered by several key limitations: 1) an overreliance on subjective and high-level measures, such as screen time, 2) the underuse of social media trace data and 3) lack of ecologically valid experimental tasks, and 4) the absence of a framework for understanding social media engagement. Here I address that challenge by developing novel computational models that provide a theoretical formalization of the complex interactions between the developing cognitive processes and social media affordances. In addition, I will analyse social media trace data, develop novel ecologically valid experimental tasks, and use neuroimaging to further test and refine these formal models. This project will focus on the neurocognitive development of fundamental cognitive processes that interact with the two key affordances that social media platforms provide: 1) social feedback processing and, 2) social information processing. The computational framework is grounded in 1) models of neurocognitive development, 2) reinforcement learning models, and 3) Bayesian models of belief updating. Our findings will significantly advance our understanding of the social media engagement of youth on the mechanistic level, and will provide a fruitful framework and toolbox for future studies.	social media, reinforcement learning, youth, adolescence, computational social science	w.vandenbos@uva.nl

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188	The Human Mind and Its Complexity	Personalizing the Unconscious: a Cognitive, Neural and Developmental Investigation	TEL AVIV UNIVERSITY			Consciousness is often described as the tip of the iceberg, under which a rich unconscious world exists. But is this metaphor accurate?The literature provides a mixture of contradicting findings, with some claiming that almost any cognitive function can be performed without awareness, while others arguing that unconscious processes are limited to routine, simple operations.Currently, there are two gaps in this body of knowledge, though; first, the field has almost solely examined group-level findings, without taking individual differences into account. Second, it is based on studies probing specific processes at specific time points; no study to date has tried to take a more global approach, looking for common mechanisms that persist over time, and potentially over tasks. Here, I aim at bridging over these two gaps, providing a novel framework: I suggest that individuals consistently differ in their Susceptibility to Unconscious Processing (SUP). I hypothesize that SUP is a stable trait that can explain conflicting findings and shed new light on the interplay between conscious and unconscious processes. Starting with a task for which evidence for stable individual differences exist, I suggest three possible neural mechanisms that can explain such differences. These mechanisms will be tested using electrophysiology, neuroimaging, and developmental studies. I also introduce a novel protocol for pitting conscious and unconscious processing against each other, and biasing this competition via feedback.Finally, I will conduct a large-scale study testing the riskier hypothesis that SUP might not only be stable over time, but also across tasks.Together, this study will provide a much needed, unparalleled systematic investigation of the reliability and replicability of key findings in the field. This research strives for a paradigmatic shift in the way we conceptualize, study and utilize unconscious processes, laying the foundations for a new science of the unconscious.		mudrikli@tauex.tau.ac.il
189	The Human Mind and Its Complexity	Divergence and convergence in dialogue: The dynamic management of mismatches	GOETEBORGS UNIVERSITET	www.christinehowes.com/divcon		Human interaction is deceptively simple to engage in, yet surprisingly challenging to account for theoretically. Existing theories of language and cognition cannot fully account for the complex dynamics of verbal and non-verbal behaviours in interaction, which is becoming even more apparent with our increasing use of computer-mediated communication, such as the currently ubiquitous Zoom calls. With DivCon, my vision is to transform our basic understanding of human interaction by showing how successful dialogue is driven by incremental, local and dynamic processes of mismatch management.In our everyday interactions, we continuously make predictions about what will happen next, based on how our own and others' behaviour affects the world, to open up new possible courses of action. In dialogue, these predictions are about sounds, words, inferences and even non-speech actions such as gestures or eye gaze. If our expectations are not met, we have to ascertain if the mismatching input can be resolved, or integrated as a surprising but rewarding outcome (as in the case of humour). DivCon will produce a suite of corpus and experimental data for exploring the timely issues of communication via different forms of computer-mediated communication, including text-based chats, video calls and virtual reality meetings. To do this, the project will create a novel experimental platform for experiments in real time live multimodal interactions using avatars and virtual reality. The formal arm of the project will develop a precise theory of divergence and convergence in interaction which unifies verbal and non-verbal dialogue phenomena including gesture, gaze, feedback and laughter, using core notions of prediction and underspecification. This model will be implementable in conversational AI –an important step in the path to genuinely adaptive conversational AI systems, which are still beyond the reach of researchers despite the promise of recent decades.		christine.howes@gu.se

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190	The Human Mind and Its Complexity	The interplay of neural networks enabling social interaction	TECHNISCHE UNIVERSITAET DRESDEN		social neuroscience, empathy, theory of mind, fmri	The quality and number of social interactions are among the best predictors of long-term health. So how do good social interactions arise? Social neuroscience has focused on a number of affective and cognitive functions as potential “ building blocks” of social interaction. However, utilizing mainly simplistic and passive paradigms, we still fail at describing how actual, live social interactions emerge – and why they so often go awry, especially in people with mental disorders. Here, the concept of “building blocks” may have become an impediment to progress. Recent evidence suggests that in more complex experimental tasks, socio-affective and -cognitive processes are not simply stacked up, but are dynamically working together, just as the underlying neural networks seem to engage in lively interplay. INTERACT’s main objective is to understand how adaptive social interactions emerge, based on elucidating the interactions of networks and processes. INTERACT will take a major leap forward with a systematic and mechanistic, yet fully socially-interactive approach. Across six work packages, INTERACT will move from the comprehensive investigation of behavioral and neural interaction patterns of social affect and cognition in controlled lab settings to completely free social interactions in people ’s everyday lives. Combining a novel experimental approach with dual neuroimaging (hyperscanning) and multisite neurostimulation, neuroeconomics, and multi-agent ecological ambulatory assessment, INTERACT will shift from a modular to a complex systems study of actual social interaction. It also provides steps towards specific and targeted interventions in people with social interaction difficulties. INTERACT aspires to bridge the gap between basic and applied research, developing an interdisciplinary model of social interactions that expands our knowledge and applies it to real-world settings.	social neuroscience, cognitive neuroscience, affective neuroscience, fmri, clinical psychology	philipp.kanske@tu-dresden.de
191	The Human Mind and Its Complexity	Universal prevention of maternal perinatal mental disorders and its implementation as normalized routine practice	UNIVERSIDAD DE SEVILLA	https://grupo.us.es/eperinatal/	Mental Health; Digital; Pregnancy; Randomized Control Trial; Implementation; Health Services	Maternal mental disorders are the most common complications during pregnancy and within the first year after childbirth (defined as the perinatal period) and are the leading cause of maternal suicide. Affected mothers cannot function properly, causing a devastating impact on the entire family. Effective primary prevention interventions are urgently needed. However, the current scientific evidence is insufficient to implementing primary preventive programs at the population level. I aim to establish the effectiveness of universal preventive interventions for maternal perinatal mental disorders and to support their implementation as normalized routine practice in global healthcare services. Integrating classical and emerging methodological frameworks (family systems, self-determination theory, and normalization process theory), as well as the perspective of patient and public involvement in research, I will: (a) Develop a personalized mobile-Health preventive intervention for mothers and their partners, which integrates evidence-based psychological components and personalized health recommendations; (b) Test preventive intervention effectiveness for reducing the incidence of maternal depression and anxiety disorder, reducing father/partner symptoms of depression and anxiety, and promoting child health and development; (c) Apply a causal methodology, to pinpoint the underlying mechanisms for the effectiveness of the preventive intervention; and (d) Understand the implementation process and identify the factors that can promote or inhibit implementation. With the multidisciplinary team that I lead – and a large-scale hybrid effectiveness-implementation trail in real-world maternal health services – this research programme promises to be the first in its field. The resulting robust scientific evidence and novel explanatory model will create a new research paradigm. A toolkit for implementation research will enhance translation as normalized routine practice.	Mental Health; Digital; Pregnancy; Randomized Control Trial; Implementation; Health Services	emotrico@us.es

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192	The Human Mind and Its Complexity	Sensation and inferences in perception, metacognition and action	PHILIPPS UNIVERSITAET MARBURG	https://www.uni-marburg.de/en/fb04/team-schuetz/sences	Visual perception, Eye Movements, EEG, Psychology, Neuroscience	The perceptual experience of humans is seamless, although there are major spatial gaps in the available sensory information due to internal (e.g. absence of photoreceptors in the blind-spot) or external reasons (e.g. occlusion by other objects). While the contents of these sensory gaps seem to be completed by inferences, it is unknown how those inferences are dealt with in further processing compared to veridical sensory information. Recently, we and others showed that inferred information is preferred over sensory information in metacognition. This contradicts one of the axioms of current thinking about human information processing, according to which information is weighted by its reliability. SENCES aims to investigate the processing and usage of inferred information in comparison to veridical sensory information. First, we will use psychophysical and behavioral experiments to understand the role of inferences in perception, metacognition and action. Second, we will use EEG to distinguish between different models concerning the neural processing of inferences. Third, we will assess the role of inferences in pathological retinal scotomata and their plasticity along three time scales: across the lifespan by comparing healthy observers and patients experienced with missing sensory information due to long-term visual disorders; in the mid-term by studying the progression of pathological retinal scotomata in patients; in the short-term by training healthy observers with artificially missing sensory information. SENCES will provide crucial insights into how a seamless perceptual experience is constructed and how it is shielded from gaps in sensory information. Studying different phenomena of perceptual completion will allow for the discovery of general principles. Finally, it will uncover positive and negative consequences of perceptual completion in pathological scotomata and might point towards new approaches for early diagnosis and behavioral treatment.		a.schuetz@uni-marburg.de
193	The Human Mind and Its Complexity	Knowledge-First Social Epistemology	UNIVERSITY OF GLASGOW	https://www.knowledgelab-research.com/	knowledge; information; communication; trust	This highly ambitious project proposes a new research programme for social epistemology. Social epistemology investigates the epistemic effects of social interactions: e.g., how we gain knowledge from social sources (others' testimony, the media), how we should respond to disagreement, how groups (scientific teams, organisations) can know. It is among the most thriving areas in contemporary philosophy. However, there is little agreement concerning the best methodological approach to social epistemological issues. Individualism puts the individual first; it asks: 'What are the epistemic responsibilities of individuals in social settings?' Its main weakness is that it is too demanding to be empirically plausible: according to Individualism, the individual has to do most of the work in separating reliable from unreliable sources. In contrast, Socialism puts the social factor first; it asks: 'How does the social environment need to be for individuals to acquire justified beliefs?' On this view, individuals need to do more or less epistemic work, depending on the social norms in force at the context. Socialism is too permissive, in that it licences socially accepted but epistemically irresponsible behaviour. KNOWLEDGELAB develops a novel methodology for social epistemology, one that puts knowledge first; it starts with the function of social epistemic interactions, i.e. that of generating knowledge. It asks: 'How should we proceed in social epistemic interactions in order to generate knowledge?' KNOWLEDGELAB employs this novel methodology in the service of the epistemology of testimony, disagreement and groups, and develops the first integrated account of the epistemology of mass media in the literature. This framework is highly relevant in the context of a globalized society, replete with both easy-access information and misinformation: it is more important than ever to know what separates trustworthy sources of information from untrustworthy ones.		mona.simion@glasgow.ac.uk

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194	The Human Mind and Its Complexity	A Predictive Coding Perspective of Brain Dynamics: the case of Oscillatory Travelling Waves	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	https://artipago.github.io/	Predictive Coding; Neural traveling waves; Cognitive Neuroscience; Computational Psychiatry	One of the most exciting yet puzzling questions in Neuroscience is how the brain coordinates the activity between different areas, integrating distinct representations into conscious percepts and thoughts. For decades neuroscientists have investigated how the brain orchestrates diverse regions' activity, pointing at oscillations as one of the key mechanisms involved in such a process. However, previous research has mainly focused on the temporal aspect of oscillatory dynamics, largely overlooking how oscillations propagate through the brain. Although rhythmic traveling waves have recently gained renewed interest, their functional role and relation to cognitive functions remain largely unknown. In this project, I will address this fundamental question: what is the role of oscillatory traveling waves in brain dynamics? I plan to take on this challenge using a multi-scale computational approach, modeling neural dynamics within and between cortical regions, as well as cortical-thalamic interactions. Importantly, the novelty of this approach consists in framing the model in the light of Predictive Coding principles, to test the compelling yet striking hypothesis that traveling waves encode Predictions and Prediction-Errors. The results of the simulations will be compared against experimental recordings in human participants to validate and assess the model's predictions. Lastly, some implementations will turn into deep learning architectures, to test their dynamics in visual tasks while improving current models of artificial vision. All in all, this proposal can significantly advance our understanding of the neurophysiological mechanisms involved in sensory and cognitive functions, testing whether and how oscillatory traveling waves are a critical mechanism in neural dynamics, and producing fundamental results in the scientific field and future technological applications.		andrea.alamia@cnrs.fr
195	The Human Mind and Its Complexity	Structuring spatial knowledge through domain-general, non-spatial learning mechanisms	UNIVERSITA DEGLI STUDI DI PAVIA	https://sites.google.com/unipv.it/lucarinaldi	language, semantic memory, cognitive maps	Is space the main organizer of our mental reality? The answer to this question is apparently "yes". According to recent views, nearly any type of knowledge would be organized through low-dimensional geometries relying on the same computations that are at play in the navigation of the physical space, as attested by the involvement of the hippocampal-entorhinal region in high-level cognition. From an evolutionary standpoint, spatial processing mechanisms might have thus developed from originally mapping the navigable environment to representing cognitive spaces. Moving beyond this spatiocentric view of the human mind, OutOfSpace will test the fascinating yet apparently counterintuitive hypothesis that non-spatial associative learning mechanisms are active (if not the main) ingredients in structuring spatial representations. To pursue this aim, OutOfSpace will employ cognitively plausible computational models (i.e., distributional semantic models) based on non-spatial associative learning mechanisms to extract latent knowledge from natural language; this non-spatial information will be then used to predict a variety of spatial representations, using a pioneering interdisciplinary approach that combines computational, behavioural, eye tracking, fMRI, TMS-EEG and intracranial EEG work in both sighted and blind individuals. OutOfSpace will thus make a breakthrough on two fronts: (i) probing whether language - a non-spatial learning environment - can encode and recode spatial knowledge without the need for a dedicated spatial memory system; (ii) attesting the strict interplay between spatial and non-spatial learning mechanisms in structuring mental representations. More generally, these findings will open the venue to developing a more comprehensive, empirically-based cognitive neuroscience framework for processing and representing spatial information.		luca.rinaldi@unipv.it

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196	The Human Mind and Its Complexity	Valence asymmetries: the positive, the negative, the good and the bad in language, mind and morality	UNIVERSIDAD POMPEU FABRA	https://www.upf.edu/web/valence-asymmetries	valence, negativity bias, moral cognition, value judgments, semantics, pragmatics	An asymmetric behavior between the positive and the negative has been evidenced in psychology, for information processing, attention, recognition and decision making, in philosophy, for judgments about morality and intentionality, and in linguistics, for a range of lexical, syntactic, semantic and pragmatic phenomena. Negative information grabs our attention, we process it more carefully, we recall it with greater precision. We easily blame others for the negative side-effects of their actions, but do not praise them for the positive ones. It takes many nice words to overthrow one nasty remark. When we say that something is "not good", we usually imply that it is bad, but by saying "not bad" we do not imply that it is good. Valence asymmetries have arisen on many horizons but have seldom been brought into correspondence, and are at odds with most theories of value. The present project is a pioneering attempt to secure the premises for a cross-fertilization between the different accounts of valence asymmetries. It will deploy methods from philosophy (argumentation and conceptual analysis), formal semantic and value-theoretic models, and experimental methodology from psycholinguistics and moral psychology. It has three main objectives: - highlight the fundamental role that valence plays beyond emotion, in particular, in value judgments and language; - examine what the different asymmetries have in common, and whether they call for a unified explanation; - show that valence asymmetries are not necessarily irrational, but often derive from a fundamental asymmetry between positive and negative value, and, as such, are a key component of our cognitive and linguistic architecture. Furthermore, we will (a) articulate the relationship among the notions of valence, value and polarity; (b) put forward a novel account of the asymmetry of negation; (c) unearth new asymmetries in the realm of morality, virtue and vice; and (d) provide an account of valence reversals.		isidora.stojanovic@upf.edu
197	The Human Mind and Its Complexity	The Origins of Human Rhythm	UNIVERSITA DEGLI STUDI DI ROMA LA SAPIENZA		rhythm; music; evolution; animal; behavior; speech; acoustics	Humans are particularly rhythmic animals. Why did the human sense of rhythm develop? Many hypotheses try to explain the origins of our acoustic rhythm capacities, but few are empirically tested, compared, and comparatively investigated. This project searches for the evolutionary roots of human rhythmicity, breaking new ground through three concerted approaches. First, I zoom in on key rhythmic properties: isochrony, an even occurrence of events in time, and meter, a relative accentuation of events. Second, I compare hypotheses on rhythm origins, selecting the most relevant ones to music and speech and testing them against each other. Third, I target rhythm precursors in other species as predicted by these alternative hypotheses. I test four hypotheses, which propose that 1) gait or 2) breathing control, and the ability to 3) learn new sounds or 4) sing in a chorus are evolutionary precursors to human rhythm. I will use different measures including behavior, electrophysiology, gait tracking, breathing, and computational modeling to test whether the four features above predict rhythmic capacities. Comparative animal work is needed to test whether similar evolutionary pressures lead to similar rhythmic traits. I will collect data from humans and four more species. I will test seals, displaying vocal learning, and porpoises; both mammals have developed breathing control. I will also test siamangs, displaying rhythmic locomotion, and indris; both primates naturally sing in choruses, a rare trait in non-human mammals. Finding rhythm in other species will provide a test bench to reconstruct the origins of human rhythm. Resting on my background in bioacoustics and mathematics, the project expands in new challenging directions, such as neurophysiology of marine mammals, automated gait analyses, and biomusicology. In brief, I will show which species have rhythm, and why humans evolved to be such chatty, rhythmic creatures.		abcbbc-lab.sapienza@uniroma1.it

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198	The Human Mind and Its Complexity	Fundamentals of formal properties of nonmanuals: A quantitative approach	UNIVERSITETET I BERGEN	https://www.uib.no/en/nonmanual	sign language	Sign languages, in addition to using the hands, also use positions and movements of other articulators: the body, the head, the mouth, the eyebrows, the eyes and the eyelids, to convey lexical, grammatical, and prosodic information. This linguistic use of the nonmanual articulators is known as nonmanuals. Contrary to current assumptions in the field of sign linguistics, this project proposes the hypothesis that all sign languages use the same basic universal building blocks (nonmanual movements) but that each language is different in how it combines these building blocks both sequentially and simultaneously. Languages also differ in the regularity, frequency, and the alignment properties of the nonmanuals. In order to test this hypothesis, the project will investigate formal properties of nonmanuals in five geographically, historically, and socially diverse sign languages using data from published naturalistic corpora of the sign languages, Computer Vision for extracting measurements of the movement of nonmanual articulators, and a statistical technique of Functional Data Analysis for a quantitative comparison of dynamic nonmanual contours. This will result in the first quantitative formal typology of nonmanuals grounded in naturalistic corpus data. The novel methodology proposed in this project requires testing, adjustment, and development, which constitutes an important component of the project. The developed methodological pipeline will be a secondary output enabling large-scale reliable quantitative research on nonmanuals in future. Finally, the established typology of formal properties of nonmanuals in the five sign languages will serve as basis for a cross-modal comparison between nonmanuals and prosody/intonation in spoken languages in order to separate truly universal features of the human linguistic capacity from the effects of the visual vs. auditory modalities.		vadim.kimmelman@uib.no
199	The Human Mind and Its Complexity	Effect of linguistic experience on metacognition in language tasks and transfer to non-linguistic behaviour	UNIVERSIDADE DE COIMBRA	https://www.uc.pt/lmd/	metacognition, language, decision-making	This project explores metacognitive monitoring: the ability of individuals to track decisions, cognitive states, and behavior in uncertain situations. In earlier studies, I showed that Basque-Spanish bilinguals outperform monolinguals in metacognitive efficiency in tasks that engage cognitive processes activated when we hear natural speech. I suggested that bilinguals estimate the likelihood of making an error in language tasks better than monolinguals, i.e., they have enhanced error-monitoring skills in language tasks. However, bilinguals do not represent a homogeneous population. They differ in age of acquisition, relative proficiency in their languages, switching behavior, and also in typological distance between languages in their inventory. Basque and Spanish are typologically different languages. I hypothesize the variety of typologically different structures presents additional cognitive challenges and increases speech processing load, enhancing metacognition. I will test that the modulatory effect of bilingualism should be more modest in those bilingual populations where languages are typologically closer and the variety of language structures to be processed is narrower. I predict that exposure to more diverse phonological cues will enhance monitoring phonological tasks of any type, irrespective of phonological properties in bilinguals' native languages. I will also explore whether this metacognitive enhancement will be transferred from phonological to syntactic tasks, even if bilinguals' languages have typologically different phonology but similar syntax. Finally, I will explore if metacognitive enhancement in language tasks is transferred to non-linguistic behavior. In contemporary society, where bilingualism is a norm rather than exception, it is important to be aware to what extent metacognitive enhancement due to individual linguistic experience is transferred to non-language behavior and influences decision making both at individual and group levels.	cognitive science, neuroeconomics	leona.polyanskaya@gmail.com

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200	The Human Mind and Its Complexity	Experience Effects on early language acquisition	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	exelang.fr	language development; infancy and childhood; big data; machine learning	To what extent does experience affect child language acquisition? Answering this is crucial for our understanding of human cognition, but current evidence is insufficient because causal links between experience and outcomes cannot be established with typical approaches. We will study how the speech infants hear affects their learning of the sounds and structures of their native language, as represented in the speech the same infants produce, using an innovative and ecological technique: Audio-recordings collected with a recorder worn by the child throughout a normal day. Fifteen large-scale corpora will be combined, totaling over 25,000h of audio, collected from over 1,400 infants, living in rural and urban sites in every peopled continent, and learning a wide variety of mostly unrelated languages. We will develop cutting-edge machine learning algorithms to automatically analyze these long, messy, and multilingual recordings. This will yield measures representing infants' experiences (the speech addressed to them, and the speech they overhear) as well as how advanced their own vocalizations are. A subset of data come from Randomized Control Trials (RCTs) where treatment groups have received behavioral interventions aimed at increasing the quantity of speech infants are addressed. We aim to establish to what extent speech addressed to the infants and overheard speech affect their development by triangulating analyses of variation across individuals, cultures, and treatment-control contrasts. In parallel, we will use a reverse-engineering approach to assess the theoretically-predicted effects of experience. A variety of learning mechanisms will be implemented in unsupervised learning systems which take as input audio like that heard by infants and produce as output "vocalizations". If a system yields the same experience-outcome curves found in the infants' data, then those learning mechanisms plausibly resemble those used by infants.		alecristia@gmail.com
201	Cultures and Cultural Production	Olfactormativity: Exploring the Intervening Performativity of Smell	UNIVERSITAT FUR KUNSTLERISCHE UND INDUSTRIELLE GESTALTUNG LINZ	https://olfac.kunstuni-linz.at/	smell; sensory studies; performativity; performing arts; intervention; decolonizing; atmosphere; environment	Smells intervene in human experience. Used by police or military for crowd control, they are a perfidious weapon. Yet, they also offer a wealth of material for intervening arts, the exploration of which is currently gaining traction against a backdrop of climate change and the rise of sexism and racism. So far, however, research on the intervening potential of smell has remained the province of Military Sciences, with research on intervening arts focusing on the visual and the auditory, neglecting the disruptive power of olfaction. OLFAC bridges this gap by, for the first time, exploring the intervening performativity of smell at the intersection of arts and politics. Assuming that odour can be used both to stigmatize and, at the same time, to help "unlearn" socially trained norms, OLFAC will (1) empirically investigate olfactory actors, techniques and technologies applied across performing arts and governmental contexts and (2) develop an integrative, transculturally aligned, and intersectionally oriented theory of Olfactormativity. Fundamentally, the project explores the following questions: How do olfactory techniques and technologies applied in performing arts relate to those used by police and military? What dangers and potential for change do they pose? In what sense are olfactory actors capable of interrupting, subverting or displacing movements of assembly? To what extent can olfactory art break up historically evolved social structures and change perceptual routines? Does the subversive use of odours lead to radical ruptures and changes in terms of gender, class, and ethnicity? Or does it ultimately lead to strengthening conventional concepts of identity? A highly transdisciplinary endeavour, OLFAC draws together approaches and findings from Art-Related Disciplines, Cultural Studies, Anthropology, Psychology, Neurobiology and Chemistry and is set to establish an entirely new playing field for studying the interaction of power, arts, and the senses.	smell; sensory studies; performativity; performing arts; intervention; decolonizing; atmosphere; environment	silke.felber@kunstuni-linz.at

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202	Cultures and Cultural Production	The Italian Lauda: Disseminating Poetry and Concepts Through Melody (12th-16th centuries)	UNIVERSITA DEGLI STUDI DI TRENTO			The lauda, a vibrant expression of popular piety, is the poetic-musical genre that from the second half of the twelfth century marked the birth and the spread of singing in the Italian language. It was based on melodies of varied origins, but mostly functional in orally conveying – through minstrels, lay confraternities and preachers – the dissemination of texts and (not only spiritual) concepts among a largely illiterate population. Despite this 'volatility', a good corpus of laude has been preserved in written form for ritual needs, sometimes with musical notation, forming an impressive repository of 'frozen orality'. While realizing the importance and vastness of this heritage, scholars for over a century have been mainly engaged in alternatively considering it either from a literary or a musical point of view. Therefore, no systematic research has yet to shed light on the specific nature of the phenomenon, its dynamics of creation and transmission and all indicators that make it a reliable mirror of society, culture and mentality in medieval and early Renaissance Italy. The LAUDARE project aims to approach the Italian lauda in its intrinsic intermediality by collecting the whole corpus of texts handed down with music up to the mid 1500s and comprehensively exploring the dynamics of composition and transmission of poems and related tunes according to the mechanisms of orality. An open access database, making searchable the entire corpus, will allow wide-ranging surveys such as the territorial impact of a text and/or its musical setting as well as the diffusion of melodic patterns and text formulas. The results will be collected in a specific volume. Other expected outputs are a handbook, at least ten open access articles, three workshops and two international conferences with proceedings, one of which will have involved related disciplines such as medieval and religious history, linguistics, palaeography, iconography, anthropology, and urban studies.		francesco.zimei@gmail.com
203	Cultures and Cultural Production	THE ROMAN TURN AMONG JEWS, GREEK PAGANS, AND CHRISTIANS	THE HEBREW UNIVERSITY OF JERUSALEM			ROMANA aims to unveil the ubiquitous presence of Rome in Jewish, Greek-Pagan and Christian texts and to expose the strategies of cultural interaction between imperialist forces and a range of minority groups. It will explore how intellectual discourses that have defined the West, namely those of Greek elites, Christian groups, as well as Hellenistic and rabbinic Judaism, were constructed through a series of contested, hidden, and disavowed interactions with the dominant force of empire. The project will redraw the traditional map of the Roman Empire to challenge its sharp dichotomy between Rome and the provinces and demonstrate the deep entanglements of each group of "provincial" elites despite their claim to cultural purity. The starting point is first-century Hellenistic Judaism, as its main representatives—Philo and Josephus—became active in Rome as prolific authors writing in Greek, who combined philosophical, literary and legal interests with a keen appeal to Roman audiences. Their modes of acculturation will serve as a compass to unlock similar cultural entanglements in the Second Sophistic, early Christianity and rabbinic literature. The project objectives entail a focused study of three trajectories, philosophical, literary and legal, to be exposed as doubly entangled, namely with each other and with Roman discourses. The method will be a close, comparative and culturally aware reading of whole corpora of texts in Greek, Hebrew/Aramaic and Latin, based on the available manuscripts, moving through Greek-Christian writing into Rabbinic Judaism and the texts that contest the space between them. We will reach insights of a new order in fields which have thus far been overwhelmingly studied in double isolation or on the limited basis of digital searches of keywords. The results will be published in 6 monographs, special issues in leading journals, a consultation at an international conference and wide dissemination in Israel, up to changes in school curricula.		maren.niehoff@mail.huji.ac.il

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204	Cultures and Cultural Production	Text and Idea of Aristotle's Science of Living Things	EBERHARD KARLS UNIVERSITAET TUEBINGEN	https://www.tida.uni-tuebingen.de/	Philosophy, Mind, Aristotle, Science, Greek Philosophy	Text and Idea of Aristotle's Science of Living Things (TIDA) pursues two objectives, one philosophical, the other philological, both of which can only be achieved in tandem: subjecting Aristotle's treatise on the soul, the De Anima (DA), and related treatises, to a new and comprehensive philosophical interpretation, while making available the original Greek texts in a way that complies with the standards of contemporary textual criticism. Philosophically, the aim is to replace the interpretive approach that governed philosophical discussions around the DA for the past 5 decades with a more coherent and philosophically more informative interpretation. According to the received approach, the argument of the DA falls into the domain of 'philosophy of mind'. This assumption, fruitful though it was for our understanding of many of the DA's arguments, obfuscates the main aim and purpose of the treatise. TIDA shows how the DA is not concerned with the philosophy of mind as such, but with defining the first principle of the science of living things; we show how the DA divides explanatory labour with the other treatises pertaining to that science, and – most importantly – what the resulting scientific theory of living things has to say about the issues of the philosophy of mind. Philologically, the goal is to produce reliable critical editions of the relevant texts, print and digital, which we – astounding as it might seem – still do not possess. As the constitution of the texts will depend on the philosophical evaluation of alternative manuscript readings, only the closest collaboration between textual critics and philosophers will yield progress. There is reason to expect improved original texts and a genuinely new and more informative perspective on Aristotle on the mind. In effect, TIDA consists in a five-year interdisciplinary research team, designed to give future philosophical and philological work on Aristotle's science of living things a new and lasting foundation.	Philosophy, classics, mind, soul, science	klaus.corcilius@uni-tuebingen.de
205	Cultures and Cultural Production	The Philosophy of Experiential Artifacts	UNIVERSITA DEGLI STUDI DI GENOVA	https://pea.unige.it/	Aesthetics, Philosophy of Technology, Philosophy of Mind, Phenomenology	Ancient Greeks used one word, techne, to designate both technical and artistic practices. It is only in modern times that art gained autonomy, becoming the object of one philosophical discipline: aesthetics. However, the emergence of mass media, and then of digital media, has brought art close to technology, challenging its autonomy. In this situation, some basic philosophical questions about art regain centrality: Why art? What is art for? What is the role of art in a technological society like ours? The traditional answer stresses the uniqueness of art, pointing to the essential difference between artworks and technical artifacts. The increasing interchange between art and technology, however, encourages us to question this statement, pursuing an alternative strategy. The hypothesis is that artworks belong to a technical kind which has been overlooked so far: the kind of experiential artifacts whose function consists in triggering experiences. Art is severed from technology only if one focuses on artifacts such as drills or lathes whose function consists in producing concrete effects. Yet, once experiential artifacts have been recognized, one can fruitfully connect art to technology, rethinking forms of art as techniques for generating different types of experiences. The PEA project launches the philosophy of experiential artifacts as a new area of inquiry in which the relationship between art and technology can be properly theorized, thereby offering a new conceptual toolbox for historical and empirical research. This will be done through a fourfold methodology in which aesthetics and the philosophy of mind analyze the experiences that experiential artifacts are meant to trigger, while metaphysics and the philosophy of technology investigate the structure in virtue of which they perform this function. PEA will thus reconceptualize artworks as technical artifacts that we value for the way in which they enable us to enrich, share and coordinate our experiences.	Aesthetics, Philosophy of Technology, Philosophy of Mind, Phenomenology	enrico.terrone@unige.it

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206	Cultures and Cultural Production	Feminisms and the Mobilisation of Law in Gulf Countries	KOBENHAVNS UNIVERSITET			Abstract: Current literature have tended to analyze feminist activisms in MENA almost exclusively from the point of view of their effect on social change broadly defined, reemphasising the reifications of women as victims by sharia laws, the veil and repressive cultural and political systems. In addition, scholars have often directed their attention to visible forms of feminist activism including protesting in revolutionary countries such as Egypt, Tunisia, Lebanon, Yemen, Bahrain, among others, and have marginalised feminisms in stable countries. In this context, GulfFeminisms project is groundbreaking in three ways. First, it examines the under-studied domains of the genealogies of feminisms, and the mobilisation of the law in the three Gulf States of Saudi Arabia, Oman and United Arab Emirates. Women's rights in all the three countries are interpretatively, but differently, operationalized under Sharia law, abridging women's freedom to fully participate in decision-making processes at the national level. While established scholarship has provided valuable studies of how patriarchal religious and political authorities use legal and religious frameworks to repress feminists, maintain gendered inequalities and restrict women's rights. This project shifts the established scholarly perspective by examining how feminisms in the gulf are self-motivated political movements that mobilise laws, including Sharia, to operationalise women's agencies and practices within private and public spheres and to generate political change. Second, GulfFeminisms offers an original and leading perspective on feminisms in MENA as a practice promoting positive social and political change. Third, to analyse the relation of feminisms and the mobilising of the law, GulfFeminisms combines the multidisciplinary, novel, comparative analytical framework of Feminist Comparative Policy theory (FCP), and Epstein and Martin's (2004) approaches to qualitative and quantitative empirical law research.		jihan_zakarriya@hotmail.com
207	Cultures and Cultural Production	Graphs and Ontologies for Literary Evolution Models	RIJKSUNIVERSITEIT GRONINGEN	golemlab.eu	knowledge graph, narrative, cultural evolution, reader response	The "Graphs and Ontologies for Literary Evolution Models" (GOLEM) project will create statistically robust models explaining how fiction evolves, based on the analysis of millions of stories and the effects they have on readers. This is the first time in history that this kind of data is available on such a large scale, thanks to the fact that readers all over the world use digital and social media to share fictional stories and to comment on them, e.g. on fanfiction websites or on publishing platforms like Wattpad. GOLEM will use computational literary studies and cultural evolution theory to create accurate models of how the (formal and content-related) cultural traits found in fiction spread and combine. The basis of this evolutionary analysis of fiction will be a knowledge graph database – an infrastructure of interlinked data about stories and reader response – which will be used to test hypotheses related to the accumulation of cultural traits in stories and their effectiveness in achieving cognitive and emotional effects on readers. State-of-the-art machine learning algorithms and advanced statistical modelling tools will be employed to create a major breakthrough in computational literary studies, possibly also contributing to the revision of cultural evolution theories. By focusing on the relations between stories in five different languages, collected from countries in all continents, GOLEM will provide an unprecedented insight into how storytelling, one of the most ancient cultural systems, evolves. Literary history and criticism have offered refined accounts of how fiction works, mostly relying on case studies of limited extent. It is now time to provide robust statistical evidence of the anthropological function of fiction and of how it adapts to different circumstances and cultures, empowering readers to cope with their cultural or societal contexts.		f.pianzola@rug.nl

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208	Cultures and Cultural Production	Modernizing Empires: Enlightenment, Nationalist Vanguards and Non-Western Literary Modernities	ALMA MATER STUDIORUM - UNIVERSITA DI BOLOGNA		cultural history, comparative literature, computational literary studies	This project is a comparative study of cultural reforms, linguistic renewal and literary renaissance movements in three imperial traditions, caught between the East-West divide: Russia, Turkey and Japan. It looks at the negotiated cultural models in modernization and westernization processes and argues that their shared historical experience resulted in a common intellectual vocabulary and narrative models shared by otherwise extremely diverse cultures. Despite these unmistakable parallels, literary studies have failed to address this shared history. This project aims to bridge this gap by developing a comparative model, drawing a polycentric and plural map of literary modernity. In three subprojects, this project investigates structural similarities in 1.Questions and concepts in literary criticism; 2.Translational practices and translated works from Europe, and 3.Narrative logic and typologies in fiction. It is the first comparative multilingual study of the non-Western literary modernities to bring these specific traditions together. It contests Eurocentric models of literary history which interprets these cases as failures or late emulations. It challenges an overemphasis on single national traditions or on postcolonial approaches, and limited body of studied texts and analysis techniques in the study of the non-West. The project follows a multi-method research strategy to conduct historical and literary comparisons between the emerging national literary systems, combining qualitative and quantitative methods in order to map transnational networks of narrative strategies, conceptual systems and translation practices. It brings new directions in Digital Humanities, expanding it to non-Western and multilingual comparative research. Finally, it makes a much-needed contribution to the current literary corpus by making unknown and untranslated texts available and accessible.		ozen.dolcerocca@unibo.it
209	Cultures and Cultural Production	The Sensuous Appeal of the Holy. Sensory Agency of Sacred Art and Somatised Spiritual Experiences in Medieval Europe (12th-15th century)	UNIVERSITA DEGLI STUDI DI PADOVA	https://sensartproject.eu/	Sensory studies; material culture studies; Art history; Middle Ages; Medievl devotion	Is sight the only sense actively involved in the perception of art? This is a crucial question for Western culture, dominated today by the hegemony of vision and the suppression of the other senses. By challenging the current ocularcentric paradigm, and assimilating notions on the cultural values of sensation, SenSArt provides the first examination of medieval sacred art from the unconventional lens of its sensory agency. Between the 12th and the 15th century Europe underwent an extraordinary artistic evolution and an impressive cultural revitalization, which sparked a reassessment of the role of sensory perception in systems of knowledge and spiritual enlightenment. SenSArt explores and compares different social environments in six selected regions, pursuing three groundbreaking objectives: A) it will analyse quantitatively and qualitatively the perceptual schemes that orientated the reception of sacred art, scrutinizing how art solicited its beholders through multiple sensory inputs; B) it will develop and investigate the new notion of ‘sensory agency’ of art, establishing sacred art as a primary actor capable of exerting, through sensorial stimulation or deprivation, a social agency on its audience; C) it will provide an overall phenomenology of experiences on a European scale, by comparing the diverse patterns that different social groups lived on a local, regional and supranational scale. SenSArt will achieve its goals by developing a new combined approach at the crossroad of Art History, Philosophy and Text Studies; it will establish a multidisciplinary team of scholars to delve into a comparative set of materials, including normative texts on the senses and works of art. The project promises to bring about a paradigm shift in our understanding of Medieval Europe. It will shed new light on wide historical, devotional and cultural phenomena, outlining complex networks of social interactions where humans, art and the senses interplayed with each other.		erc.project.sensart@gmail.com.

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210	Cultures and Cultural Production	Resilient Cultures – Music, Art, and Cinema in Mainland China and Hong Kong	UNIVERSITEIT VAN AMSTERDAM		Resilience, Art, Popular Music, Cinema, Queer	How to be critical in a context where critique is disavowed? How to speak against power while being silenced? How to stay amidst suppression? RESCUE studies how cultural practices in the domains of popular music, contemporary art, and queer cinema, in mainland China and Hong Kong, develop resilient tactics to express their social and political discontent. It theorises resilience and cultural critique in times of intensified authoritarianism and rapid platformization. Whereas such practices can resort to a history of experiences in China to negotiate a recently intensified authoritarianism, cultural practitioners in Hong Kong are facing a compressed authoritarianism – still searching for resilient tactics. RESCUE studies indie music in Hong Kong; folk music in China; the role of official and unofficial art institutes in China and Hong Kong; socially engaged art projects in rural and urban areas in China and Hong Kong; and queer cinema and queer film festivals in China and Hong Kong. It develops a relational comparative analysis between different cultural fields, and at different localities (Hong Kong, Beijing, Shanghai, Guangzhou, Tianshui), to unpack the (im)possibilities of critique. RESCUE develops an innovative methodological toolkit, combining ethnography with textual analysis, digital methods, and collaborative research. RESCUE will establish and consolidate a network of academics, cultural practitioners, and activists in mainland China, Hong Kong, East Asia, and Europe, through multiple workshops, a podcast series, performances, screenings, and an exhibition – thereby increasing the social impact of the project. Findings will not only attest to the multivocality, diversity, and vitality of cultural production in mainland China and Hong Kong, thus pushing back against the idea of the omnipotent Chinese state, but also inspire and forge connections to other localities facing a comparable predicament (e.g. Brazil, Hungary, India, Russia, and Turkey).		b.j.dekloet@uva.nl
211	Cultures and Cultural Production	Expanding Agency: Women, Race and the Global Dissemination of Modern Architecture	UNIVERSITY COLLEGE DUBLIN, NATIONAL UNIVERSITY OF IRELAND, DUBLIN	https://expanding-agency.com	Architecture Gender Globalization Design Modernism	Expanding Agency will explore the role that women and members of ethnic minorities, primarily African-Americans, played in transmitting modern architecture and design internationally, including within Europe, between 1920 and 1970. Strands devoted to patronage, journalism, entrepreneurship, and institution building will offer alternatives to accounts that focus primarily on architects. This will expand our understanding of who had agency in this important story and more generally in the shaping of the built environment. Taking a global approach that stresses comparisons across continents will also help build a more nuanced understanding of how architecture, landscape architecture, interior decoration, and the design of furnishing are transformed by new ideas that emanate from a multiplicity of sources. This in turn can help support a more diverse profession that, in the wake of #metoo and Black Lives Matter, is better prepared to engage with a broad public, including to address such social challenges as the integration of migrants and sustainability.	Architect Architectural History Women's Studies Gender Studies Modernism Design	kathleen.jameschakraborty@ucd.ie

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212	Cultures and Cultural Production	Fishing Architecture: The Ecological Continuum between Buildings and Fish Species	UNIVERSIDADE DO PORTO	https://fishingarchitecture.com/	Architecture, Marine biology, Fisheries, Environmental History	To what extent can fish produce architecture? This project sets out to trace a socioecological history of North Atlantic architecture in relation to fisheries, elucidating the relationships between marine environments and terrestrial landscapes and assessing the ecological impact of fishing constructions and the natural resources they depend upon. Fishing Architecture covers a broad spectrum in terms of both geography and time, a choice that was made to avoid deterministic analysis and engage with transnational phenomena. Thus, the focus is on the North Atlantic—its shores housing diverse architectural cultures and its waters home to a wealth of fish species—and follows a time frame that runs from the industrialization of fisheries in the early 19th century to the full globalization of the industry at the end of the 20th. The extant scholarship on marine ecology, fisheries, and fishing communities includes extensive research on fish populations, navigation systems, technology, bioeconomics, architecture, and cultural practices. Yet, comprehensive interdisciplinary analysis of the field is hindered by its own specialization. Facing the impending challenges of the environmental predicament, this project will use the material history of architecture as a powerful tool for advancing interdisciplinary research and, along with it, our understanding of the ecological impacts of human activity. The assessment will be organized along five analytical axes: (1) marine ecosystems; (2) fishing technology; (3) food processing; (4) politics; and (5) consumption habits, effectively avoiding the conventional architectural approach to understanding the built environment. This strategy allows us to identify critical knowledge gaps to be worked on and, most significantly, fosters a fresh perspective on construction in which fishing landscapes and buildings are understood as material traces of dynamic socioecological relationships and as part of the continuum between land and sea.		andre@dafne.pt
213	Cultures and Cultural Production	Scholars, Animals, Images, Geographies, and the Arts: De-exoticizing Eastern Europe in the Early Modern Period	UNIWERSYTET WARSZAWSKI	https://cordis.europa.eu/project/id/101141906		Building on Claude Lévi-Strauss's oft-cited claim that "animals are good to think with," SAIGA sets out to forge a zoological trail in the understanding of Eastern Europe between the sixteenth and late eighteenth centuries. Focusing on animal representations, the project will shed new light on the role of images in the production and transfer of knowledge. The project will highlight the region's underrated contributions to the development of natural history by examining the overlooked Eastern European nodes in networks of scholars. By investigating various patterns of transmission of knowledge from East to West, this study will consider the vital role of Eastern informants, both trusted experts and unreliable amateurs. With animals as the primary object of investigation, the project will direct attention to the arduous processes of discovering Eastern European fauna. While some species had already been recorded by ancient authors (though seldom if ever seen), other species were only documented in the early modern period, turning Eastern Europe into a rewarding research opportunity for naturalists. Tracing the replication of images of Eastern European fauna, the project seeks to understand how early modern naturalists accounted for the discrepancies among ancient, medieval, and contemporaneous sources, and how their strategies of verification varied between the sixteenth and eighteenth centuries. Mapping this knowledge transfer onto the articulation of early modern geographies—which also attempted to make sense of the regions situated between Europe and Asia—the project promises to move the study of Eastern Europe beyond the paradigm of "demi-Orientalism," which all too often imposes a modern othering lens onto the earlier past of the region. Finally, the project will foreground the role of the arts, above all various printmaking techniques, in projecting the image of the region as an environmental and cultural landscape defined and distinguished by its animals.		g.jurkowlaniec@uw.edu.pl

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214	Cultures and Cultural Production	Philology as Science in 19th-Century Europe	UNIVERSITEIT GENT	https://www.metaphilology.ugent.be	Cultural History, Modern History, Philology, History of Science	Philology once defined what it meant to be scientific – and it may yet once again. Increasingly a broad array of scholars using digital methods cite the historical accomplishments of philology as a model for systematic study around unwieldy and heterogenous textual corpuses. Despite this renewed interest, there is still no systemic account for the huge range of activity and aegis, data and networks, that propelled philology to its status as a model or even the 'queen of science' in C19 Europe. In drawing on history of science, media studies, information studies and diverse textual methods, this project offers that holistic account of how and why philology as a 'science in the making' achieved such extraordinary success. It articulates the widely sought yet unachieved bridge that would permit rigorous interdisciplinary exchange between philology – its historical and contemporary iterations – and present-day endeavors in the fields of digital humanities, critical data studies, infrastructure studies and de/post-colonial studies. PhiSci takes philology seriously as a science and gives it the kind of treatment that has dominated history of science for the last generation. Pioneering a novel account of philology from the French Revolution to First World War, it pursues a central question: How did local ensembles of protocols, representation, instrumentation and cooperation consolidate into robust programs for the genesis of stable knowledge and knowledge communities? It gives special attention to heterogeneity and universality in key concepts and practices and to physical aspects like media and infrastructure: elements undervalued or rarely grasped in terms of their epistemic work for producing data, evidence and facts. PhiSci will thus explain how philology operated as a relational system that – in the diversity of its data and perpetual flux in its projects and personnel –projected unity that enabled it to wield a scientific authority greater than the sum of its parts.	Cultural History, Modern History, Philology, History of Science	paulmichael.kurtz@ugent.be
215	Cultures and Cultural Production	Exiled Empiricists: American Philosophy and the Great Intellectual Migration	TILBURG UNIVERSITY-UNIVERSITEIT VAN TILBURG	https://exiledempiricists.com/	Philosophy, history, migration, logical empiricism, pragmatism	In the 1930s, hundreds of European academics fled to the United States, escaping the quickly deteriorating political situation on the continent. Among them were a few dozen philosophers from a variety of different schools: logical empiricists, phenomenologists, and critical theorists. Especially the first group would have a tremendous impact on American philosophy. Although the local intellectual climate had been dictated by distinctively American traditions such as pragmatism, U.S. philosophers soon began to advance views that were heavily indebted to the empiricists, thereby transforming the American philosophical landscape. Historians have reconstructed the fate of the exiled empiricists. Still, little attention has been paid to the American context in which their movement came to full bloom. This is remarkable since any account of the empiricists' success requires an explanation of why the Americans were so susceptible to their views. What explains the surprisingly positive reception of logical empiricism? And why were the Americans more receptive to empiricism than to phenomenology or critical theory? This project shifts the perspective from the migrant philosophers to the local philosophical climate by 1) quantitatively analyzing thousands of American journal publications and 2) qualitatively examining the archives of dozens of key U.S. philosophers and institutions. Today, it seems natural to carve up the philosophical landscape into an 'analytic' and a 'continental' tradition. Yet few philosophers realize that this deeply engrained distinction is relatively new; it first became popular in the United States in the years after the intellectual migration. In studying the unique American melting pot of philosophical schools (e.g. pragmatism, logical empiricism, phenomenology, critical theory), this project offers a broader, unifying perspective on 20th-century philosophy, thereby transcending the school-based barriers that have often shaped its historiography.	History, philosophy, sociology, digital humanities, america studies	a.a.verhaegh@tilburguniversity.edu

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216	Cultures and Cultural Production	Systems of Transmitting Early Modern Manuscript Verse, 1475–1700	UNIVERSITY OF GALWAY	stemma.universityofgalway.ie	networks, graphs, poetry, manuscript culture, early modern England, complex systems	STEMMA offers the first large-scale quantitative analysis of the circulation of early modern English poetry in manuscript between 1475 and 1700. It addresses a significant gap by developing innovative computational methods for studying the social and material forces that informed literary culture. Scholars have tended to address individual manuscripts as case studies. In contrast, STEMMA revolutionizes the study of manuscript poetry by taking a data-driven approach to identify patterns and trends at scale. At its centre is the poet John Donne, whose reluctance to circulate his verse makes the survival of at least 4,249 manuscripts of his work all the more puzzling; the poems of his next most-circulated contemporary survive in fewer than 1,000 witnesses. To understand how Donne's poems, and early modern poetry more generally, circulated throughout the English-speaking world, the project synthesizes six of the most comprehensive datasets about early modern manuscripts and applies insights from social network analysis and graph theory to model the larger transcontinental communications system. The project's objectives are to provide the first comprehensive study of early modern English manuscript verse circulation; to combine, augment, and enrich the most important bibliographical datasets and return them as Linked Open Data; to develop transferable and extensible methods for analysing the circulation of manuscript poetry; to offer a thoroughly revised account of the production and circulation of literary manuscripts after the introduction of print; to provoke a reassessment of historical metanarratives that privilege print and obscure the diverse agents who participated in early modern literary culture; and to facilitate new modes of research and discovery. The project offers benefits for scholars of early modern Europe as well as those working on computational and digital projects addressing a range of time periods, national traditions, and disciplinary orientations.	statistics, Bayesian, probability, graph theory, networks, complex systems	erin.mccarthy@universityofgalway.ie
217	Cultures and Cultural Production	An Ontological Reconstruction of Gaming Disorder: A Qualitative Meta-Phenomenological Foundation	JYVASKYLAN YLIOPISTO	https://ore.jyu.fi	meta-science, psychology, technology use	Videogames have become one of the most prevalent forms of cultural production around the world. While their role in teaching and physical culture ("esports") keeps growing, the health debates on videogame play, or gaming, culminated in 2019 with the World Health Organization's historical decision to add "gaming disorder" to the International Classification of Diseases. This made gaming, next to gambling, the first and only cultural product with a diagnostic category of addictive use. The above echoes a greater conflict between culture and human development: how can science address potential problems in intensive technology use, when intensive use is also globally integrated into healthy everyday living? To build a foundation for answering this question, I pursue a Meta-Phenomenological Taxonomy of intensive gaming on three levels of lived experience: play, health, and design interaction. The taxonomy is "meta-phenomenological" in the sense that it is structured on the experiences of intensively gaming individuals. These experiences surface in distinct sociocultural contexts in interaction with specific videogame designs, which are the studied meta-areas. This interdisciplinary project is cross-cultural, longitudinal, and qualitative. Participants with and without health problems (n=240) will be followed for three years in South Korea, Slovakia, and Finland. In collaboration with clinical experts, phenomenological interviews are carried out with diaries that include gaming activity logs. The design structures of the videogames in the participants' lives are analyzed to map out the phenomenological forest of health and play with specific design interactions. The elements are refined into a taxonomy that not only serves as a new foundation for "gaming disorders" but also situates such instances in the colorful spectrum of diverse lives and designs at large—providing grounds for sustainable future theory development at the intersection of health, culture, and design.		vmkarhwu@jyu.fi

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218	The Study of the Human Past	Masters of the stone: The stonecutters' workshops and the rise of the late antique epigraphical cultures (third-fifth century AD)	UNIWERSYTET WARSZAWSKI	https://stonemasters.uw.edu.pl/	ancient history, archaeology, epigraphy, Greek, Latin, early Byzantium, Late Antiquity, artisans	The STONE-MASTERS project aims at exploring one of the most startling problems in the global history of research on collective memory and commemorative practices - the transformation of Roman Imperial epigraphic traditions in the later 3rd c. AD, and the subsequent rise of the so-called epigraphic cultures of Late Antiquity. The problem has been passionately debated since the 1980s, but so far no definite conclusions have been reached. In this project, the PI argues that the main reason for the transformation is to be ascribed to the dissemination of changes in the elite's approach to epigraphy by the workshops of stonecutters and mosaicists, and that only a thorough study of workshops can provide us with a complete understanding of the processes underpinning this same transition. So far, epigraphists of the Roman period have had few instruments to draw upon for the purposes of pursuing synthetic workshop studies, and have been overwhelmingly captivated by other strands: the quantitative research, the study of the self-representation, the visibility of inscriptions, and the "viewers' culture". The PI maintains that a significant leap in our understanding is, however, attainable through the building of a highly regionalized network/stemma of workshops, which will identify workshops of origin for all the inscriptions from the 3rd-5th c., and through applying the methodologies of workshop studies developed for other craftsmanships and periods (in particular for early Greek vase painters, and for scribes and scriptoria) which the PI will adapt to the needs of the Graeco-Roman epigraphy. Assuming that these new methodological lenses will redefine the field and re-focus our attention on the actual actors behind the production of epigraphy - artisans and workshops - as primary agents of top-to-bottom cultural transfer, then we can anticipate an entire restructuring of our understanding of the way artisans disseminated elitist culture in the lower echelons of society.	ancient history, archaeology, epigraphy, Greek, Latin, early Byzantium, Late Antiquity, artisans	stone.masters@uw.edu.pl
219	The Study of the Human Past	Unde venis? Unraveling the enigma of stećci tombstones	ZNANSTVENORAZISKOVALNI CENTER SLOVENSKE AKADEMIJE ZNANOSTI IN UMETNOSTI	https://www.stecci-stone.eu/	archaeology, spatial studies, medieval funerary cultures, social archaeology	Stećci are medieval tombstones dispersed throughout Bosnia and Herzegovina, Croatia, Montenegro and Serbia. Still preserved in situ in tens of thousands in the landscapes, they are common grave markers of the Late Medieval and early Ottoman (12th C - 16th C) Western Balkans' plural societies. Although erected in the geographical region known for the 'medley of peoples,' stećci are not attributed to any ethnic or religious group and have always been considered enigmatic, lacking a clear, explicit belonging. The sheer number and dispersed distribution have hampered stećci scholarship, confining our understanding of this heritage to visual information and historical overviews. This multi-scale, multi-proxy archaeological project will integrate innovative and multidisciplinary approaches to study medieval funerary archaeology. The principal goal is to understand the social life of the society that left us these remarkable monuments. Focusing on medieval Herzegovina, the cradle of the stećci phenomenon, the proposed research into the social lifeways of these monuments will redefine the scholarship of the medieval Western Balkans funerary culture and situate it within a European context, significantly raising its visibility within international scholarship and the public domain. In addition to increasing our understanding of stećci, STONE will establish a discipline of medieval epigraphy in the Western Balkans; introduce epiconography, a conceptually innovative approach to study inscriptions and decorations on stećci; use a prehistoric landscape approach to investigate medieval landscape and initiate a paradigmatic shift away from the current culture-historical approach to the study of past societies. The proposed research will serve as a propulsive force within Western Balkan medieval archaeology, enabling it to make a decades-long leap to align with current medieval European funerary and research trends.	spatial studies, remote sensing, medieval archaeology, cultural astronomy, archaeology	scaval@zrc-sazu.si, urska.strazisar@zrc-sazu.si

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220	The Study of the Human Past	Cold War Europe Beyond Borders. A Transnational History of Cross-Border Practices in the Alps-Adriatic area from World War II to the present.	ZNANSTVENO - RAZISKOVALNO SREDISCE KOPER	https://erc-openborders.eu/	Modern and contemporary history	This project aims to rethink the history of Cold War Europe by examining the development of transnational cross-border cooperation from the end of World War II to the present. Overcoming traditional narratives of a clear-cut European separation symbolised by the Berlin Wall, a decentralised analysis of recent European history will show us that the question of a divided continent should be reframed. The final objective is to challenge a dichotomous vision of two separate Europes, “East” and “West”, from a new, border perspective. To this end, a highly qualified team of senior and junior scholars under my guidance will focus on the Alps-Adriatic region, a historical area that is now shared by Austria, Italy, Slovenia and Croatia. This case involves a relatively narrow geographical area but an unusually broad typological range of subjects. During the Cold War it was divided among socialist but non-aligned Yugoslavia, capitalist but neutral Austria, and NATO and EEC member Italy. Its development from the "southern end" of the Iron Curtain in 1946 to the "most open border" during the Cold War and a precursor to present-day Schengen Europe, represents a paradigmatic case to study an alternative attitude towards borders, frontiers and boundaries. Drawing on Cold War and borderland studies, social history and the history of European integration, which up till now have not found common ground, our innovative conceptual elaboration will demonstrate the interplay between top-down politics and bottom-up initiatives, thus offering a new, and more nuanced history of Cold War Europe from the border perspective. Reconsidering the European past from this transnational angle, both in terms of geographic and methodological perspectives, will allow us to rediscover the human face of European integration and will offer us a new platform for contemporary discussions on sovereignty, territoriality and belonging and on the future role of borders in Europe and in the world.	Global history, transnational history, comparative history, entangled histories	ana.sajn@zrs-kp.si
221	The Study of the Human Past	MOdelling THe Evolution of the mother-infant RelationshipS	UNIVERSITA DEGLI STUDI DI ROMA LA SAPIENZA	https://www.erc-mothers.eu/	Dental Histology; Biogeochemistry; dental enamel; trace elements; dietary shifts	The intimate relationship between mother and infant, since the first moments after conception, contributed to shaping the evolution of our species and its behaviour. The mother-infant nexus changed through time adapting to environmental changes, new subsistence economies and social constraints. Yet, how the biocultural transitions across human evolution influenced the mode and time of pregnancy and nursing of human infants is under-investigated. MOTHERS will use recently developed cutting edge methodologies of trace elemental and isotopic analyses in dental enamel and dentine to identify the change from an exclusive breast milk diet to one that includes non-milk foods and to assess the mother’s diet and well being. Indeed, dietary behaviour, including that of the mother during pregnancy, deeply affects human growth and development from the earliest phases of ontogenesis and is chemically recorded in developing dental enamel. The goal of MOTHERS is to build consistent interpretative models, based on contemporary infants with controlled dietary and anamnestic history, to reconstruct health, diet, and growth trajectories in early life on an extensive collection of human dental specimens from the Upper Palaeolithic to Neolithic, until urbanization, in Italy and Croatia. Also, the profound chemical differences in dental enamel between breastfed and herbivore milk/formula-fed children will allow the identification of the early use of non-human milk and shed light on the herbivore domestication and on alloparental care in past human populations. This project adds value and competitiveness to the bioarchaeological research landscape in Europe. Not only will my project be of interest to a broad range of academics within the social sciences, but it can inform present-day public health policy measuring the effect of dietary shifts in children’s growth and development.		alessia.nava@uniroma1.it

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222	The Study of the Human Past	Environmental metal pollution revealed in archaeological human remains	UNIVERSIDAD DE SANTIAGO DE COMPOSTELA	http://www.polutedpast.zuir.es/	archaeology, human remains, metals, lead, mercury, paleodiet, paleopathology, ancient text	Environmental metal pollution threatens us all. While discussions of further prevention continue, the historical dimension is rarely considered. The long history of metal contamination has been well traced in natural archives (e.g. lake sediments and peat). However, there is a need for long-term studies directly on humans remains to fully understand how metal pollution affected the life of our ancestors. PollutedPast will fill this gap by linking new research on skeletal remains from archaeological sites with research done using natural archives. The overall objective is to determine the severity of metal pollution in preindustrial populations. This will be achieved by meeting four prerequisites: 1) availability of high chronological resolution studies in natural archives, 2) periods of contrasting pollution levels, 3) areas with contrasting pollution histories, and 4) availability of well-suited and studied osteological collections. The investigations will concentrate on collections from NW and SE Spain, and SE Sweden, selecting individuals from Roman to Late Medieval times. Individuals at risk (babies, those with chronic infectious diseases) will also be targeted. The methodological approach is based in a revolutionary combination of techniques. Multielemental (>30) and high-resolution (every 200µm) analyses of bones, bioapatite and teeth will provide critical insights into metals incorporation. Lead, copper and mercury, metals different sources and biogeochemical cycles, will be researched in depth and compared with well-reconstructed pollution histories in natural archives from the selected areas. Lead isotopes will be used, aided by mixing models, to trace the sources and estimate the proportion of pollution-lead in skeletons. This project will generate ground-breaking knowledge about the long-term impact of metal contamination – by mining and metallurgy - and explore how differences in resources management may have had consequences regarding human societies.	osteoarchaeologist, paleoenvironmentalist, paleopathologist, forensic sciences, paleographer	elena.brea@usc.es, olalla.lopez@usc.es
223	The Study of the Human Past	Eastern Central Europe’s earliest shelters	UNIVERSITEIT LEIDEN			From penthouses to igloos, homes are a cornerstone of human society, deeply entrenched in our evolutionary past. Their staggering array of architecture simultaneously shape and reflect our sociocultural traditions, structure our local economies, and have enabled us to inhabit all four corners of the earth. Yet surprisingly little is known about their earliest forms—Palaeolithic shelters. This is because no systematic attempts have been made to target their early archaeological signatures. HOME will search for a diversity of Palaeolithic shelters during the Late Pleistocene through informed systematic surveys and excavations of archaeological sites in East-Central Europe, a place where early mammoth bone structures suggest precocious shelters, but where the record remains inconclusive. This project’s goal is to uncover and assess a variety of Palaeolithic shelters with the aim to understand the diverse ways that humans lived and survived in some of the coldest, harshest climates. The objectives are to: (1) Recognize the factors that influence the location and design of forager shelters through a goal-directed study of ethnographic documentation. (2) Develop new geophysical methods to identify open-air shelter residues in large-scale archaeological surveys. (3) Determine how one of the earliest unambiguous built structures, a mammoth bone structure, was used with the latest techniques in archaeological science. (4) Compare and contrast how these open-air shelters relate to a regional cave occupation through targeted excavations. The results will elucidate how our ancestors adapted to past climate change and expanded into new biomes, ultimately leading to our ubiquitous population of the earth. In addition to its significance to archaeology and anthropology, the outcomes have implications for theories of culture, evolution and human resilience by helping us understand the physical building blocks of early societies.		w.chu@arch.leidenuniv.nl

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224	The Study of the Human Past	Pliocene Hominin Dispersal to southern Africa: Choice or Chance?	Senckenberg Gesellschaft Fur Naturforschung		Paleoanthropology; Plio-Pleistocene hominin evolution	Modern humans are unique in their ability to adapt to, and to thrive in, different environments. This trait facilitated their dispersal out-of-Africa to higher latitudes, i.e. to temperate and seasonal habitats, during the Pleistocene. However, there are Plio-Pleistocene hominins at higher latitudes in South Africa (SA) from ~3.7Ma onwards. Did human behavioural/physiological flexibility evolve early in our evolutionary history? Alternatively, did Pliocene hominins occupy such temperate zones due to different palaeoclimatic conditions in deep time and/or due to stochastic events? To untangle these questions this project will: (1) determine the geomorphological and palaeoecological changes in the Kalahari/proto-Limpopo basin, (2) create dynamic palaeo-precipitation/-vegetation models from various archives, (3) carry out detailed anatomical, functional and morphometric analyses of the hominin fossil record and (4) combine the datasets to appraise species diversity (functional adaptations), geneflow (hybridization) and dispersal scenarios (palaeobiogeography). 3 key working hypotheses underlie the proposal: 1. >2.6Ma East African (EA) hominin ranges expanded/contracted in accord with wet and dry phases; periodically, the southernmost populations became reproductively isolated. Early SA hominins represent descendants of Australopithecus anamensis and Australopithecus afarensis, respectively. 2. ~2.6-1.5Ma With the onset of the Northern Hemisphere Glaciation and the re-organisation of the drainage pattern within the Kalahari basin, dispersal corridors repeatedly closed (vicariance) and opened, resulting in intermittent levels of gene flow (i.e. hybridization) between EA and SA hominins. 3. <~1.5Ma Tectonic and hydrographic changes led to the Zambezi River becoming a powerful barrier during the Pleistocene. SA hominins younger than 1.5Ma are likely the result of endemism; competitive exclusion amongst these hominins resulted in exploitation of distinct ecological niche	Evolutionary dynamics and modelling; Functional morphology; Biomechanics;	G.Macho@ucl.ac.uk
225	The Study of the Human Past	Beyond Property: Law and Land in the Iberian World (1510-1850)	GOTTFRIED WILHELM LEIBNIZ UNIVERSITAET HANNOVER	iberland.eu	land tenure; Spanish empire; Portuguese empire; Iberian world; law	The experience of empire decisively shaped the institution of private property in land. From a global perspective, however, the history of this institution is far from straightforward. While European scholarship places the advent of individual property rights in the late 18th century, scholarship on Asia, Africa, and the Americas often attributes the onset of the paradigm of private property to the arrival of Europeans in the 16th century. This discrepancy of almost 300 years is difficult to reconcile. If Europeans had not yet experienced it themselves, how could they introduce the paradigm of proprietary rights across the world during the process of colonization? IberLAND revisits these incongruent historiographical narratives by studying the development of land tenure regimes in the African, American, Asian, and European territories of the Portuguese and Spanish empires. IberLAND takes a unique approach to the study of land tenure by departing from traditional approaches that assume that Europeans ‘invented’ ideas of private property and then ‘transplanted’ them to their overseas possessions. By contrast, IberLAND aims to construct a non-Eurocentric history of the development of land tenure from a global perspective. The research approach cuts across traditional research frontiers not only by integrating diverse regional historiographies but also by combining European and colonial (legal) history. The project will focus on six case studies and build on extensive research in local archives. The research will be strongly interdisciplinary and will gain insights from global, legal, and ethno-history in dialogue with legal theory, postcolonial studies, and decolonial perspectives. By providing a decentered history of land tenure, IberLAND should influence research in the fields of law, anthropology, and history, and provide a global perspective of law for an interconnected world in which conflicts about land use and extractivism are becoming increasingly important.		iberland@hist.uni-hannover.de

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226	The Study of the Human Past	A bio-archaeological study of 1,800 years of resilience and adaptation to urbanity	DIMOKRITIO PANEPISTIMI O THRAKIS		bioarchaeology, urbanization, evolution, palaeogenomics, stable isotopes, palaeodiet, standards of living, palaeopathology, kinship, social organization, immnune system evolution, dental microbiome, breastfeeding weaning	CityLife explores, from a bioarchaeological perspective, how historical populations adapted to an urban environment and developed resilience to the disadvantages of urban life. By exploiting the vast amount of information contained in human skeletal remains, the project will clarify the roles of biological factors in the durability and sustainability of pre-industrial urban societies. Newly developed osteological, chemical isotope, and genomic methods will be used in this project, together with cutting-edge tools for statistical evaluation. CityLife will evaluate the living conditions, economy, population structure, pathogen load, and immune defenses in a sample of more than 4,500 skeletons from a hotspot of European urban culture: Thessaloniki. This city in northern Greece still exists today, and in historic times it formed a bridge between the Roman West and the Byzantine East. Thessaloniki offers the unique constellation to study urban life from 300 BC to AD 1,500 and thus to draw inference about an urban population in a single place continuously over 1,800 years. The main objectives of the project are to a) infer urban living standards by studying secular changes in anthropometric indexes, infant diet, childhood stress, and trauma in a combined manner; b) investigate the resilience and sustainability of urban food systems by reconstructing individual diets and local supply networks; d) investigate social structures, religious cohabitation, and migration by genetically reconstructing the degree of kin and non-kin relationships; and e) explore the effects of pathogen exposure on human evolution and health by studying genes associated with increased immunological response and the oral microbiome. CityLife will examine empirically tangible aspects of biocultural development to answer the simple question of how humans became urban species.	bioarchaeology, urbanization, evolution, palaeogenomics, stable isotopes, palaeodiet, standards of living, palaeopathology, kinship, social organization, immnune system evolution, dental microbiome, breastfeeding weaning	cpapage@he.duth.gr
227	Human Mobility, Environment, and Space	The active travel backlash paradox: opposition and acceptability determinants of built environment-based sustainable travel interventions	UNIVERSITAT AUTONOMA DE BARCELONA	https://webs.uab.cat/atrapa/	urban planning; acceptability; electoral analysis; environmental psychology; survey experiments	Transport policy is a contentious issue. In recent years, ambitious proposals aiming at reducing car use and creating a more sustainable, equitable, and healthy transportation system have been met with strong opposition movements. However, little is known about the factors and nature of these opposition movements. At the same time, mayors, and elected leaders worldwide, who have pushed for ambitious built environment-based travel demand policies, have later been vindicated by major re-election wins. This would suggest the existence of an “active travel backlash paradox”, one where loud opposition movements might be concealing substantial silent support towards measures that aim to transform the built environment, in order to make it more walkable and cyclable. Validating the existence of this paradox, and expanding our understanding of opposition and acceptability factors towards built environment-based sustainable travel interventions, has major implications both locally and globally. To this end, the ATRAPA project sets out to (1) test the existence of the paradox and (2) to further our understanding of opposition and acceptability towards built environment travel demand interventions. To do so I will use a multi-scale, multi-method design to be applied in eight leading European cities. Thanks to highly disaggregated spatial election data and geolocated information on land-use transformations, I will be able to assess the associations between voting behaviour and built environment-based sustainable travel interventions. In parallel, I will use an international public opinion survey and interviews with experts to understand, the socioeconomic, individual, and contextual factors behind acceptability/opposition levels. This will assist in understanding their causes, and their spatial and social distribution, and permit exploration of much-needed future least-opposition pathways towards efficient and widely-accepted sustainable transport policies.	quantitative expert; geography; environmental psychology; political science	oriol.marquet@uab.cat

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228	Human Mobility, Environment, and Space	Our sustainabLe futurE, the ValuEs that dRive it, and how to get there	UNIVERSITAET KASSEL	https://www.uni-kassel.de/forschung/en/lever/lever-research-project	transformative transdisciplinary research, sustainability science, sustainability transformations, values	Grand and persistent social-ecological challenges, such as climate change, push forward a rapidly growing discourse on how sustainability science can support society in dealing with today's global crises. Between studying change and contributing to change, sustainability science seeks both to analytically understand sustainability problems, but also to design interventions that can contribute solution-options to these problems. However, knowledge about how to intervene in order to reach a desirable vision (i.e., transformation knowledge) is typically missing. Especially how to deliberately engage with values as places of intervention (leverage points), as proposed by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, remains a critical knowledge gap. To fill these gaps, LEVER aims to critically develop and apply a transformative theory and practice to support the (co-)production of transformation knowledge, including a focus on transformation knowledge necessary to investigate and unleash values as leverage points for sustainability transformation. To this end, LEVER originally combines transdisciplinary research with the empirically rigorous methods of social science experiments. The scientific breakthrough consists in delivering an integrated theory of transformative research, capable of representing the many co-evolving links between its design principles, philosophy of science, normative assumptions, and ethical dimensions. Methodologically, LEVER opens new avenues on how to produce transformation knowledge, by experimenting with, testing and evaluating novel transformative methods. Finally, LEVER seeks to answer the globally relevant and timely question of how to unleash values. Using a treatment and control group experimental design, LEVER assesses the impact of values-targeting interventions and demonstrates the potential of values as leverage points. LEVER pioneers a salient conscious science-society relationship in Europe.		andra.milcu@uni-kassel.de
229	Human Mobility, Environment, and Space	Spatial-Temporal Dynamics of Flood Resilience	LUDWIG-MAXIMILIANS-UNIVERSITAET MUENCHEN	https://www.erc-stories.com	Climate resilience; Flood resilience; Urban resilience; Agent-based modeling; Social networks	Existing studies on flood-society relations overwhelmingly concentrate on risk, exposure, vulnerability, damage, loss, and adaptation needs, most of which adopt a negative perspective. The fact that various human societies have well survived and continuously developed in flood prone areas (e.g., coasts, river deltas, flood plains, hilly valleys) is far less studied. Closing this research gap requires a deeper historical perspective to investigate the resilience of human society to floods, i.e., flood resilience and its changes. The Tea-Horse Road (THR) area, a flood hotspot across the mountainous Southeast Tibetan Plateau, is an ideal natural laboratory to study the spatial-temporal dynamics of flood resilience due to its long and uniquely documented history with extensive hazard experiences. STORIES will set up a theoretical framework on the multi-spatial-temporal features of flood resilience at the THR region, which covers the spatial differences (household, community, city and region) over the past 600 years regarding the governance, technology, society, and culture perspectives of flood resilience. A set of quantitative proxy data, historical archives, literature re-analysis, statistical data, observation data and field survey data will be integrated into both the empirical study in the case areas and the agent-based modelling across the cases. Specifically, STORIES aims to 1) establish a theoretical understanding of the spatial-temporal scales of flood resilience; 2) investigate the spatial patterns and temporal evolution of flood resilience at the THR cases; 3) model the spatial-temporal dynamics of flood resilience using agent-based models; 4) transfer and generalize the research findings of the THR cases to the Mekong River Delta and beyond. By doing so, STORIES will present pioneering work to shape the emerging research field of flood resilience, offering new and multi-dimensional knowledge on the dynamic nature of flood-society relations.		emlyn.yang@lmu.de

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230	Human Mobility, Environment, and Space	Data Stories: Producing stories about and with property and planning data	NATIONAL UNIVERSITY OF IRELAND MAYNOOTH	https://datastories.maynoothuniversity.ie/	data, planning, housing, Critical Data Studies, Geography	Planning and property data are the key evidence base for how cities are understood, planned and developed, informing public perception, guiding investments, and shaping policy. Yet, little critical attention has been paid to planning and property data and their lifecycles, circulation, politics, power and use in policy and stakeholder decision-making. This lacuna raises two important challenges that require redress if the validity of analysis, interpretation and decision-making is to be improved. First, transforming the ontological and epistemological understanding of planning and property data amongst those that utilise them. Second, fostering a reflexive approach to data politics and power in organisations that produce, share and use planning and property data. DATASTORIES will tackle these challenges by conducting research in a creative, highly engaged way with key stakeholders across three domains (state, business, NGOs/civil society). It will develop an innovative methodological approach that blends social science and research-creation methods, working with creative writers and artists, to map an entire data ecosystem (Dublin, Ireland), unpack data assemblages and produce a variety of data stories. 12 in-depth case studies will produce 36 data stories about and with planning and property data. The project will produce four key advances: new knowledge about the evidence-base for planning and property and its use; critical insight into the politics and praxes of data; novel research-creation methods and an assessment of their efficacy; and an extended conception of data stories and an understanding of their production and utility for different audiences. DATASTORIES will produce three ground-breaking impacts: conceptual – transforming the epistemology of planning and property research; applied – positively influencing the data processes and practices of key stakeholders; methodological – validating research-creation and data stories as social sciences methods.		Rob.Kitchin@mu.ie
231	Human Mobility, Environment, and Space	Playing urban mobility games with intelligent machines. Framework to discover and mitigate human-machine conflicts.	UNIWERSYTET JAGIELLONSKI	https://rafalkucharskipk.github.io/research/coexistence/	reinforcement learning; game theory; transportation science; machine learning	AI-driven technologies are ready to enter urban mobility. They promise relief to the notoriously congested transport systems in pursuing sustainability goals. Since AI already outperforms humans in the most complex games (chess and Go) it is likely to win the urban mobility games as well, outperforming us e.g. in: route choices (to arrive faster), mode choices (to reduce costs), pricing strategies and fleet management (to increase market shares and profits). Tempting us and policymakers to gradually hand over our decisions to intelligent machines. The consequences of this ongoing revolution are challenging to predict and largely unknown. While the abundance of previous studies proves the positive potential of AI in urban mobility (from autonomous vehicles via optimal routing up to fleet management), the negative impact is overlooked. Conversely, our scenario of interest is the machine-dominated urban mobility system, where (collective) decisions of machine intelligence improve system-wide performance, yet at the cost of humans, now facing e.g. longer travel times, greater monetary costs or being nudged to change natural travel habits into the optimal ones - desired by the machine-centred system. Such scenarios, however, need to be discovered. To this end, COeXISTENCE embarks on the interdisciplinary expedition inside the virtual environment of urban mobility, where machines and humans play the game for limited resources. In the four pre-identified games I will explore the conflict scenarios, demonstrate them on reproducible case-studies, quantify with proposed measures and finally mitigate with a proposed multi-objective reinforcement learning framework, where machines learn to mitigate conflicts while simultaneously reaching their inherently selfish objectives. Reaching the projects' objectives will be ground-breaking when new phenomena are discovered and lead to breakthrough when they are mitigated pushing the system towards the synergy of COeXISTENCE.		rafal.kucharski@uj.edu.pl

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232	Human Mobility, Environment, and Space	Transformation towards long-term sustainability beyond Sustainable Development Goals	RIJKSUNIVERSITEIT GRONINGEN		SDGs, Synergies and trade-offs.	Countries are not on track to meet the 2030 Agenda for Sustainable Development that comprises 17 Sustainable Development Goals (SDGs) and 169 targets to be achieved by 2030. Although SDGs aim to shift the world onto a sustainable and resilient path, countries are not yet able to make transformative changes for long-term sustainability that requires building social prosperity and foundations within planetary boundaries. Failing to achieve SDGs will negatively affect billions of people and worsen environmental conditions and socio-economic problems. Therefore, BeyondSDG aims to understand the necessary conditions for long-term sustainability, including achieving SDGs, based on the following specific objectives: i) identify critical targets for prioritising SDGs; ii) investigate the effects of (under)achieving SDGs on long-term sustainability beyond 2030; and iii) identify sustainability targets for the post-2030 development agenda. For this, BeyondSDG will apply a threefold scientific approach that combines statistical analysis of empirical and modelled data, qualitative analysis of literature, and knowledge co-creation with stakeholders, including sectoral experts and policymakers, based on systems thinking. This combination of three approaches is complementary and essential to deal with the complex topic of long-term sustainability. Consequently, BeyondSDG will lead to a breakthrough in interdisciplinary research by combining approaches from sustainability science, earth system modelling, and environment and resource management. Mainly, it will bring the following ground-breaking findings: critical targets where adequate actions can lead to progress across most SDGs, negative impacts of underachieving SDGs on people, the planet, and prosperity, required extra efforts for long-term sustainability besides achieving SDGs, and sustainability targets for the post-2030 Agenda based on lessons learned from SDGs, state-of-the-art science, and stakeholder partnerships.		p.pradhan@rug.nl
233	Human Mobility, Environment, and Space	SUrrogate measures for SAFE autonomous and connected mobility	LUNDS UNIVERSITET	https://cordis.europa.eu/project/id/101039222	Traffic Safety, Surrogate Measures of Safety, Extreme Value Theory, Accident Prediction	SUperSAFE "SUrrogate measures for SAFE autonomous and connected mobility" will address the problem of the safety evaluation of the interaction between conventional vehicles and connected and automated vehicles (CAVs). The project builds on the notion that vehicle automation is posing new risks that the traditional accident-based and proactive safety analysis methods are unable to investigate. In SUperSAFE, I will select the relevant variables drew on the newly identified risks posed by CAVs, and with these I will develop a new proactive method based on surrogate measures of safety for studying the effects of the physical and digital infrastructure on the interaction between road users in a mixed-mobility environment. Also considering the benchmarks for cities' liveability and transport sustainability that include road casualties as a primary factor, the European White Paper on Transport calls to reach zero fatalities by 2050 following Vision Zero's policy (zero serious casualties). Recent statistics indicate a reduction of traffic accidents but also that this development has slowed and additional efforts are required. At the same time, CAVs are already a reality. Tendency towards vehicle automation is even more evident in the European policies which encourage member states to push with the introduction of vehicles with advanced driver assistance systems. However, the road towards full automation is still not open because there is a fear of crashes/injuries and low acceptance of potential CAV accidents. This is mainly because the CAVs' behaviour vis-a-vis the conventional vehicles on the road and the digital and physical infrastructure is still unknown. To meet these rapidly approaching needs, I propose SUperSAFE, which will contribute to attaining the aforementioned European goals by developing a scientifically rigorous method of estimating risk based on the road users' real needs to improve traffic safety in the transition period to fully automated driving.	Statistic, Traffic Simulation, Road Safety	carmelo.dagostino@tft.lth.se

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234	Human Mobility, Environment, and Space	Explaining human decision-making by combining choice and process data	DANMARKS TEKNISKE UNIVERSITET			Decision-making is a core element of human activity, and the decisions we make can have significant consequences for ourselves, others, and the world we live in. Thus, the ability to explain and predict decision-making is vital for improving individual and societal outcomes, especially when addressing global challenges like climate change, sustainable energy, ageing populations, and public health. Mathematical models of decision-making can help us to understand and predict human behaviour. Despite significant progress, several scientific challenges persist in the applicability of advanced behavioural models to real-world problems. Many models focus on predicting decision outcomes rather than explaining the decision process itself. Information contained in neurophysiological process data that emerge during decision-making are often ignored, and methods for collecting behavioural data fail to create realistic impressions of scenarios representing the future. IMMERSION aims to advance the study of human decision-making by developing new innovative methods for combining choice and process data. This includes new models for integrating choice and process data, new statistical inference procedures tailored to such models, and new methods for collecting rich behavioural data in immersive experiments. The proposed research will create a paradigm shift in behavioural research with impacts on many application domains. IMMERSION will equip researchers with a new powerful toolkit for extracting deep behavioural insights from rich data using advanced models. The proposed research includes substantial empirical work applying IMMERSION's methodological innovations to real-world problems with implications for the human-centric design of future transport systems. This work includes case studies to explain and predict human decision-making in the contexts of transportation infrastructure development, pedestrian-autonomous vehicle interactions and pedestrian wayfinding.		rickr@dtu.dk

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235	Synergy	The impacts of ocean fine-scale whirls on climate and ecosystems	HELMHOLTZ-ZENTRUM FUR OZEANFORSCHUNG KIEL (GEOMAR)		Fine-scale ocean processes, Heat and carbon exchange, Air-sea interactions, Marine biogeochemistry, Biodiversity', Ocean-atmosphere coupling, Climate change, High-resolution ocean modeling, Agulhas Current System, Interdisciplinary research	WHIRLS is about small processes having large-scale impacts. Heat and carbon are the currencies of regional and global climate, constantly exchanged between the ocean and the atmosphere. This exchange is strongly influenced by fine-scales ocean eddies—whirls—that flux heat and carbon towards, or away from, the air-sea interface. When the ocean gives up heat and carbon to the atmosphere, climate is warmer and wetter, and vice versa. Carbon that is fluxed towards the air-sea interface, where sunlight is available, can be taken up by phytoplankton that form the base of the oceanic food web. Eddies and fronts alter vertical nutrient fluxes and ocean stratification which help shape biodiversity and ecosystems. The proliferation of fine-scale processes, and their interdisciplinary and large-scale impacts are poorly understood. In WHIRLS we will use a synergistic and interdisciplinary approach to study fine-scale processes across a continuum of scales (1–100 km) and assess their impacts on air-sea exchange and marine biogeochemistry and biodiversity. We focus on the Agulhas Current System around South Africa because it is a global hotspot of eddy activity, ocean-atmosphere heat exchange, and marine productivity and diversity It is also a region that plays a key role for the global ocean circulation and global climate and climate change. We will use multiple coordinated observing strategies, including research vessels and a large ensemble of autonomous platforms, to collect physical, chemical, and biological datasets across scales. These data will be supplemented by high-resolution models of the ocean and the atmosphere, developed with a focus on the Agulhas Current System, as well as the latest data science methodologies. WHIRLS will improve the understanding of fine-scale processes and its representation in future earth system models for better predictions and projections of the future climate.	Ocean Dynamics, Fine-scale ocean processes, Submesoscale and mesoscale eddies, Ocean turbulence, Coastal and open-ocean dynamics, Vertical mixing and stratification, Climate and Earth System Science, Ocean-atmosphere interactions, Climate variability and change, Ocean heat and carbon fluxes, Sea level dynamics, Regional climate	sabrina.speich@lmd.ens.fr

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236	Synergy	Smart Water Futures: designing the next generation of urban drinking water systems	ATHENS UNIVERSITY OF ECONOMICS AND BUSINESS - RESEARCH CENTER	https://waterfutures.eu/		The world population living in urban settlements is expected to increase to 70% of 9.7 billion by 2050. Historically, as cities grew, new water infrastructures followed as needed. However, these developments had less to do with real planning than with reacting to crisis situations and urgent needs, due to the inability of urban water planners to consider long-term, deeply uncertain and ambiguous factors affecting urban development and water demand. These, coupled with increasingly uncertain climate conditions, indicate the need for a more holistic and intelligent decision-making framework for managing water infrastructures in the cities of the future. This project aims to develop a new theoretical framework for the allocation and development decisions on drinking water infrastructure systems, so that they are socially equitable, economically efficient and environmentally resilient, as advocated by the UN Agenda 2030, Sustainable Development Goals. The framework will integrate real-time monitoring and control with long-term robustness and flexibility-based pathway methods, and incorporate economic, social, ethical and environmental considerations for sustainable transitioning of urban water systems under deep uncertainty with multiple possible futures. The Water-Futures team will build on synergies from the four research groups, transcending methodologies from water science, systems and control theory, economics and decision science, and machine learning, into an integrated decision and control framework, to be implemented as an open-source research toolbox. The new science outcomes will be applied to three case studies exemplifying different types of urban water systems: a mature, relatively stable system; a mature and rapidly expanding system; and a relatively recent supply system in a developing country with high growth and special challenges, including limited resources, intermittent supply and high water losses.		pkoundouri@aueb.gr
237	Synergy	A Post Growth Deal	UNIVERSITE DE LAUSANNE	https://www.realpostgrowth.eu/	degrowth, post-growth, sustainability, ecological economics	How can we sustain human well-being within planetary boundaries? What policies and provisioning systems could enable societies to prosper without growth? What politics and alliances are necessary for seeing post-growth policies through, and how can the public be engaged in them? What new scientific paradigm could answer such questions? Societies face multiple intertwined crises. Bold alternatives are sorely needed. This project develops frameworks for 'Post-Growth Deals', from empirical research through to practical applications. First, we develop equitable North-South convergence scenarios, modelling human well-being achievement in all countries within planetary boundaries. Second, we articulate post-growth policy packages for the Global North and South, assessing their political acceptability and modelling their effects. Third, we develop models of provisioning systems to ensure future populations have adequate energy, food, shelter, health and social security. Fourth, we learn from political movements, studying politics and alliances that could bring post-growth transitions forward. Fifth, we identify practical steps to bring Post-Growth Deals to life, working with four representative communities to co-produce knowledge and action on the ground. The potential gains of this research are immense: post-growth transitions may unlock a far more ecologically stable and socially prosperous future than current trajectories lead to. REAL brings a paradigm shift moving post-growth science from economics to sustainability studies. We propose a new trans-disciplinary '5Ps of post-growth' science, grounded in resource/energy modelling, political-economy and socio-political analysis – a skill-set that no single researcher or team presently possesses. The PIs are leaders in their fields and bring complementary expertise in: modelling of provisioning systems (JST), political economy and North-South relations (JH), and the politics of socio-environmental transformations (GK).		julia.steinberger@unil.ch

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238	Synergy	Quantum hyperpolarisation for ultrasensitive nuclear magnetic resonance and imaging	UNIVERSITAET ULM			Many of the most remarkable contributions of modern science to society have arisen from the interdisciplinary work of scientists enabling novel methods of imaging and sensing. Outstanding examples are nuclear magnetic resonance (NMR) and magnetic resonance imaging (MRI) which have enabled fundamental insights in a broad range of sciences extending from Chemistry to the Life Sciences. However, the key challenge of NMR and MRI is their very low inherent sensitivity due to the weak nuclear spin polarisation under ambient conditions. This makes the extension of magnetic resonance to the nanoscale (small volumes) and to the observation of metabolic processes (low concentrations) impossible. HyperQ will address this challenge with the development of room-temperature quantum control of solid-state spins to increase nuclear spin polarisation several orders of magnitude above thermal equilibrium and thereby revolutionise the state-of-the-art of magnetic resonance. Essential for this development is the synergy of an interdisciplinary team of world leaders in quantum control and hyperpolarised magnetic resonance to enable the development of quantum control theory (“Quantum Software”), quantum materials (“Quantum Hardware”), their integration (“Quantum Devices”) and applications to biological and medical imaging (“Medical Quantum Applications”). HyperQ will target major breakthroughs in the field of magnetic resonance, which include chip-integrated hyperpolarisation devices designed to operate in combination with portable magnetic resonance quantum sensors, unprecedented sensitivity of bio-NMR at the nanoscale, and biomarkers of deranged cellular metabolism. The HyperQ technology will provide access to metabolic processes from the micron to the nanoscale and thereby insights into metabolic signatures of a broad range of disease such as cancer, Alzheimer and the mechanisms behind neurodegenerative disease. This will enable fundamentally new insights into the Life Sciences.		fedor.jelezko@uni-ulm.de

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239	Synergy	PErPetuating Stemness: From single-cell analysis to mechanistic spatio-temporal models of neural stem cell dynamics	RUPRECHT-KARLS-UNIVERSITAET HEIDELBERG		stem cells, mathematical modelling, structured population models	Neural stem cell (NSC) populations in the vertebrate brain generate adult-born neurons for plasticity, growth, and repair. Neurogenic and gliogenic capacity, based on long-term NSC maintenance, functionally define “stemness”. Stemness embodies massive NSC heterogeneity at the single cell level and requires control of maintenance or differentiation decisions at the population level. These features remain mechanistically unreconciled. We hypothesise that spatiotemporal interactions among heterogeneous NSCs are coordinated to control the population behaviour. Thus, we propose a multi-dimensional project exploring these features in time and space, to decode the mechanistic principles of stemness. To this end, we bring together experimental and theoretical groups with complementary expertise in NSC biology, biostatistics and mathematical modelling. In an iterative experimental-mathematical approach, we will (1) solve the topology of individual NSC trajectories in transcriptomic space, (2) identify local cell-cell coordination mechanisms that impact these trajectories in situ, and (3) decode the resulting systemic properties and outputs of NSC ensembles at long-term and large spatial scales. This programme will result in original methods, including retrospective transcriptomics in single cells, innovative barcode transfers, and a novel mathematical framework to describe structured spatio-temporal population dynamics. We will focus on two biological model systems, the adult mouse ventricular sub-ventricular zone and zebrafish pallium, where NSC ensembles display comparable heterogeneity but differ in spatial organisation and fate dynamics. Together, PEPS will uncover the general principles and regulatory mechanisms of perpetuating stemness in time and space. It will lay the conceptual and methodological foundation to manipulate stem cell systems to improve their stability or output, and also produce new methods of universal value for studying cellular systems.	mathematical modelling, linking process-based modelling with data analysis	biostruct@math.uni-heidelberg.de
240	Synergy	De novo construction and evolvability of Minimal Lifelike Systems	PARMENIDES STIFTUNG		Systems Chemistry, Synthetic cell, Origin of Life	The de novo creation of living systems is a long-standing dream of humanity. To realise this dream, we need a clear conceptualisation of the goal and the experimental means to put it to practice. We think now, time is ripe to make a serious attempt. There is emerging consensus that a minimal living system should be out-of-equilibrium and self-sustaining, have metabolism, an inheritance system, a boundary to keep the constituents together and that a population of such systems should be able to undergo Darwinian evolution. The aim of this proposal is to develop, for the first time, synthetic chemical systems with all of these features. Due to its very nature MiniLife is standing on two, equally strong feet: chemistry and biology. The strongest link between them is autocatalysis, which allows reproduction. Our approach to creating the first artificial chemical living system takes the following steps: (1) Identification of new, and development of existing, autocatalytic (super)systems that function as chemical (and informational) replicators. (2) Coupling of metabolism with chemical replicators. (3) Coupling of autocatalysis to compartment growth and division. (4) Synthesis of a chemical supersystem comprising all three components (replication, metabolism and compartmentalisation). (5) Demonstrating minimal Darwinian evolution upon subjecting the systems synthesized in 1-3 to out-of-equilibrium selection regimes. (6) Approaching a minimal living system by enhancing of the evolvability of the triple systems developed in 4. We have assembled a strong consortium that brings together PIs of previous ERC Advanced Grants in three key areas to be integrated: Ashkenasy and Otto bring expertise in synthetic chemical self-replicating systems; Griffiths brings expertise on compartmentalisation using microfluidics, and Szathmáry is a leading expert on theory of replicator evolution and computational modelling. Success would constitute a landmark achievement in basic science.	Systems chemistry	gonenash@bgu.ac.il

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241	Synergy	Human History of Marine Life: Extraction, Knowledge, Drivers & Consumption of Marine Resources, c.100 BCE to c.1860 CE	THE PROVOST, FELLOWS, FOUNDATION SCHOLARS & THE OTHER MEMBERS OF BOARD, OF THE COLLEGE OF THE HOLY & UNDIVIDED TRINITY OF QUEEN ELIZABETH NEAR DUBLIN	https://www.tcd.ie/tceh/4-oceans/	Environmental history, climate history, marine history, economic history, zooarchaeology, historical ecology	4-OCEANS aims to assess the importance of marine life for human societies during the last two millennia. We contend that the harvest of marine resources played a critical, but as yet underappreciated and poorly understood, role in global history. To bridge this gap in our understanding, the four PIs will form an interdisciplinary team combining expertise in marine environmental history, climate history, natural history, geography, historical ecology and zooarchaeology. We will examine when and where marine exploitation was of significance to human society; how selected major socio-economic, cultural, and environmental forces variously constrained and enabled marine exploitation; and identify the consequences of marine resource exploitation for societal development. Through these objectives we will discover how marine resources as novel wealth altered societies throughout history. How might marine wealth have enabled some societies to escape food shortages? How did it trigger long-term socio-economic impacts and ecological consequences? How were marine resources valued, consumed, and energetically transformed? Revealing this history will open a new window on human-nature dynamics of profound importance for understanding developmental trajectories of human societies. 4-OCEANS will transcend the binary distinctions of East and West, global-north and global-south, indigenous and colonial, resource exploitation and wildlife conservation, nature and culture. In doing so, 4-OCEANS will uncover and chart historical trajectories towards sustainable and unsustainable food security and resource extraction, identifying their complex underlying drivers.	Environmental history, climate history, marine history, economic history, zooarchaeology, historical ecology	fludlow@tcd.ie
242	Synergy	Reconstructing the environmental, biological, and societal drivers of plague outbreaks in Eurasia between 1300 and 1900 CE	UNIVERSITETET I OSLO			Synergy-Plague is a multi-disciplinary project to bring our knowledge and understanding of plague, past and present, to new heights. Focussing on the environmental, biological, and societal aspects of plague outbreaks in Eurasia between circa 1300 and 1900 CE, it will address four main questions: (1) Why/how did plague re-emerge in 14th century Central Asia? (2) Why/how did plague re-occur and spread in Eurasia after the Black Death? (3) Why/how did clinical and demographic patterns of plague infection differ across space and time? (4) Why/how did plague disappear from Europe and the Middle East in the 18th and 19th centuries? Our project is based on the hypothesis that plague waves and clinical differences resulted from unique alignments of multiple events: environmental (climatic and soil-chemical), biological (from individual to ecosystem) and societal (demographic, socio-economic and political). Four PIs from the natural sciences and humanities, together with their team members, will jointly study how plague re-emerged in 14th century Central Asia and radiated repeatedly from Eurasian wildlife reservoirs in the following centuries, only to disappear in the 18th-19th centuries. We will develop and analyse new dendrochronological and (paleo-)soil data, textual documentary evidence, and epidemiological models. To understand how plague reached and spread in human populations, paleo-environmental and historical data together with relevant experimental work will be combined with statistical and mathematical modelling. To appreciate why clinical signs and mortality rates varied in space and time, historical evidence will be examined together with new entomological data and ancient DNA (aDNA) of historical plague strains (from humans and anthropophilic rodents). Synergy-Plague will revolutionise our understanding of plague and contribute to our ongoing struggle with epidemic diseases, present and future.		ulf.buentgen@geog.cam.ac.uk

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243	Synergy	Nanoscale water: A Quantum Understanding of Angstrom-scale transport	MAX-PLANCK-GESELLSCHAFT ZUR FORDERUNG DER WISSENSCHAFTEN EV			Water is a substance that needs no introduction: It shapes our blue planet, is life-enabling, and scientifically fascinating with a host of anomalous behaviours. Despite centuries of studies, breakthroughs in the last decade have shown that when wWater is an abundant, yet exceptional and life-enabling substance. The past decades have seen tremendous progress in our understanding of the many peculiarities of water, many of which can be traced to the nature of the interactions between water molecules. When confining water to nanometer-range pores and cavities, wholly new and unexpected phenomena appear: water flows differently in confinement, its phase diagram changes drastically, and conventional theories break down. This is exciting from a scientific perspective, but also of great technological importance: nanoscale water is fundamental to water purification and desalination, where water has to flow through nanopores, and for energy-related processes as a source of protons and hydrogen. Here, we aim for fundamental new scientific insights into water at key length- and time-scales by bringing together a critical mass of researchers with complementarity skillsets in nanofluidics, spectroscopy, and theory and simulation. We follow a radically new perspective for nanoscale water transport, envisioning confined water not only in terms of real-space confinement, but also in terms of its collective modes: how they couple and resonate with the confining material and its - quantum - excitations to affect global transport. Seeing water dynamics in both the real and Fourier worlds allows us to naturally address quantum couplings and light- matter interactions and their effect at nanoscales. This opens a new world of possibilities, e.g., by controlling water motion through fine-tuning of its excitations, quantum engineering of water transport is made possible. Such views have the potential to enable world-changing novel technologies in the water-energy nexus and related fields.		bonn@mpip-Mainz.mpg.de

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244	Synergy	Plasmodesmata, Symplasmic pores for plant cell-to-cell communication	HEINRICH-HEINE-UNIVERSITAET DUESSELDORF	https://www.sympore.org	Plasmodesmata, structure-function analysis	During evolution of multicellularity, cells differentiated to become specialized and interdependent. Multicellular organisms invented channels for nutrient exchange and communication between cells. Plants uniquely developed plasmodesmata, complex cell-cell connections traversing the cell wall. Roles ascribed to plasmodesmata include selective transport of signals, ions, metabolites, RNAs and proteins. Due to technical hurdles, composition, structure and regulation of plasmodesmatal conductance remain enigmatic. Genetic approaches to study plasmodesmata were hampered by lethality or redundancy. Novel technologies now set the stage for resolving roles of plasmodesmata in transport and signaling in an interdisciplinary approach. We will use proximity labeling proteomics to obtain plasmodesmatal composition, and PAINT and cryo electron tomography (cryoET) for near atomic structures. Models of plasmodesmata will be built from bottom up and top down approaches and combined with quantitative assessment of plasmodesmatal activity. Novel biosensor approaches together with knock down by genome editing will permit quantitation of transport of the diverse cargo. Single cell sequencing helps fine-tuning mutant selection and targeting of subtypes. Four labs will join forces: highly recognized experts in biophysics and cryoET (WB), advanced imaging and developmental signaling (RS), high-end proteomics and lipidomics (WS), and interactomics, transporters and cutting-edge biosensor technology (WF). We will iteratively address: (1) systematic quantitative identification of components, (2) their localization and dynamics, (3) structures and molecular building blocks of diverse plasmodesmatal types, and (4) transport and signaling mechanisms. We expect breakthrough discoveries and completely new understanding of plasmodesmatal function and evolution. Since plasmodesmata play key roles in nutrient allocation and virus spread, we lay the basis for novel biotech solutions in agriculture.	qualified in molecular biology, plant physiology, microscopy	ruediger.simon@hhu.de
245	Synergy	Unraveling the complexity of fungal drug tolerance at multiple scales of biology	CHARITE - UNIVERSITAETSMEDIZIN BERLIN		fungal pathogens, Candida alibicans, antimicrobial resistance and tolerance, metabolism, stress responses	Mortality from invasive fungal infections approaches 50%, despite the use of available antifungal drugs. While bacterial studies have focused on drug resistance, the rare appearance of antifungal drug resistance does not explain these treatment failures. Antifungal tolerance is a poorly understood property that is expressed to different degrees in different non-resistant isolates, yet has not been measured routinely in the clinic or in most research studies. We do not know how tolerance differs between isolates, what biological mechanisms drive it, how it affects only some cells in a single isolate, or whether it can be inhibited to improve treatment outcomes. Recently, the Berman lab found that tolerance is an intrinsic property, in which some cells of a non-resistant isolate continue growing in the presence of the drug that has the potential to explain antifungal treatment failures. In parallel, the Ralser lab found that inhibitors of metabolic pathways affect the stress survival of some cells and the Berman lab found that these inhibitors can clear tolerance and convert an antifungal drug from fungistatic to fungicidal, thereby killing the cells and halting their adaptation. Together, we combine expertise in pathogenic fungi (Berman) and metabolic systems (Ralser) to reach fundamental understandings of tolerance across the range of its biological scales by: 1) capturing the diversity of tolerance in a genomic and proteomic data resource of >1000 isolates; 2) identifying metabolic pathways and molecular mechanisms that drive tolerance within isolates; and 3) probing processes and compounds that affect phenotypic heterogeneity between cells and suppress tolerance. By elucidating the mechanisms that drive tolerance and fungal single-cell diversity, we propose to render tolerance targetable, providing a paradigm shift in anti-fungal treatment strategies.	proteomics, metabolomics, chemical proteomics, antimicrobials	markus.ralser@charite.de

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246	Synergy	Horse Power: Interactions between China, Mongolia and the steppe 2000-0 BCE	THE CHANCELLOR, MASTERS AND SCHOLARS OF THE UNIVERSITY OF OXFORD			Horse Power will examine the complex interactions between the eastern steppe and China from the second millennium BCE to the formation of the Xiongnu empire in Mongolia and the Qin state in China after 300 BCE. From the second millennium BCE two great worlds formed, traded and fought across Eurasia. From Mongolia to the European steppe great horse and herding cultures coalesced across thousands of kilometres of grassland. To the south, a string of states existed from Egypt to the Chinese Central Plains, some already ancient and others newly created. Interaction between these worlds was constant and profoundly formative for all parties, a fact we are only starting to fully appreciate. To examine the connections between the steppe, Mongolia and China's Central Plains we will combine the latest scientific techniques in genetics and metallurgical analysis with theory concerning politics and power within and between China and its northern neighbours. Three principal empirical elements underpin the project: ancient DNA from horses; the characterization of bronzes to throw light on their movement and recycling; the structure and contents of archaeological sites (mainly graves) in China, Mongolia and the steppe. We will develop theory on the nature of leadership and power, particularly in mobile societies. Science will meet social science in a mutually informative manner and we will work across linguistic boundaries (Chinese, Mongolian, Russian, English) in a spirit of the co-production of knowledge with important partners including The Emperor Qin Shihuang's Mausoleum Site Museum in China and Mongolian universities. We will reflect on our working practices, engaging a broader public in how a complex research project works. An innovative artistic programme will engage a range of local communities, horse enthusiasts and local artists in the work and results of the project. Working together we will create a picture of this complex region impossible if we had worked alone.		chris.gosden@arch.ox.ac.uk
247	Synergy	urbisphere - coupling dynamic cities and climate	THE UNIVERSITY OF READING		urban, climate, dynamic cities	urbisphere will change how the scientific community conceptualises, characterizes and forecasts cities in the climate system and in urban planning, by developing a radically new approach to integrate multiple dimensions of urban change, their interaction and feedbacks. It aims to forecast and project urban futures and climates in a dynamic framework considering weather, air quality, differential exposure and vulnerability of people at neighbourhood to city scale. It will provide new insights into existing and emerging risks, based on a synergistic effort across disciplines which currently work mostly in parallel. Urban-Surface Models (USM) and Human Exposure and Vulnerability models (HEV) will be developed and coupled to improve the forecasting of exposure, emissions, and intervention potentials in cities. This will transform emergency/risk management, atmospheric forecasting and long-term urban development/adaptation strategies in the urban sphere. The system will use a real-time 4D Smart Urban Observation System (SmUrObS) to provide targeted urban form/function/emissions/exposure data using novel ground and remote sensing technology. The USM-HEV-SmUrObS system will equip us with: 1) a deep understanding of socio-economic dynamics and human behaviour and responses to weather and climate, economic (and other) drivers that transform cities' exposure and vulnerability to climate change-related hazards (like heat); 2) a consistent method that can be scaled from detailed high-resolution modelling of intra-neighbourhood scale characteristics, to climate and socio-economic modelling and assessment at city, regional and global scales; 3) an approach that can inform global climate and global vulnerability and risk modelling; will allow consistent downscaling to the city for decision making for local urban risk and resilience management; and provide information on the dynamic nexus of exposure and vulnerability of people in cities.	climate, meteorology, microemeteorology, boundary layer meteorlogy, ubran climate	c.s.grimmond@reading.ac.uk

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248	Synergy	Understanding and Modelling the Earth System with Machine Learning	UNIVERSITAT DE VALENCIA	https://www.usmile-erc.eu/	machine learning, AI, earth, climate science, causality, hybrid models	Earth system models are fundamental to understand climate change. Although they have improved significantly, considerable biases and uncertainties in their projections remain. Process parameterisations limit the models' ability to simulate both global and regional Earth system responses, which are key for assessing climate change and its impacts on ecosystems and society. In recent years, the volume of data from high-resolution models and observations has substantially increased to petabyte scales. Concomitantly, the field of machine learning (ML) has quickly developed, promising breakthroughs in detecting and analysing non-linear relationships and patterns in large multivariate datasets. Yet, traditionally, physical modelling and ML have been often treated as two different worlds with opposite scientific paradigms (theory-driven versus data-driven). Thus, despite its great potential, ML has not yet been widely adopted for addressing the urgent need of improved understanding and modelling of the Earth system. USMILE will combine multi-disciplinary expertise in ML and process-based atmosphere and land modelling to completely rethink model development and evaluation. ML will further allow us to define novel observational constraints on Earth system feedbacks and climate projections. We will (1) develop ML algorithms to enhance Earth observation datasets accounting for spatio-temporal covariations, (2) deploy ML-based parameterisations and sub-models for clouds and land-surface processes that have hindered progress in climate modelling for decades, and (3) detect and understand modes of climate variability, multivariate extremes and uncover dynamical aspects of the Earth system with novel deep learning and causal inference techniques. USMILE will drive a paradigm shift in the current modelling of the Earth system towards a new data-driven physics-aware science and to an unprecedented reduction of uncertainties in projections.	ML, AI, causality, emulation, hybrid AI	gustau.camps@uv.es
249	Synergy	Evolution of Cognitive Tools for Quantification	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	https://quanta.eva.mpg.de/	precise quantification, number sense, notations, number symbols, cognitive evolution, cross Cultural analysis	Exact quantification, including the ability to count, depends on both conceptual breakthroughs and cognitive tools such as numeral systems. These tools appear in striking diversity across cultures and manifest in different modalities (verbal, body-based, written, or material). To address the tantalizing questions of when, why, and how they emerged and evolved, we test two previously untestable key hypotheses: that conceptual breakthroughs and tools co-evolved, with different modalities coactively scaffolding the breakthroughs; and that the tools diversified in response to changing cultural requirements. Reconstructing this evolution is the prime goal of QUANTA. Addressing its ambitious objectives requires an unprecedented synergetic combination of (i) archaeological, ethnographic, and linguistic insights into numeral systems worldwide, including prehistoric artefacts and symbols, and on contemporary contexts in which quantification occurs and changes; (ii) a cognitive framework for deriving evolutionary hypotheses from system properties; (iii) powerful computational (phylogenetic) methods for testing these hypotheses and thereby reconstructing cultural evolution; and (iv) innovative means to substantially extend the temporal scope of these methods into the past, to include the first attested instances of quantification. To achieve this goal, QUANTA brings together four leading PIs with unique and complementary expertise in exactly these means. By integrating an evolutionary approach with a cognitive perspective on quantification, QUANTA will transform this research field. Its novel strategy will, for the first time ever, yield substantiated insights into the emergence and evolution of numeral systems, thus advancing our understanding of human cognition and its dependence on cultural tools. While the highly interdisciplinary, multi-method approach renders this a high-risk project, QUANTA has the potential to bridge the gap between previously incommensurable fields.	statistics, morphometric geometry, surface analysis, Palaeolithic archeology, CTscan, cross Cultural analysis	francesco.derrico@u-bordeaux.fr

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250	Synergy	Realizing Leibniz's Dream: Child Languages as a Mirror of the Mind	GEISTESWISSENSCHAFTLICHE ZENTREN BERLIN EV	https://leibnizdream.eu	linguistics, semantics, language acquisition	Children around the globe acquire language and with it the human ability to communicate complex thoughts. This project develops a new linguistic theory to explain language and its acquisition. Our central hypothesis is that language radically compresses thought structures to sound or sign. While current theories assume a parallel between thought and language or meaning-preserving transformations, we assume that thought is mapped to language by only realizing some pieces of conceptual representations. Adult language is hyper-efficient at compressing information. For this reason, Leibniz and many others over the last 300 years have been unable to agree on the primitives of human thought. We predict that child languages are a better mirror of the human mind. Our initial evidence suggests that children are not able to compress conceptual representations as efficiently as adults. Sometimes children produce more material than adults, leading to so-called commission errors, which have never been systematically investigated. Furthermore, comprehension is easier for children when there is a one-to-one match between language and thought. To test our central hypothesis and specify how conceptual structure is compressed into language, we carry out a series of at least twelve targeted language acquisition studies on a global scale. We have recruited collaborators for more than 50 languages from 21 different language families, two sign languages and two creoles to carry out our studies. With this data, we can formulate a complete formal model of the semantic primitives, their combination into conceptual structures, the morphological compression mechanism, and the acquisition process within our model. To accomplish these goals, we rely on insights from formal semantics, generative syntax, distributed morphology, and several other linguistic frameworks. As part of our work, we also create the first open, global research collaboration to conduct language acquisition studies.	linguistics, language acquisition, semantics	uli@alum.mit.edu
251	Synergy	Smart Water Futures: designing the next generation of urban drinking water systems	KWR WATER B.V.	https://waterfutures.eu/	drinking water networks, deep uncertainty, decision making	The world population living in urban settlements is expected to increase to 70% of 9.7 billion by 2050. Historically, as cities grew, new water infrastructures followed as needed. However, these developments had less to do with real planning than with reacting to crisis situations and urgent needs, due to the inability of urban water planners to consider long-term, deeply uncertain and ambiguous factors affecting urban development and water demand. These, coupled with increasingly uncertain climate conditions, indicate the need for a more holistic and intelligent decision-making framework for managing water infrastructures in the cities of the future. This project aims to develop a new theoretical framework for the allocation and development decisions on drinking water infrastructure systems, so that they are socially equitable, economically efficient and environmentally resilient, as advocated by the UN Agenda 2030, Sustainable Development Goals. The framework will integrate real-time monitoring and control with long-term robustness and flexibility-based pathway methods, and incorporate economic, social, ethical and environmental considerations for sustainable transitioning of urban water systems under deep uncertainty with multiple possible futures. The Water-Futures team will build on synergies from the four research groups, transcending methodologies from water science, systems and control theory, economics and decision science, and machine learning, into an integrated decision and control framework, to be implemented as an open-source research toolbox. The new science outcomes will be applied to three case studies exemplifying different types of urban water systems: a mature, relatively stable system; a mature and rapidly expanding system; and a relatively recent supply system in a developing country with high growth and special challenges, including limited resources, intermittent supply and high water losses.		dragan.savic@kwrwater.nl

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252	Synergy	Learning from Bats: New Strategies to Extend Healthspan and Improve Disease Resistance	UNIVERSITY COLLEGE DUBLIN, NATIONAL UNIVERSITY OF IRELAND, DUBLIN			The medical, financial, and emotional costs imposed by ageing and infectious diseases are major challenges for our societies. Strikingly, while past research has not provided solutions for extending human healthspan and preventing the harmful consequences of infections, nature has solved both problems in the only flying mammals – the bats. Among mammals, bats exhibit an exceptional longevity with little signs of age-related diseases. Despite being reservoirs for numerous deadly viruses, viral infections in bats are mostly asymptomatic due to unique immune system adaptations. The overarching goal of BATPROTECT is to achieve breakthroughs in our understanding of the molecular basis of bats' extended healthspan and disease resistance to ultimately discover new directions to improve human healthspan and disease outcome. BATPROTECT integrates a team of world-leading experts in bat biology, genomics, immunology and gerontology to synergistically: (i) elucidate the molecular mechanisms that bats use to slow down expected ageing; (ii) identify the driving molecular mechanisms behind bats' viral tolerance and limited age-related inflammation; (iii) uncover the genomic basis and evolution of extended healthspan and disease tolerance in bats; and, (iv) develop transgenic animal models to functionally validate the uncovered bat adaptations. We will generate 150 reference quality bat genomes, the novel immunological, bioinformatic, cellular and molecular tools required to take an integrative multi-omics approach and uncover the age and immune changes that occur in wild and captive bats across the ageing spectrum. We will identify the top regulators of longevity and immunity, using deep neural networks analyses, to functionally validate in our cellular systems and novel transgenic animal models- BatWorms and BatMice. Ultimately, we will provide a deeper understanding of extended healthspan and disease resistance and will pave the way for future therapeutics.		emma.teeling@ucd.ie, gemma.watts@ucd.ie
253	Synergy	Reconstructing the environmental, biological, and societal drivers of plague outbreaks in Eurasia between 1300 and 1900 CE	UNIVERSITETET I OSLO	https://www.synergy-plague.org/	population biology, ecology, evolution, statistical and mathematical modelling	Synergy-Plague is a multi-disciplinary project to bring our knowledge and understanding of plague, past and present, to new heights. Focussing on the environmental, biological, and societal aspects of plague outbreaks in Eurasia between circa 1300 and 1900 CE, it will address four main questions: (1) Why/how did plague re-emerge in 14th century Central Asia? (2) Why/how did plague re-occur and spread in Eurasia after the Black Death? (3) Why/how did clinical and demographic patterns of plague infection differ across space and time? (4) Why/how did plague disappear from Europe and the Middle East in the 18th and 19th centuries? Our project is based on the hypothesis that plague waves and clinical differences resulted from unique alignments of multiple events: environmental (climatic and soil-chemical), biological (from individual to ecosystem) and societal (demographic, socio-economic and political). Four PIs from the natural sciences and humanities, together with their team members, will jointly study how plague re-emerged in 14th century Central Asia and radiated repeatedly from Eurasian wildlife reservoirs in the following centuries, only to disappear in the 18th-19th centuries. We will develop and analyse new dendrochronological and (paleo-)soil data, textual documentary evidence, and epidemiological models. To understand how plague reached and spread in human populations, paleo-environmental and historical data together with relevant experimental work will be combined with statistical and mathematical modelling. To appreciate why clinical signs and mortality rates varied in space and time, historical evidence will be examined together with new entomological data and ancient DNA (aDNA) of historical plague strains (from humans and anthropophilic rodents). Synergy-Plague will revolutionise our understanding of plague and contribute to our ongoing struggle with epidemic diseases, present and future.	plague biology, flea biology, rodent biology, mathematical and statistical modelling	n.c.stenseth@mn.uio.no

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254	Synergy	Functional cartography of intestinal host-microbiome interactions	KAROLINSKA INSTITUTET		Spatial transcriptomics, mucosal immunology, microbiota, inflammatory bowel diseases, colorectal cancer	Microbiome-host crosstalk is crucial for gut homeostasis and its dysregulation is a hallmark of diseases such as colorectal cancer (CRC) and inflammatory bowel disease (IBD). Despite its key relevance for a holistic understanding of the human superorganism and its (patho-)physiology, how local host-microbiome interactions form specific niches in the gut and how these niches function at the cellular and molecular level remains unexplored, mainly due to a lack of suitable technologies. To fill this gap, we propose to jointly reconstruct the host transcriptional and microbiome compositional landscape of the human gut across a large number of healthy individuals as well as IBD and CRC patients. For this, we will leverage a combination of novel spatial profiling technologies for unbiased transcriptome sequencing and microbiome profiling at single-cell resolution in situ. First, we will spatially delineate local niches formed of specific microbes and host cells. To dissect this complex crosstalk into specific interactions, we will secondly use in vitro and in vivo models to introduce perturbations either on the host or the microbiome side. Finally, we will integrate the resulting data to deconvolute host-microbiome circuits computationally and to predict functional niches, in particular host responses to pathogens of relevance in IBD and CRC. Interesting predictions will be tested in organoid and animal models. Developing a spatially resolved computational model of the gut ecosystem will allow us to predict early local events in disease onset; from these we will identify and validate prognostic IBD and CRC biomarkers for future clinical translation. This work will revolutionize our understanding of intestinal host-microbiome interactions by adding a first-ever functionally resolved spatial dimension with clinical relevance for the future diagnosis and treatment of intestinal disorders.	Mucosal immunology, organoids, microbiota, spatial biology	eduardo.villablanca@ki.se
255	Synergy	Smart Water Futures: designing the next generation of urban drinking water systems	UNIVERSITY OF CYPRUS	https://waterfutures.eu	smart water systems; monitoring and control of urban water systems; water management and planning	The world population living in urban settlements is expected to increase to 70% of 9.7 billion by 2050. Historically, as cities grew, new water infrastructures followed as needed. However, these developments had less to do with real planning than with reacting to crisis situations and urgent needs, due to the inability of urban water planners to consider long-term, deeply uncertain and ambiguous factors affecting urban development and water demand. These, coupled with increasingly uncertain climate conditions, indicate the need for a more holistic and intelligent decision-making framework for managing water infrastructures in the cities of the future. This project aims to develop a new theoretical framework for the allocation and development decisions on drinking water infrastructure systems, so that they are socially equitable, economically efficient and environmentally resilient, as advocated by the UN Agenda 2030, Sustainable Development Goals. The framework will integrate real-time monitoring and control with long-term robustness and flexibility-based pathway methods, and incorporate economic, social, ethical and environmental considerations for sustainable transitioning of urban water systems under deep uncertainty with multiple possible futures. The Water-Futures team will build on synergies from the four research groups, transcending methodologies from water science, systems and control theory, economics and decision science, and machine learning, into an integrated decision and control framework, to be implemented as an open-source research toolbox. The new science outcomes will be applied to three case studies exemplifying different types of urban water systems: a mature, relatively stable system; a mature and rapidly expanding system; and a relatively recent supply system in a developing country with high growth and special challenges, including limited resources, intermittent supply and high water losses.	Automation and Control, Machine Learning, Fault Diagnosis, Smart Water Systems	mpolycar@ucy.ac.cy

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256	Synergy	Tackling the Cyclacene Challenge	EBERHARD KARLS UNIVERSITAET TUEBINGEN	www.cyclacene.de	polycyclic aromatic hydrocarbons, pi materials, strain, strong electron correlation, low-temperature spectroscopy	Cyclacenes, i.e., cyclic versions of acenes consisting of linearly fused benzene rings, were first discussed in 1954 by Heilbronner, but - despite considerable synthetic efforts over decades - have remained an elusive class of compounds. Theoretical investigations suggest that cyclacenes are highly reactive due to pronounced polyradical character and significant ring strain. All prior attempts to synthesise cyclacenes failed, mainly because the final synthetic step of establishing a fully conjugated π-system was energetically prohibitive. Despite these challenges, cyclacenes remain intriguing synthetic targets because of their unique chemical, electronic, and structural properties as well as their potential applications in organic (opto-)electronics or spintronics. In this collaborative project, we will develop novel synthetic approaches, which synergistically combine efficient and high-yielding synthetic strategies of belt-type precursors that we will transform to cyclacenes by extrusion of suitable leaving groups under cryogenic matrix isolation conditions, on surfaces, in the solid state, and ultimately even in solution. Our synthetic approach is highly modular and allows to structurally vary the belt-type precursors, and thus the cyclacenes, by placing different substituents at the rims, including peri-annulation or isosteric substitution of CH units by heteroatoms. This research, combined with state-of-the-art computational investigations and characterization even on the single-molecule level, will provide unprecedented insight into the structure-property relationship of the fully conjugated zigzag topology present in cyclacenes and address fundamental questions of chemical reactivity and the interplay of aromaticity, strain and polyradical character. This knowledge will finally allow us to synthesise interlocked structures based on cyclacenes and to apply cyclacenes in controlled reactions on surfaces for creating further elusive materials such as polyacenes.		holger.bettinger@uni-tuebingen.de
257	Synergy	NEw generation MEthods for numerical SImulationS	UNIVERSITE DE MONTPELLIER	http://erc-nemesis.eu/	Numerical analysis, polytonal methods, discrete complexes	Relevant partial differential equations (PDEs) problems of the 21st century, including those encountered in magnetohydrodynamics and geological flows, involve severe difficulties linked to: the presence of incomplete differential operators related to Hilbert complexes; nonlinear and hybrid-dimensional physical behaviors; embedded/moving interfaces. The goal of the NEMESIS project is to lay the groundwork for a novel generation of numerical simulators tackling all of the above difficulties at once. This will require the combination of skills and knowledge resulting from the synergy of the PIs, covering distinct and extremely technical fields of mathematics: numerical analysis, analysis of nonlinear PDEs, and scientific computing. The research program is structured into four tightly interconnected clusters, whose goals are: the development of Polytopal Exterior Calculus (PEC), a general theory of discrete Hilbert complexes on polytopal meshes; the design of innovative strategies to boost efficiency, embedded into a general abstract Multilevel Solvers Convergence Framework (MSCF); the extension of the above tools to challenging nonlinear and hybrid-dimensional problems through Discrete Functional Analysis (DFA) tools; the demonstration through proof-of-concept applications in magnetohydrodynamics (e.g., nuclear reactor models or aluminum smelting) and geological flows (e.g., flows of gas/liquid mixtures in underground reservoirs with fractures, as occurring in CO2 storage). This project will bring key advances in numerical analysis through the introduction of entirely novel paradigms such as the PEC and DFA, and in scientific computing through MSCF. The novel mathematical tools developed in the project will break long-standing barriers in engineering and applied sciences, and will be implemented in a practitioner-oriented open-source library that will boost design and prediction capabilities in these fields.		jerome.droniou@umontpellier.fr

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258	Synergy	Quantifying the impact of major cultural transitions on marine ecosystem functioning and biodiversity	THE UNIVERSITY OF EXETER	https://seachange-erc.eu/	Marine ecosystem; biodiversity; Holocene; North Sea; Antarctica; Brazil; stable isotopes; DNA; conservation	The seas are changing. Marine conservation seeks to protect valuable habitats but the pristine state of marine ecosystem functioning and biodiversity – that is, the system as it operated before there was any large scale human impact – is conjectural. Conservation management strategies are often based on highly altered ecosystems where the degree of human-induced change is unknown. In SEACHANGE, we propose a structured and systematic approach to the reconstruction of marine ecosystem baselines to quantify the impact of anthropogenic cultural transitions on marine biodiversity and ecosystem functioning. SEACHANGE will address two key questions: 1) What was the nature of long-term changes in prehistoric marine biodiversity and ecosystem functioning over a 3000-year period in NW Europe and the degree of human impact associated with major socioeconomic changes across the Mesolithic-Neolithic boundary? 2) What has been the scale and rate of marine biodiversity loss and changes to ecosystem functioning as a result of fishing intensity and marine habitat loss during the last 2000 years (including the Industrial Transition) in the North Sea and around Iceland, eastern Australia and the west Antarctic Peninsula? To address these questions we will analyse: 1) absolutely-dated annually-resolved bivalve shell series (“sclerochronologies”); 2) marine sediment cores; 3) archaeological midden (waste) materials including shells and bones. We will date these samples precisely and undertake zooarchaeological and palaeoecological, stable isotope geochemical and environmental DNA/DNA metabarcoding analyses. We will compare the data with historical and archival sources, and we will generate numerical ecosystem simulations. We will identify how depleted the current marine environment is compared with that before large scale human impact and what measures are needed, and how long will it take, for marine biodiversity to recover.	Sclerochronology; paleoecology; paleoceanography; historical ecology; marine ecology; conservation biology	j.scourse@exeter.ac.uk
259	Synergy	Harnessing the splicing code for targeted control of gene expression	FUNDACIO CENTRE DE REGULACIO GENOMICA		pre-mRNA splicing, small molecule, molecular mechanisms	Alternative splicing (AS) of mRNA precursors plays important roles in tissue-specific gene regulation and biological regulatory mechanisms, as it can radically alter protein expression, cell phenotypes and physiological responses. Altered splicing also contributes to disease mechanisms, ranging from neurodegeneration to cancer. Drugs modulating AS have recently provided the first therapy for Spinal Muscular Atrophy, a common genetic disorder, illustrating the huge potential for treating many other diseases of unmet need, if only we understood the mechanisms controlling splice site selection and how to regulate them with small molecules. Unfortunately, despite decades of research, a comprehensive understanding of the mechanisms that control specificity of AS is lacking. This gap in basic knowledge prevents opportunities to harness splicing modulators as tools to study gene function, novel therapeutics or other biotech applications. This Project addresses head-on the major technical challenges that have limited progress in the AS field. Building on extensive preliminary data, we will use a multidisciplinary approach that combines chemical, structural, cellular, systems biology and machine learning to characterize mechanisms of splice site selection and identify targets for modulating these mechanisms using tool compounds. The outcomes will define key regulatory sequences, splicing factors and molecular interactions involved, thereby illuminating how the splicing machinery efficiently accommodates, yet also discriminates between, a wide range of splice site sequences. This will enable future applications harnessing splice site selection. Our primary goal is to answer the central question, ‘Is it generally possible to modulate splicing with high specificity using small molecules?’ Success will transform our basic understanding of human gene expression and unleash major opportunities for Pharma to develop new therapeutics.	RNA biology, RNA processing, chemical screens	juan.valcarcel@crg.eu

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260	Synergy	Horse Power: Interactions between China, Mongolia and the steppe 2000-0 BCE	BRITISH MUSEUM			Horse Power will examine the complex interactions between the eastern steppe and China from the second millennium BCE to the formation of the Xiongnu empire in Mongolia and the Qin state in China after 300 BCE. From the second millennium BCE two great worlds formed, traded and fought across Eurasia. From Mongolia to the European steppe great horse and herding cultures coalesced across thousands of kilometres of grassland. To the south, a string of states existed from Egypt to the Chinese Central Plains, some already ancient and others newly created. Interaction between these worlds was constant and profoundly formative for all parties, a fact we are only starting to fully appreciate. To examine the connections between the steppe, Mongolia and China's Central Plains we will combine the latest scientific techniques in genetics and metallurgical analysis with theory concerning politics and power within and between China and its northern neighbours. Three principal empirical elements underpin the project: ancient DNA from horses; the characterization of bronzes to throw light on their movement and recycling; the structure and contents of archaeological sites (mainly graves) in China, Mongolia and the steppe. We will develop theory on the nature of leadership and power, particularly in mobile societies. Science will meet social science in a mutually informative manner and we will work across linguistic boundaries (Chinese, Mongolian, Russian, English) in a spirit of the co-production of knowledge with important partners including The Emperor Qin Shihuang's Mausoleum Site Museum in China and Mongolian universities. We will reflect on our working practices, engaging a broader public in how a complex research project works. An innovative artistic programme will engage a range of local communities, horse enthusiasts and local artists in the work and results of the project. Working together we will create a picture of this complex region impossible if we had worked alone.		rliu@britishmuseum.org
261	Synergy	Glycans as Master Switches of B Cell Activity in Autoimmunity	GENOS DOO ZA VJESTACENJE I ANALIZU	glycanswitch.eu		Autoimmune diseases including rheumatoid arthritis (RA) are often life-threatening disorders with increasing disability having a negative impact on patients' quality of life. Mechanisms leading to the breach of tolerance in development of autoimmunity are still largely unknown. Protein glycosylation is an essential regulatory mechanism in the immune system. We recently demonstrated that N-glycosylation of the variable region (Fab) of autoantibodies is a hallmark of RA development and progression. We also demonstrated that autoantibodies acquire these Fab glycosylation signatures already many years before disease onset. We herein hypothesize that Fab glycosylation at the level of the B cell receptor is a key molecular switch promoting the selection, activation and proliferation of autoreactive B cells leading to the concomitant breach of immunotolerance. Within GlycanSwitch, we will map the Fab glycome of various types of RA autoantibodies and autoreactive B cells. We will study the factors and underlying cellular mechanisms that regulate Fab glycosylation of B cell receptors and autoantibodies. We will investigate the immunological effects of Fab glycosylation and the impact in B cells signalling and activation in the context of molecular and cellular interacting partners in the immune microenvironment. Finally, we will test in relevant mouse models how Fab glycosylation of autoantibodies and autoreactive B cells contributes to the breach of tolerance. We expect that the obtained insights into the role of glycans as key checkpoint for the selection of autoreactive B cells and the rise of autoimmunity will provide leads for targeted therapeutic interventions as well as rationales for the early detection of RA and autoimmune diseases in general. We foresee that the knowledge generated will allow us to embark on a targeted prevention clinical study in patients at risk for RA to turn off the GlycanSwitch leading to chronic RA.		glauc@pharma.hr

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262	Synergy	urbisphere - coupling dynamic cities and climate	FOUNDATION FOR RESEARCH AND TECHNOLOGY HELLAS	https://urbisphere.eu	Earth Observation, urbanization, urban climate, climate change, urban planning	urbisphere will change how the scientific community conceptualises, characterizes and forecasts cities in the climate system and in urban planning, by developing a radically new approach to integrate multiple dimensions of urban change, their interaction and feedbacks. It aims to forecast and project urban futures and climates in a dynamic framework considering weather, air quality, differential exposure and vulnerability of people at neighbourhood to city scale. It will provide new insights into existing and emerging risks, based on a synergistic effort across disciplines which currently work mostly in parallel. Urban-Surface Models (USM) and Human Exposure and Vulnerability models (HEV) will be developed and coupled to improve the forecasting of exposure, emissions, and intervention potentials in cities. This will transform emergency/risk management, atmospheric forecasting and long-term urban development/adaptation strategies in the urban sphere. The system will use a real-time 4D Smart Urban Observation System (SmUrObS) to provide targeted urban form/function/emissions/exposure data using novel ground and remote sensing technology. The USM-HEV-SmUrObS system will equip us with: 1) a deep understanding of socio-economic dynamics and human behaviour and responses to weather and climate, economic (and other) drivers that transform cities' exposure and vulnerability to climate change-related hazards (like heat); 2) a consistent method that can be scaled from detailed high-resolution modelling of intra-neighbourhood scale characteristics, to climate and socio-economic modelling and assessment at city, regional and global scales; 3) an approach that can inform global climate and global vulnerability and risk modelling; will allow consistent downscaling to the city for decision making for local urban risk and resilience management; and provide information on the dynamic nexus of exposure and vulnerability of people in cities.	urban climate, urbanization, Earth Observation, urban modelling	zedd2@iacm.forth.gr
263	Synergy	Uncovering the molecular effects of the tubulin code and their impact on organism-wide functions	INSTITUT NATIONAL DE LA SANTE ET DE LA RECHERCHE MEDICALE		Neorpbiology, tubulin, axons, zebrafish, neural circuits	Microtubules (MT) are core components of the eukaryotic cytoskeleton with essential roles in cell division, cell shape, intracellular transport, and motility. Despite their functional divergence, MTs have highly conserved structures made from almost identical molecular building blocks – tubulin proteins. A variety of posttranslational modifications (PTMs) diversifies these building blocks, which is thought to control most of the properties and functions of the MT cytoskeleton, a concept referred to as the 'tubulin code'. While they appear to have subtle effects at the molecular level, tubulin PTMs are essential for maintaining cellular functions of MTs over large spatial and temporal scales. Yet, a comprehensive knowledge of the principles of the tubulin code, connecting its functions across the molecular, cellular and organismal levels, is almost entirely lacking. Our project aims to obtain a novel molecular and mechanistic understanding of how tubulin PTMs control long-term cellular function and homeostasis. Our unique approach bridges all relevant scales of biology and relies on a synergy between our powerful experimental models and expertise in biochemistry, structural biology, single-molecule assays, systems-biophysics, cell biology, and physiology. Specifically, we will: (1) Determine how different tubulin PTMs affect biophysical and structural properties of MTs and their interactions with associated proteins; (2) Define the impact of tubulin PTMs on overall MT cytoskeleton behaviour and the resulting physiological implications in neurons; (3) Combine zebrafish and mouse models and develop a novel fish model for lifelong in-vivo imaging to determine how the tubulin PTMs control lifelong MT-based functions. Our work will define the importance of tubulin PTMs by revealing their critical molecular functions over the lifetime of an organism. The project has the potential to substantially change our perception of the cytoskeleton's role in homeostasis and disease.		filippo.del-bene@inserm.fr

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264	Synergy	A background-free experiment to discover the nature of neutrinos based on single Barium Atom Light Detection	UNIVERSIDAD DEL PAIS VASCO/ EUSKAL HERRIKO UNIBERTSITATEA	https://www.ehu.eus/en/web/campusa-magazine/-/9.3-million-euros-to-investigate-the-origin-of-the-universe	Fluorescent sensors, barium tagging, supramolecular chemistry, chemical synthesis, computational chemistry	Searching for neutrinoless double beta decays (NLDBD) is the only practical way to establish if the neutrinos are their own antiparticles, a discovery of enormous importance for particle physics and cosmology. Due to the smallness of neutrino masses, the lifetime of NLDBD is expected to be much longer than the ones from the noise associated with the natural radioactive chains. A positive identification of NLDBD decays requires finding a signal that cannot be mimicked by radioactive backgrounds. In particular, the NLDBD decay of Xe-136 could be established by detecting the doubly ionized daughter atom, Ba2+ created in the decay. Such a detection could be achieved via a sensor made of a monolayer of molecular indicators. The Ba2+ would be captured by one of the molecules in the sensor, and the presence of the single Ba2+-complexed indicator would be subsequently revealed by a fluorescent response after interrogation with a laser system. Our proposed sensor is based on a new type of molecular bicolor fluorescent indicators, able to shift their emission spectra when complexed with Ba2+. The interrogation and detection system will be based in fast, two photon absorption microscopy. The primary goals of this proposal are: 1, a full demonstration of the feasibility of a sensor capable of detecting single Ba2+ ions in a High Pressure Xenon Chamber (HPXe), and 2) the construction of a large HPXe demonstrator, the BOLD detector, which will implement a full Barium Tagging Detector System and will demonstrate the feasibility of building a background-free experiment at the ton-scale, with large discovery potential.	Fluorescent sensors, barium tagging, supramolecular chemistry, chemical synthesis, computational chemistry	fp.cossio@ehu.es
265	Synergy	Single Molecular Devices by Atomic Manipulation	UNIVERSIDAD DE SANTIAGO DE COMPOSTELA	https://www.usc.es/ciqus/en/groups/commo	synthesis of nanographenes, carbon-based materials, on-surface synthesis, molecular materials, synthetic chemistry	Breakthroughs in on-surface chemistry and characterization techniques have recently enabled the creation of novel molecules and the direct imaging of reaction intermediates at the single molecule level. Here, by employing the novel concepts of charge manipulation within molecules and coherent control of reactions by lightwave scanning tunnelling microscopy, we will bring the control and resolution of chemical reactions to an unparalleled level. We will combine our expertise in solution synthesis of dedicated organic molecules, on-surface chemistry, atomic manipulation and single-molecule characterization with ultimate resolution in space and time. The combination of on-surface chemistry with charge-state control, possible by working on insulating supports, will unlock a plethora of novel charge-driven reaction pathways far from equilibrium. Employing ultrafast pulses, we will resolve chemical reactions with unprecedented resolution in the space and time domain step-by step unravelling the mechanisms of relevant molecular transformations. We will discover and characterize novel on-surface reactions, elusive molecules, intermediates and transition states and fabricate molecular machines and complex molecular networks with engineered topologically protected band structures. Charge control within molecular devices on insulating supports will allow us to study electron transfer, carrier generation and recombination, redox-reactions and electroluminescence at the molecular level. Novel molecular machines will be directed by controlling single-electron charges within the device. Logic functions based on single-electron transfer will be implemented in molecular networks. Controlling and investigating these atomically defined devices on their intrinsic length and time scales will revolutionize our fundamental understanding of the molecular world with impact on fields as diverse as chemical synthesis, light harvesting, molecular machinery and computing.	synthesis of nanographenes, carbon-based materials, on-surface synthesis, molecular materials, synthetic chemistry	diego.pena@usc.es

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266	Synergy	Sub-percent calibration of the extragalactic distance scale in the era of big surveys	CENTRUM ASTRONOMICZNE IM. MIKOLAJA KOPERNIKA POLSKIEJ AKADEMII NAUK	https://arauca ria.camk.edu. pl/	extragalactic distance scale, Hubble constant, standard candles, pulsating stars, binary systems	After detection of the accelerated expansion of the Universe (Nobel prize 2011) and the existence of an enigmatic “dark energy” component of the matter-energy content of the Universe the physical explanation of the nature of dark energy has become a major challenge for astronomers and physicists in recent years. The recent empirical determinations of H0 complicated even more our understanding of the Universe since they differ by about 4σ from the value obtained from Planck data and the ΛCDM model, which suggest that new physics might be required in the models. We will calibrate two geometrical methods which will yield 1% distances a thousand times further out than Gaia parallaxes. The great advantage of our approach is the full control on all potential errors affecting the distance determinations, including systematic errors elusive in most other methods. In addition, we will provide mutual crosschecks at the sub-percent accuracy level with three completely independent geometrical methods. This will allow for the first time to verify the accuracy (and not only precision) at this unprecedented level of precision. Applying these methods we will calibrate the extragalactic distance scale with an unprecedented precision and accuracy. This will allow for a 1% H0 determination with Cepheids and SN Ia. Novel reverberation studies of AGN continua will allow us to determine H0 completely independently, and provide direct insight into the larger redshift Universe, including the H(z) dependence which will constrain other cosmological parameters. Our results will have strong impact on many fields of modern astrophysics. In particular they will definitively answer the question if new physics beyond the standard cosmological model is required. They will also be central to understand the physical nature of dark energy which constitutes about 72% of the matter-energy of the Universe.		pietrzyn@camk.edu.pl
267	Molecules of Life: Biological Mechanisms, Structures and Functions	Development of Reconstructed Electron Energy Loss techniques for Elemental Mapping in macromolecular structures	MAX-PLANCK-GESELLSCHAFT ZUR FORDERUNG DER WISSENSCHAFTEN EV		electron energy loss spectroscopy, cryo-electron microscopy, elemental mapping	A perfect macromolecular structure would provide an all-atom description of the molecule, including not only the well-ordered polypeptide or polynucleotide framework but all other species: metals and other ions, cofactors, lipids, substrates and inhibitors. However, current structural data include no or very little information on elemental composition, leading to significant errors and omissions in atomic models. To address this issue, I propose to develop a method, Reconstructed Electron Energy Loss - Elemental Mapping (REEL-EM), that will map elemental distribution within macromolecular complexes by bringing together well-established principles in analytical electron microscopy (EM) and biological cryogenic EM. Atomic-resolution elemental mapping in the electron microscope is well established for dose-tolerant samples. Electron Energy Loss (EEL) techniques capture information from inelastic scattering events in the sample, and energy losses are characteristic of the element and chemical state of the scattering atom. These techniques require a high electron dose to achieve useable signal-to-noise ratio, severely limiting their application to biological samples. Our novel approach combines the image processing tools of single-particle cryo-EM with EEL techniques, allowing us to add EEL signal in the 3D particle space, effectively dividing the dose required for sensitive elemental analysis between many images. Preliminary work in my research group confirms that our proposed approach is valid - we are able to generate maps of specific elements in the 3D particle space. I propose to extend this early work to achieve single-atom detection at 1-nm spatial resolution in the course of this five-year project. Our work will characterise and optimise all aspects of data collection and processing for REEL-EM. We will apply our methodology to two important macromolecular complexes: the skeletal muscle ryanodine receptor and the mitochondrial F-type ATP synthase.	image processing, scanning transmission electron microscopy, electron energy loss spectroscopy	需咨询NSFC项目联系人

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268	Molecules of Life: Biological Mechanisms, Structures and Functions	Cofactors at the core of tau prion behaviour	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	https://www.fichou-lab.cnrs.fr/home	amyloid, tau, tauopathies, structural biology, biophysics, EPR	Tau is an intrinsically disordered protein that regulates microtubule activity in neurons. Aggregation of tau into amyloid fibrils is diagnostic of several diseases, termed tauopathies, that include Alzheimer's disease. Distinct amyloid aggregate structures, so-called "strains", are involved in different tauopathies. These assemblies can spread and recapitulate pathological phenotypes when injected in cells and animals. This is the hallmark that tau aggregates follow a prion behaviour. To date, the factors guiding the formation or propagation of specific strains are unknown. Showcasing this crucial gap in knowledge is the fact that none of the brain-extracted tau amyloid structures has been reproduced in vitro. This project intends to establish a paradigm shift for the very definition of tau strain. I propose the novel hypothesis that the co-aggregation of tau with other biomolecules such as lipids or polyanions, so-called cofactors, is a defining property of tau prion strains. To demonstrate this hypothesis, I will test that the tau-cofactor interactions (i) dictate the structure of tau aggregates, (ii) enable structure replication through seeding and (iii) dictate the neuropathology developed in cells and mice after inoculation of tau seeds. My approach is to study the pathological properties and the conformational evolution of tau aggregates in the presence of biologically-relevant cofactors possessing different physico-chemical properties. By mapping the interactions between tau and cofactors, my goal is also to establish the canonical rules governing tau structural differentiation. This proposal combines multiple methods including EPR and NMR spectroscopy, AFM-based nanospectroscopy, biochemistry, cell biology and animal histology. The proposed paradigm shift would have a very high impact in the field of tauopathies, for example by enabling accurate structure-based drug discovery, revealing new drug targets and pinpointing key deleterious metabolic pathways.		需咨询NSFC项目联系人
269	Integrative Biology: from Genes and Genomes to Systems	Gene expression dosage as a driver of cellular and physiological traits	KUNGLIGA TEKNISKA HOEGSKOLAN	101043238	functional genomics, human genetics, statistical genetics, single cell, gene regulation, regulatory networks	The expression dosage of a gene is a fundamental determinant of its downstream function at the cellular and organismal level, and its genetic or environmental perturbations are a driving force of most common and rare disease in humans. However, we have limited understanding of the specific shape of dosage-to function-curves for human genes, what factors and mechanisms drive their variation across genes, phenotypes and cellular contexts, and how this contributes to functional architecture of human traits. This project addresses these questions using large human genetic data sets and cutting-edge experimental approaches. Using blood cell traits as our study system, we will characterize the relationship between gene dosage and cellular and physiological function in in unprecedented scale and depth. This addresses fundamental questions in systems biology and produces insights that can also benefit genomic medicine and drug development. The Work Packages of this study will: 1) Establish the dosage-to-function relationship for hundreds of human genes, associating genetically driven gene dosage to blood cell traits in large human genetic data, and by an innovative CRISPR-based experimental approach that maps gene dosage changes to multiple cellular phenotypes; 2) Elucidate how cellular the dosage-to-cellular-function relationships differ between cellular states, and use single-cell RNA sequencing to analyze how regulatory networks mediate context-specific dosage-to-function effects; 3) Characterize upstream genomic and environmental regulators of gene dosage. This project will build the first comprehensive, generalizable picture of gene dosage-to-function relationships in humans. Our analysis will link these insights to functional architecture of human traits, providing unique generalizable insights into how disruption of gene dosage and regulatory networks underlies human traits at the cellular and physiological level.	functional genomics, human genetics, statistical genetics, single cell, gene regulation, regulatory networks	需咨询NSFC项目联系人

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270	Cellular, Developmental and Regenerative Biology	Propagation of cellular memory through dormancy	MAX-PLANCK-GESELLSCHAFT ZUR FORDERUNG DER WISSENSCHAFTEN EV		stem cells, epigenetics, dormancy, genome organization, metabolism	Decades of work established the importance of dormant cells in reproduction and regeneration, however, a central unsolved question is how the cell propagates transcriptional memory and cellular identity through dormancy. Current approaches tend to characterize dormancy as a binary on-off switch. In contrast, a highly coordinated and precisely timed set of events are needed to successfully transition cells into dormancy, to maintain dormancy, and to exit it. In DOR-CODE, I will leverage the latest gene editing and genome profiling tools on an inducible and reversible embryonic dormancy model that I spearheaded (Bulut-Karslioglu et al, 2016, van der Weijden et al, 2022) to discover the genomic basis of dormancy. My mission is to reveal the temporal regulatory code of dormancy - 'DOR-CODE' - without which cellular identity cannot be propagated through time. Recent work by us and others has started to reveal the epigenomic landscape of dormancy: a highly repressed state with elevated DNA and histone methylation and decreased transcriptional output. Cellular strategies to counteract this overall repressive state at regulatory sites at the correct times are key for the retention of developmental potential. Here, I will identify DNA and histone demethylation strategies to propagate transcriptional memory at key regulatory elements (Objectives 1&2) and connect locus-specific regulation (Objectives 1&2) to genome macro-organization (Objective 3). By building direct links between anabolic growth and genome regulation, I will demonstrate how timely gene reactivation is ensured to enable exit from dormancy. The conceptual leap and mechanistic insights resulting from DOR-CODE will (1) enhance our knowledge of embryonic dormancy and lay the foundation for better in vitro embryo preservation, (2) bring a fresh perspective to related systems such as regeneration, longevity, and cancer dormancy, and (3) fuel the research in my lab for decades to come.	molecular and/or developmental biologist and/or computational researcher	需咨询NSFC项目联系人
271	Immunity, Infection and Immunotherapy	PIWI-interacting RNAs at the interface of virus-host conflicts in Aedes aegypti mosquitoes	STICHTING RADBOUD UNIVERSITAIR MEDISCH CENTRUM		piRNA pathway; PIWI protein; mosquito; arbovirus; insect virus.	Background: The mosquito Aedes aegypti transmits viruses with pandemic potential but is also host to a large repertoire of mosquito-specific viruses and endogenous retroviruses. These viruses may invade the ovaries and eventually the oocyte to be transmitted from mother to offspring and to expand in the population. This transmission route exposes them to the specific host defense mechanisms of the ovary, which they must overcome to ensure onward transmission. This intriguing virus–host conflict is crucial for virus evolution and ecology and for host reproduction and survival, but has thus far not been studied. Hypothesis: I hypothesize that a specific class of small RNAs, called PIWI-interacting RNAs (piRNAs), are essential for protection of the mosquito germline from virus infection. Aim: My goal is to define the role of the piRNA pathway as a host defense system against RNA viruses, endogenous retroviruses, and other genomic parasites, and to identify viral counter-defense mechanisms. Additional to these fundamental aims, we will reprogram the piRNA pathway to induce resistance against pathogenic viruses in mosquitoes. Approach: This interdisciplinary project c¬ombines powerful genetic, genomic, and proteomic approaches at the intersection of virology, RNA biology, and entomology. Of particular importance, we will establish urgently needed tools for tissue-specific gene inactivation in vivo to define the functions of the expanded PIWI gene family of mosquitoes. Importance and Innovation: ERC project PIWIdefense will be the first to define host defense functions of the piRNA pathway in the germline of a major vector mosquito. The project generates unprecedented insights into the fundamental processes that shape the fascinating virus–host conflicts in mosquitoes. In addition, the project establishes a novel approach that can be translated into mosquito-centered intervention strategies against arthropod-borne viruses.	Postdoc level or higher; RNA biology	需咨询NSFC项目联系人

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272	Immunity, Infection and Immunotherapy	Letting up senescence and inflammaging through T cells	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	https://mmittelbrunnlab.cbm.uam.es	Immunosenescence, Aging, T cells, inflammation	With the increase in human life expectancy, there is an urgent need to understand the common molecular pathways by which aging results in a progressively higher susceptibility to chronic morbidity, disability, and frailty. In the last years, immunometabolism has emerged as a new field to boost immune responses for cancer immunotherapies as well as to dampen autoimmune diseases. A recent discovery from my lab has revealed the critical role of T cell metabolism in accelerating the onset of age-associated diseases and multimorbidity. This finding has opened a new path to investigate the diverse T cell intrinsic and external stimuli that instruct T cell differentiation towards a dysfunctional state during aging, with the final goal of designing effective strategies to promote healthy aging. LetTBe will address the hypothesis that the time-dependent deterioration of T lymphocytes contributes not only to immunosenescence but also to the general aging process. The LetTBe project proposes to use multidisciplinary approaches to target age-associated T cells for preventing inflammaging, senescence and age-associated multimorbidity. Our central goals are: 1) To define age-associated T cells heterogeneity with special focus in their cellular origin, clonality, metabolic vulnerabilities and transcriptomic signatures; 2) To decode the environmental signals that are imprinted on age-associated T cells and contribute to their development; 3) To identify new strategies to targeting age-associated T cells for slowing down immunosenescence, and for boosting resilience to inflammaging, systemic senescence and age-related multimorbidity. In sum, LetTBe puts forward an ambitious but feasible program with the wide purpose of understanding the specific molecular mechanisms and metabolic requirements of age-associated T cells, with the final goal to guide new strategies to improve healthy aging.		需咨询NSFC项目联系人
273	Immunity, Infection and Immunotherapy	Mission Remission: Integrated characterization of the HIV Reservoir and Host Immune Responses after Antibody-Immunotherapy	CHARITE - UNIVERSITAETSMEDIZIN BERLIN			The search for a therapeutic intervention that can lead to HIV remission or cure is a global priority of the HIV field. HIV-specific antibodies have the potential to alter the clinical course of infection and enhance antiviral immune responses. In addition, we have recently demonstrated that antibody-based HIV immunotherapy results in higher-than-average cases of durable HIV remission in the absence of antiretroviral medication. Moreover, passive administration of HIV-specific antibodies was associated with reductions in the size of the replication-competent HIV reservoir which is the major barrier towards a cure for HIV. While these results highlight the exceptional potential of HIV immunotherapy, it is critical to understand the underlying mechanisms responsible for higher rates of HIV remission and antibody-mediated changes in the reservoir. Therefore, we will identify individuals with long-term HIV remission from clinical antibody-immunotherapy trials before comprehensively characterizing host immune responses, host-viral gene expression and the HIV latent reservoir. By combining highly valuable clinical samples with novel strategies for the characterization of viral immunity and persistence, we aim to establish a relationship between antibody-based HIV immunotherapy, host immunological factors, adaptive immune responses, and the nature of the viral reservoir with the overarching goal of developing clinical interventions for long-term, drug-free HIV remission or cure.		需咨询NSFC项目联系人

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274	Immunity, Infection and Immunotherapy	Contextual specification of fibroblast-driven causalities in chronic intestinal inflammation and fibrosis	EREVNITIKO KENTRO VIOIATRIKON EPISTIMON ALEXANDROS FLEMINGK	https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/project-details/43108390/101055093/HORIZON		Inflammatory bowel disease (IBD) is a severe, chronic pathology presenting with progressive intestinal inflammation and fibrosis, whose exact causes and key pathways remain poorly defined. Stromal–immune cell interactions have recently gained momentum in conceptualizing tissue homeostasis and our lab offered solid evidence establishing fibroblast heterogeneity and dominant roles in intestinal pathophysiology. Our recent preliminary evidence, indicated diverse spatial distribution of subsets of activated fibroblasts and revealed synergistic interplays of important inflammatory pathways driving pathogenicity. Detailed insights into such contextual complexities remain obscure. Here, we propose a novel unifying hypothesis that progressive IBD is orchestrated by specific subsets of fibroblasts, becoming causal to pathogenesis, depending on contextual information dictated by origin, topology, and cross-talks with immune or stromal cell types. We propose to use single-cell spatiotemporal phenotyping to deconvolute fibroblast subset-specific functions in disease-staged, fibrotic and non-fibrotic animal models of IBD. We aim to: (1) Map dynamic chromatin and gene expression programs that define cellular heterogeneity and infer cell interactions to build an ‘IBD connectome’ atlas (2) Analyse the origin, spatial distribution, plasticity and lineage trajectories of intestinal fibroblasts and reveal potential functions of pathogenic subsets (3) Perform discovery screens and functional validations on known (TNF, IFNγ, TGFb and interleukins) and novel fibroblast-subset-specific pathways focusing on potential synergistic interplays (4) Employ clinical material to validate involvement of the most prominent new pathways in human. The proposed research should help tackle the complexities of chronic inflammatory and fibrotic disorders in the intestine and beyond, advance mechanistic concepts in immune disease pathophysiology and promote fibroblast-targeting therapeutic discovery.		需咨询NSFC项目联系人
275	Prevention, Diagnosis and Treatment of Human Diseases	MRI-based ID of the Vasculature across the Heart-Brain Axis	TECHNISCHE UNIVERSITEIT DELFT		Magnetic Resonance Imaging, Nuclear Spin Relaxation, Microscopic Susceptibilities	Microvascular impairment is a hallmark of many of today’s most burdening diseases, including forms of ischemic heart disease, stroke, and dementia. It is also the most promising candidate to explain the link between cardiovascular and brain disease (so-called heart-brain axis). However, only histology provides comprehensive assessment of the microvasculature, and is rarely available in vivo as it requires invasive biopsy. The lack of early, non-invasive markers limits our pathophysiological understanding and crucially affects treatment success, as preventive intervention is the only successful clinical management strategy available. With a major leap in Magnetic Resonance Imaging (MRI) physics, I will address this need and develop VascularID, a fully non-invasive toolset for the quantitative assessment of cardiac and cerebral microvasculature. This non-invasive biopsy exploits microscopic magnetic fields around the vessels to obtain structural information about the microvasculature. It is contrast-free and resilient against field inhomogeneities and can, for the first time, be used in both the heart and the brain. Combined with a new generation of non-contrast perfusion MRI, VascularID will provide comprehensive functional and structural information. My approach will first be validated in a micro-printed 3D model of the vasculature. In vivo feasibility will be demonstrated in an animal model. Proof-of-principle studies with VascularID in a cohort of patients suffering from heart disease and a cohort of patients with cerebral small vessel disease will demonstrate the clinical feasibility. I will develop, validate, and disseminate VascularID for research and clinical use to enable groundbreaking insights into the smallest blood vessels. These insights are perfectly poised to provide the missing key to the vascular underpinnings of diseases that form the major burden to our health care system in the years to come.	Nuclear Magnetic Resonance, Nuclear Spin Relaxation, Statistical Physics	需咨询NSFC项目联系人

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276	Environmental Biology, Ecology and Evolution	Uncovering the mechanisms of action of an antiviral bacterium	UNIWERSYTET JAGIELLONSKI	https://www.chrosteklab.com/projects	intracellular bacteria virus	Animals and microbes interact in intricate ways. Wolbachia, a common intracellular insect symbiont, can manipulate reproduction and protect hosts from viruses. Thus, Wolbachia is an asset in the control of insect-borne diseases. However, as Wolbachia cannot be cultured outside of host cells or genetically manipulated, the mechanisms of its antiviral phenotype remain poorly understood, and this inhibits wider exploitation. I have been working to remedy these deficiencies, and now stand poised to discover the mechanisms of Wolbachia-conferred antiviral protection by answering the following questions: 1) Where does the protection originate? Up to now, mechanisms of protection have been studied in whole organisms, often lacking resolution, or in cultured cells, which lack emergent properties. I will identify tissues and cell types of the host where protection starts. To do this, I will: a) quantify titers of Wolbachia and virus at early time points post-viral infection in insect tissues, b) measure gene expression of host and microbes to identify candidates for further molecular characterisation, and c) test the extent of the utility of widely adopted, yet unvalidated, cell-culture models of antiviral protection. 2) Which Wolbachia genes effect protection? Wolbachia research has historically been impeded by a lack of tools to study gene function. Here, I will deploy antisense technology, which I have recently developed, to interrogate function of candidate Wolbachia genes in the native system. I will also engineer new methods to target Wolbachia genes and proteins, based on my data on cell-penetrating peptide-mediated delivery of bioactive cargo to Wolbachia. This project has two major outcomes: it will uncover Wolbachia factors responsible for Wolbachia-conferred antiviral protection, and it will transform Wolbachia and symbiosis research by creating tools to study symbiont gene function.	molecular biology, biochemistry, imaging, super-resolution, intracellular membranes	需咨询NSFC项目联系人
277	Biotechnology and Biosystems Engineering	Low oxygen, key ingredient of the plant stem cell niche?	UNIVERSITEIT UTRECHT		Low oxygen, stem cells, plants, Shoot apical meristem, biosensors	Oxygen (O2) is essential for efficient energy conversion by multicellular organisms, including plants. Therefore, environmental conditions where O2 is limited (hypoxia) such as during flooding stress, pose a severe threat to plant survival and can lead to death when prolonged. I recently discovered that plant stem cells of the shoot apical meristem (SAM) are embedded in a local hypoxic niche and that this condition is even important for meristem activity. This suggests that local hypoxia may play a positive role in regulating meristems, despite being harmful to other plant tissue. Safeguarding the stem cell pool of the SAM is especially important for plant fitness, since it not only produces all above ground tissue, but also specifies the germline. In this project, I will therefore challenge the paradigm of hypoxia as a solely stressful conditions and propose that local hypoxia might create a protective environment for stem cells, whereas oxygenation outside the meristem might allow growth of differentiating organs. I will address this hypothesis via three interlinked strategies. (1) Complete the development of prototype O2 biosensors, which will unlock the ability to visualize and understand the role of O2 gradients in plant tissue. (2) Employ genetic manipulation of the O2 sensing machinery to test if and how O2 gradients provide a positional cue that spatially organizes the SAM and its derived organs. (3) Investigate the role of meristem hypoxia in formation of DNA-damaging radicals from O2 metabolism and study the evolution of the hypoxic niche and its perception. Protection of meristems and differentiating organs is essential for plants to survive flooding events which are increasing in frequency due to global warming. The novel insights on how O2 levels regulate development and the tools developed in this project will therefore be fundamental to make the strides forward that are needed to face global climate change and secure crop productivity under stress	Microscopy, biosensors, signaling molecules,	需咨询NSFC项目联系人

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278	Biotechnology and Biosystems Engineering	Nanostructure formation during food protein digestion and influence on intestinal transport	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS	https://prodigest.org/	proteins, digestibility, structure, scattering techniques	The global food system is currently facing great challenges, which are mainly motivated by environmental and health-related concerns: (i) The existing food resources are not efficiently utilized; while some of them are overexploited, causing water/soil shortage, biodiversity losses, etc., others are not properly valorized (e.g. seaweeds). (ii) Moreover, the unhealthy dietary habits of modern societies are leading to a dramatic increase in the incidence of diet-related chronic diseases (e.g. obesity, diabetes, etc.). In this context, the food industry is actively looking for 'novel' food sources with added health benefits. However, to design strategies for a sustainable production of nutritious food products from alternative sources and to predict their potential metabolic responses (e.g. satiety, allergenicity, etc.), it is essential to understand how food structure, digestibility and bioavailability are correlated. PRODIGEST seeks to investigate this topic from a novel perspective, focusing on the mechanistic and structural aspects of the gastrointestinal digestion of food proteins and studying their implications on bioavailability. The type of structures formed by the assembly of the digestion products through intermolecular associations or by interactions with physiological medium components, as well as the effect of dietary fibres (which are abundant in alternative protein sources) will be studied and linked to their intestinal transport and susceptibility to trigger metabolic responses. To address this challenge, a set of advanced structural characterization tools (including X-ray and neutron scattering techniques, peptidomic analyses and rheology), as well as intestinal transport studies, will be combined through a multi-disciplinary approach, interconnecting structural characterization, food science and biotechnology. The project outcomes will find potential applications to diverse research areas, such as nutrition, food technology, pharmacology and medicine.		需咨询NSFC项目联系人
279	Mathematics	Mathematics of Bose-Einstein Condensation	KOBENHAVNS UNIVERSITET			We propose a project in mathematics with a focus on many-body theory in mathematical physics. We are especially interested in the mathematical tools involved in the description and analysis of the recent experimental realizations of Bose-Einstein Condensation. It remains one of the most important challenges of mathematical physics to rigorously understand the formation of condensates in interacting systems. This project aims to address that challenge. Progress on the problem of condensation has been made on certain length scales, and we aim to push the boundaries of these lengths with a view towards the end-goal of actually having a mathematical proof of condensation in a continuum system of interacting quantum particles in the thermodynamic limit. To approach this objective we will study various related systems and problems with the expectation of getting improved understanding by seeing the methods in a new light. To fully solve these simpler problems will require the development of new mathematical tools and the gain of critical insight. Some of these simplified problems are concerned with the energy of the Bose gas in the dilute limit, also in dimensions different from 3, as well as LHY-physics—specially prepared systems where the normally lower order correction terms become dominant.		需咨询NSFC项目联系人

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280	Fundamental Constituents of Matter	Dipolar superfluid of diatomic molecules and Bose-Einstein condensate of tetramers	MAX-PLANCK-GESELLSCHAFT ZUR FORDERUNG DER WISSENSCHAFTEN EV			DiMoBecTe will explore the rich phase diagram of a degenerate Fermi gas of polar molecules near a field-linked scattering resonance, including the long-sought dipolar p-wave superfluid of fermionic diatomic molecules, the Bose-Einstein condensate (BEC) of tetermer molecules, and the crossover/transition in between. For this purpose, we will first create a new species of 6Li87Rb polar molecules in the quantum degenerate regime. This new kind of bialkali molecules is promising for its highly tunable interaction and its potential to reach unprecedentedly cold temperature. Both are essential to realize the dipolar superfluid and the BEC of tetramers. Specifically, we will • Realize a deeply degenerate Fermi gas of new species of 6Li87Rb molecules with flexible control of dipolar interactions via field-linked resonances that was recently demonstrated in my group. • Realize and explore dipolar p-wave superfluids featuring anisotropic pairing with non-zero angular momentum in polar molecule systems. • Realize and explore the Bose-Einstein condensate of tetramers which exhibits both strong dipolar and quadrupolar interactions, including the crossover/transition from a dipolar superfluid to a tetramer BEC. We propose DiMoBecTe at an exciting time when degenerate Fermi gases of polar molecules have finally become available in experiments, including degenerate NaK molecules attained in my group. It will provide a brand new platform to understand and design unconventional p-wave superfluidity with highly controllable interactions, and to realize Majorana modes in polar molecule systems and therefore pave the way towards topologically protected quantum computation. Furthermore, it will, for the first time bring polyatomic molecules into the quantum degenerate regime by creating a BEC of tetramer molecules.		需咨询NSFC项目联系人
281	Synthetic Chemistry and Materials	Aromatic Foldamer Mimics of B-DNA: Targeting the Alpha-Helix	LUDWIG-MAXIMILIANS-UNIVERSITAET MUENCHEN			Protein-nucleic acid interactions (PNIs) play a central role in biology and their control would enable long-desired biological interventions and future therapeutic applications. However, synthetic molecules that reproduce the overall shape and surface features of nucleic acids to interfere with PNIs have been lacking because, up to now, it has not been possible to design such extended and complex abiotic interactions interfaces. Due to their distinct chemical composition, predictable shapes, large size and conformational stability, aromatic oligoamide foldamers (AOFs) are prime candidates for breaking new ground in this field. FOLOF aims to develop AOF-based surface mimics of the B-DNA double helix targeted to the large ensemble of sequence-selective PNIs mediated by alpha-helices. Based on the PI's expertise in AOF science, FOLOF will proceed by 1) expanding the chemistry tool box to enable specific design objectives; 2) optimizing the automation of AOF synthesis for the fast delivery of long sequences; 3) identifying structural features of protein-foldamer complexes and specific foldamer features that make them outcompete DNA binding; 4) establishing protocols to iteratively improve protein binding affinity and selectivity for AOFs, and AOF-DNA covalent hybrids; and 5) developing computational tools for ab initio AOF-based DNA mimic design. Through a strategic combination of chemical synthesis, computational predictions, crystallographic structural analysis, binding studies, and screening tools, FOLOF will push the production of abiotic molecular mimics of nucleic acids to a completely new ensemble.		需咨询NSFC项目联系人

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282	Synthetic Chemistry and Materials	Design, Synthesis and Applications of Phospha(twisted)NanoGraphenes	UNIVERSIDAD DE CASTILLA - LA MANCHA		organic materials, organophosphorus materials, multifunctional materials, optical properties, heterocycles	Nano-Graphitic molecules (NGs) are pivotal for existing microelectronics and the development of emerging technologies: wearable electronics, artificial skins and nerves, etc. Their outstanding semiconducting properties rely on the efficient overlap of their carbon-scaffold and the spatial disposition of molecules. If we could twist the planar framework of NGs, diversify their pi-scaffold with heteroatoms, while keeping control over the molecular organization, we could modify their properties and access innovative materials with uncharted research opportunities for organic electronics. Through an innovative approach, I target to insert phosphorus heterocycles into (twisted)NGs as tools to tailor their properties and meticulously control their molecular arrangement. With Phospha(t)NGs, I will provide a highly versatile protocol for the preparation of novel, twisted phospha-NGs. Thanks to the unique chemistry of phosphorus, I aim at establishing an unconventional methodology to sequentially organize NGs into hierarchical architectures. My groundbreaking approach will lead to materials that were inaccessible to date as organophosphorus chemistry was too immature so far. Through an arsenal of spectroscopic techniques, I will achieve the first comprehensive investigation on the impact of heteroatoms into the twisting-induced properties of NGs. The outcomes of Phospha(t)NGs will have a wide range of applications. Here, I will test selected individual and assembled phospha-NGs as chiroptical materials and as prototypes of field-effect transistor sensors, laying the foundation for new research opportunities in material science. Thus, Phospha(t)NGs will consolidate the bedrocks for new, cutting-edge fields of research, whose development will clearly extend beyond the time-scale of this proposal.	material scientist, synthetic chemist, spectroscopist, device engineer	需咨询NSFC项目联系人
283	Synthetic Chemistry and Materials	Exciting Iron Catalysis: A route towards sustainable cross-couplings Enabled by Light	UNIVERSIDAD DE MURCIA	https://www.fjulialab.com	synthetic organic chemistry, photocatalysis, ligand to metal charge transfer, homogeneous iron catalysis	The manufacture of many high-value chemicals that sustain our daily lives depends on the ability of palladium catalysts to link together (cross-coupling) complex structural motifs. Yet, in view of the rapid increase of the price of palladium and its progressive depletion, it is crucial to invent alternative and more sustainable systems based on Earth-abundant metals to ensure the viability in the long term of these strategic processes that provide us with materials, agrochemicals or medicines. Iron is considered the most benign of transition metals because it is endless, inexpensive and biocompatible. However, despite its early discovery, iron-catalyzed cross-couplings have been underutilized owing to their narrower scope and the need for strong organometallic reductants or harsh conditions, which hampers their applicability in complex targets and densely-functionalized substrates. This proposal introduces a fundamentally new approach to overcome the issues that restrain the development of iron-catalyzed cross-couplings, exploiting the innate ability of iron complexes to harvest light and repurposing it to “activate” catalysis. Capitalizing on novel modes of reactivity accessed upon visible-light irradiation, this research programme offers a strategy to access key catalytically active iron species under mild conditions without the use of strong organometallic reductants, enabling unprecedented transformations with extended scope. ExCEL recruits charge-transfer excited states of iron complexes, providing access to Fe(I)/Fe(III) and Fe(0)/Fe(II) catalytic manifolds to achieve C–C and C–heteroatom bond formation as well as multicomponent reactions that are currently out of the reach of state-of-art iron catalysis. Overall, this proposal aims to introduce a new paradigm to upgrade and unleash the full potential of iron catalysis in organic synthesis, and will pave the way for the discovery of exciting new synthetic transformations.	synthetic organic chemistry, photoredox catalysis, methodology development, transition metal catalysis	需咨询NSFC项目联系人

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284	Synthetic Chemistry and Materials	Electrochemically Driven Organocatalytic Transformations of Alcohols, Thiols and Disulfides	KUNGLIGA TEKNISKA HOEGSKOLAN			The purpose of this research, set in the context of synthetic organic chemistry, is to develop unprecedented methods for electrochemically driven cleavage and subsequent functionalization of C–O and C–S bonds in alcohols, thiols and disulfides using organocatalysts based on phosphorus and sulfur. These radical methods will serve as keys to unlock the potential of the targeted compound classes as feedstocks for synthesis of functional organic compounds, e.g., pharmaceuticals, as well as for biomass valorization processes. Due to the complexity of the targeted transformations, the scarcity of available methods and the novelty of the outlined approach, the research will expand the synthetic toolbox, enable new retrosynthetic disconnections and late-stage (de)functionalization of, e.g., carbohydrates and peptides. Combined with the integrated mechanistic studies, the research will have a significant impact from a fundamental science perspective, as well as enable new synthetic applications. The project is divided into two main topics, each sized for one PhD student and one postdoc working together on the outlined work packages. The proposed research is supported by preliminary results that indicate its viability.		需咨询NSFC项目联系人
285	Computer Science and Informatics	Enhancing Protections through the Collective Auditing of Algorithmic Personalization	THE HEBREW UNIVERSITY OF JERUSALEM			The structure of the current data ecosystem carries grave threats to individuals' privacy and autonomy, facilitates discrimination, promotes social fragmentation, and threatens our ability to govern ourselves. Many of these concerns stem specifically from algorithmic personalization---the practice of providing individuals with personalized opportunities, information, or experiences, on the basis of their personal data and on patterns learned from others' data. Despite the urgency of the algorithmic personalization problem, the mathematical toolkit for studying and auditing for problematic algorithmic personalization remains extremely limited---particularly if we wish to do so in a manner that provides formal privacy guarantees. The goal of this proposal is to tackle this important problem head-on by establishing the mathematical foundations needed to study algorithmic personalization and to collectively audit personalization systems while guaranteeing privacy to participants. Such tools could transform our collective ability to make the best possible use of our data while ensuring autonomy, privacy, and overall positive social impact. My vision focuses on three core objectives: (1) building new mathematical concepts and definitions allowing us to articulate, prioritize, and study personalization-based problems, (2) addressing the key algorithmic challenges of privacy-preserving auditing of personalization systems, and (3) integrating deep understanding of the broader legal and ethical context into our approach. For each of these components, the proposal maps out a concrete research strategy, including preliminary steps that indicate the feasibility of this groundbreaking project.		需咨询NSFC项目联系人

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286	Systems and Communication Engineering	Spins in two-dimensional materials for tunable magnetic and optoelectronic devices	RIJKSUNIVERSITEIT GRONINGEN		spintronics, 2D materials, opto-spintronics, magneto-optics, spin laser, transition metal dichalcogenides, van der waals, heterostructures, spin-orbit torque	In order for modern information technology to continue progressing at a rapid pace we require smaller devices consuming less energy. Magnetic materials provide a promising route for nonvolatile memory devices. However, downscaling them is challenging, and information transfer between devices is hindered by short spin relaxation lengths, making it necessary to convert spin information into charge currents, leading to an increase in power dissipation. The aim of this ERC project is to exploit the properties of two-dimensional (2D) materials to combine highly-efficient magnetic devices with optical communication. Specifically, I propose to seamlessly integrate the unique and highly efficient spin-orbit torques (SOTs) of 2D semimetals with the excellent optical properties of 2D semiconductors. Low-symmetry 2D semimetals present SOT symmetries not seen in conventional devices. These are ideal for the control of perpendicular magnetic anisotropy ferromagnets as used in modern high-density memory devices, with the added advantage of their small size. Due to their reduced dimensionality, 2D semiconductors show strong light-matter interaction, efficient electric control over their optical properties, and low lasing thresholds. When combined, energy-efficient devices can be realized in which nonvolatile magnetic information is optically transported over very large distances. To achieve this goal, I will (1) create externally controlled all-2D SOT devices, (2) realize electric tunability of spins and excitons in 2D semiconductors, (3) demonstrate electrical spin injection in a 2D semiconductor with spin direction controlled using SOTs, and (4) develop externally controlled 2D spin LEDs and spin lasers. This project will pave the way for new generations of information technologies, addressing fundamental aspects along the way. It will enrich the van der Waals spintronics field and provide a new strategy towards energy-efficient data storage and transport at the nanoscale.		需咨询NSFC项目联系人
287	Systems and Communication Engineering	Model Completion through Nonlinear System Identification	TECHNISCHE UNIVERSITEIT EINDHOVEN		System Identification; Optimal Input Design; System and Control; Nonlinear Dynamics; Data-Driven Modelling	Systems and control engineers aim to master increasingly complex dynamical systems while including stronger performance, operational and energy constraints. As model-based control design remains the dominant paradigm, this results in an increasing need for nonlinear modeling. However, model interpretability and generalization capabilities form important roadblocks for a wide adaptation and applicability of nonlinear system identification methods. Strong prior knowledge is given by existing models, provided by system designers and engineers, even though they do not capture all the nonlinear dynamics of the real-life system. These models are currently not accounted for during black-box system identification. COMPLETE aims to develop a comprehensive nonlinear system identification framework to obtain accurate and interpretable models of measured complex system dynamics by completing an approximate pre-existing model through black-box nonlinear system identification. New theory and algorithms are put in place to 1) provide model structures, algorithms and theory that flexibly interconnect the pre-existing model and the black-box completion 2) ensure that data-driven completion models are interpretable and preserve key system theoretic aspects 3) data-driven experiment design strategies to detect, quantify and localize model errors at low experimental cost. These objectives are far beyond the actual abilities of system identification, lifting the model completion for dynamical systems from ad-hoc approaches to a systematic, flexible, theoretically supported framework. My leading expertise on structured nonlinear system identification, and recent proof-of-concept results ensure the feasibility of the project. The resulting system identification framework is applicable over a wide range of engineering disciplines (mechanical, electrical, biomedical) and provides system engineers with the necessary insight to guide them towards better solutions for tomorrow's industry.	System Identification; Optimal Input Design; Nonlinear Dynamics; Data-Driven Modelling	需咨询NSFC项目联系人

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288	Products and Processes Engineering	Piezoceutical biomaterial scaffolds for immunomodulatory-based myocardial repair	THE PROVOST, FELLOWS, FOUNDATION SCHOLARS & THE OTHER MEMBERS OF BOARD, OF THE COLLEGE OF THE HOLY & UNDIVIDED TRINITY OF QUEEN ELIZABETH NEAR DUBLIN	www.monaghanlab.com	tissue engineering, biomaterials, inflammation, myocardial infarction, metabolism, organoids, piezoelectrics	Cardiac injury in the form of a myocardial infarction leads to cardiac muscle death and replacement scar tissue that cannot compensate lost heart tissue. This disease does not improve with traditional drugs and places significant burden on healthcare budgets worldwide; with a reduced quality of life for patients, often leading to heart failure. Current engineered cardiac patches do not reduce inflammation and do not integrate in a sufficient manner to compensate the pumping power lost with the heart tissue. The PiezoMac patch differs fundamentally from patches reported up to now. It will contain an optimised piezoelectric capability that will yield electric fields generated by the stretching of the heart. This electric field stimulation will be optimised to drive immunomodulate and regeneration of the cardiac muscle. The shape of the patch is predesigned using finite element modelling to conform the directional dependent stretching of the heart wall; with information of patient anatomy and extent of heart attack damage derived from X-ray CT and MRI scans. These smart patches will be 3D printed (using melt electrowriting) into accurate microfibrous ordered patches whose density, micro-orientation and fibre laydown will be informed using in silico modelling of piezoelectric generation and mechanical anisotropy. We will shortlist candidate mesh designs to match the anisotropy of the heart using finite element analysis, and refine the design process using a Bayesian Optimisation approach to strike a balance between mechanical anisotropy and piezoelectric output, and ultimately halt cardiac deterioration. This pragmatic and rational approach gathers and advances cutting-edge technologies in this interdisciplinary project to address a significant unmet need in healthcare today.	tissue engineering, biomaterials, inflammation, myocardial infarction, metabolism, organoids, piezoelectrics, scaffolds	需咨询NSFC项目联系人
289	Products and Processes Engineering	Liquid Crystals in Flow: A New Era in Sensing and Diagnostics	MIDDLE EAST TECHNICAL UNIVERSITY		liquid crystals, microfluidics, sensors	Liquid crystals (LCs) are the delicate phases of matter that exhibit molecular order, fluidic nature and birefringent optical properties. LCs have been developed as materials suitable for energy- and label-free reporting of the chemical changes occurring at their interfaces such as the presence of biomolecular, gaseous or nano-/microscopic species, or the occurrence of the chemical or biochemical interactions/reactions involving these species. LC-water interfaces were employed in most promising sensors as a medium to facilitate the interaction of the LCs with the species. Although promising, the studies reported were limited to the stagnant LC systems, limiting their use in continuous sensing and diagnostic applications. This project is designed to open a new era in the sensing and diagnostic systems involving the use of LCs by introducing a microfluidic flow. The system of interest differs significantly from their counterparts with the introduction of LC-water interfaces that facilitates the exchange of analytical species during flow. However, the design of such system is challenging and critical understanding is required to proceed towards the next generation LCFlow platforms. We aim to design highly sensitive, dynamically tunable, and label-free LC based fluidic sensing platforms and therefore this proposal is structured to understand: 1) The effect of the presence of the "soft" interfaces and the LC interfacial anchoring on the flow regimes, and the LC director profiles, 2) The role of the type, scale, shape and the symmetry of the chemical heterogeneity at the contacting surfaces on the LC flow and configurations, 3) The dynamic influences of the changes occurring at the contact interfaces on the configuration and the optical appearance of the LC medium. The proposal is positioned at the intersection of fundamental knowledge generation and application. It is highly interdisciplinary in nature involving physics, chemistry, materials science and engineering.	microfluidics, liquid crystals, sensors	需咨询NSFC项目联系人

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290	Universe Sciences	Unveiling the origins of white-dwarf explosions	THE PROVOST, FELLOWS, FOUNDATION SCHOLARS & THE OTHER MEMBERS OF BOARD, OF THE COLLEGE OF THE HOLY & UNDIVIDED TRINITY OF QUEEN ELIZABETH NEAR DUBLIN		astrophysics, transients, supernovae, sky surveys	The explosive deaths of white dwarfs are essential in heavy element nucleosynthesis, galaxy feedback, and for understanding the evolution of binary systems. Type Ia supernovae (SNe Ia) are famous for their key role as cosmological-distance indicators and in the discovery of the accelerating Universe. Recent high-cadence surveys, and theoretical advances, have hinted that SNe Ia may not be the dominant way in which white dwarfs explode, with the potential existence of large populations of faint and rapidly evolving white-dwarf explosions. These unexplored classes of exotic transients may come from white dwarfs being torn apart by intermediate-mass black holes, mergers with neutron stars, or collisions in triple systems, but the mapping between explosions and observed transients is undetermined. This project aims at providing the first complete census of the multiple ways that white dwarfs explode by mapping their observations to their explosion physics and constraining their diversity. This sample will be crucial for defining optimal samples of SNe Ia for cosmology, as well as determining the rates and contributions of white-dwarf explosions to the origin of the elements. We will achieve this by i) obtaining the largest ever, rapidly discovered and spectroscopically confirmed sample, of white-dwarf transients with detailed follow-up observations, ii) the application of machine-learning techniques (e.g., neural-network emulators) for rapid comparison to sophisticated explosion models, and iii) the determination of the rates and diversity of their explosions in different galaxy environments. The confirmation and exploration of the multiple explosion channels for producing normal SNe Ia and exotic white-dwarf transients will have major implications for their nucleosynthetic yields, their use in cosmology, as well as predicting rates of double white dwarfs that will be detected in huge numbers in the Milky Way by the gravitational-wave detector, LISA.		需咨询NSFC项目联系人
291	Universe Sciences	Probing the Finely-resolved 100 TeV Gamma-ray Sky for Ultra-heavy Dark Matter	RUHR-UNIVERSITAET BOCHUM	https://epueschhe.github.io/	Dark matter, gamma-ray astronomy	Dark100 will shine a light into an underexplored dark matter particle mass range. Driven by recent theoretical developments, both in tools and motivation, Dark100 will search for dark matter particles between 100 TeV and several tens of PeV. Leveraging novel, cost-effective telescope technology, Dark100 will deploy an array of telescopes capable of probing dark matter annihilation, improving on the sensitivity of currently operating and planned gamma-ray instruments by an order of magnitude with unprecedented energy and angular resolution. Dark100 will build a unique dataset of deep gamma-ray observations of dark-matter-rich astrophysical systems. Dark matter will potentially be detected, or in the event of non-detection, limits on its velocity-weighted annihilation cross section will be set. For a non-detection, dark matter will be ruled out for part of the probed mass range and theoretical models constrained for the full probed mass range. The impact of Dark100 will be felt beyond the dark matter community. By demonstrating a new gamma-ray telescope paradigm, Dark100 will enable a range of possible astrophysical studies with gamma rays above 100 TeV, including searches for Galactic Pevatrons and transient events. Its public data archive will encourage synergy with other gamma-ray instruments. Dark100 takes advantage of a unique moment in theoretical and technological development that enables its pioneering science goals. While the theoretical motivation is fully developed and the technology is well-tested, the deployment of the Dark100 array and collection and interpretation of its observations is an ambitious project that demands the resources of an ERC consolidator grant. The PI's leadership in dark matter searches and gamma-ray analysis and simulation make her ideally suited to direct this program.		需咨询NSFC项目联系人

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292	Universe Sciences	Probing cosmic large-scale structure beyond the average	UNIVERSITAET BIELEFELD	http://cosmocora.de	cosmic large-scale structure, structure formation, galaxy surveys, dark matter, dark energy	The cosmic large-scale structure is entering a new ‘full space’ era with the launch of the Euclid galaxy survey satellite in 2023 coinciding with the first light for the Rubin Observatory. My proposal is centred on using galaxy surveys across a third of the sky as a laboratory for fundamental physics beyond the standard model by combining powerful theoretical models with exquisite data for galaxy clustering and weak gravitational lensing. To fully realise the potential of Euclid’s ‘full space’ galaxy survey, I will use my unique expertise in developing analytical, computational and statistical methods to predict and analyse the cosmic large-scale structure beyond the average. I will hunt for fundamental physics by going beyond the average probed by standard two-point analyses and unlocking additional information from novel clustering statistics sensitive to different density environments. I will provide new insights into dark matter dynamics and enable a field-based analysis by pioneering a particle-wave duality inspired phase-space technique that goes beyond the average effective fluid modelling. This will push forward modelling to a new level, overcome limitations of standard fluid and N-body methods, and enable the joint modelling of dark matter, baryons and massive neutrinos. My research program will unlock key insights into particle physics (by pinning down the total neutrino mass and potential wavelike properties of dark matter), the early universe (by constraining primordial non-Gaussianity providing hints for inflationary physics), gravity (by measuring the nature of dark energy and potential modifications of general relativity) and astrophysics (by determining the relationship between galaxies and dark matter). My expertise in developing analytical, computational and statistical methods for clustering dynamics and statistics and my leadership within the Euclid collaboration places me in a strategic position to lead such an ambitious research program.		需咨询NSFC项目联系人
293	Earth System Science	Evolution on the Nile: Faunal Regionalization and Continuity in the Pleistocene of Sudan	MUSEUM FUR NATURKUNDE - LEIBNIZ-INSTITUT FUR EVOLUTIONS- UND BIODIVERSITATSFORSCHUNG AN DER HUMBOLDT-UNIVERSITAT ZU BERLIN	https://amniota.org/paleonile/	Paleontology; Africa; Pleistocene; Sudan; Nile; Paleolithic archaeology	Over a century of paleontological investigation in Africa has revealed a rich Pleistocene fossil record that includes the evolution of hominins and their material cultures. However, the vast majority of fossil sites are located in the East African Rift Valley (EARV), and our knowledge is heavily skewed by this geographic bias. Poor continental geographic sampling means we lack an understanding of faunal regional variations, and the role of dispersal and geographic variation in the emergence of modern ecosystems. Furthermore, many have questioned the role of the Nile, the longest river in the world, in promoting faunal and cultural dispersal between Subsaharan and North Africa, and beyond to Eurasia. For decades such questions have been answered speculatively, with little data to stand on. PALEONILE is an ambitious project that will address these major gaps in our knowledge through large-scale surveys to reveal a new fossil record from the Middle Nile River Basin in Sudan. This project will test an overarching hypothesis of Pleistocene zoogeographic regionalization in the Nile Basin with respect to the EARV and surrounding areas, and will use an interdisciplinary array of paleontological, geological, geochronological, and archaeological approaches to reach its objectives. The geographic scale of the project is large and the techniques are cutting edge, including high-risk experimental methodologies such as paleobiomolecular recovery and new developments in sedimentary dating. PALEONILE forms the first ever large-scale systematic paleontological project to be conducted in Sudan, where the Cenozoic fossil record remains largely undiscovered, and its potential overlooked. PALEONILE will generate a new paradigm of zoogeographic dynamics and evolution in the African Pleistocene that represents a new synthesis of hydrographic, phylogenomic, archaeological, and paleontological evidence.		需咨询NSFC项目联系人

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294	Materials Engineering	A Research Platform Addressing Outstanding Research Challenges for Nanoscale Design and Engineering of Multifunctional 2D Materials	LINKOPINGS UNIVERSITET		materials design, 1D, 2D, synthesis, modelling, DFT, discovery, sustainability, energy, catalysis	Emerging materials science and nanoscale engineering spawn extraordinary structures. During my ERC-StG, I discovered a new family of internally-ordered 3D atomic laminates that I coined i-MAX. More recently, these phases have been used to derive a new type of 2D solids, MXenes, with ordered vacancies. Here, I consolidate research to establish a world-leading research environment with a mission to understand and exploit yet wider classes of unique functional materials; the next generation of 2D materials, beyond MXenes, from selective etching of recurring layers in 3D precursor solids. Fundamental investigations of this project have as objectives to: 1) Use a theory-assisted search, including screening of open data bases, for design of new multifunctional 2D materials. 2) Perform precise-controlled synthesis/derivation of novel 3D/2D materials based on chemical exfoliation. 3-4) Explore nanoscale engineering and property tailoring, specifically targeting 2D materials for energy storage, catalysis, and other areas where low-dimensional solids can provide unique and sustainable solutions. 5) Provide proof-of-concept for novel materials in device applications. Research breakthroughs and corresponding societal impact are envisioned as novel 2D materials provide superior properties in devices made from sustainable elements and processing. Functionalized freestanding sheets of new 2D materials are expected to have a major impact on supercapacitors and batteries, and as a catalytic material, realizing efficient hydrogen evolution. Initial results attest to this. Pioneering a new generation of 2D materials holds exceptional potential for discoveries, for use in applications meeting global challenges pertaining to energy and environment, and beyond. My experience as an international research leader gives me confidence to take on this greater challenge for innovation. Thus, an outstanding research constellation can be constituted, delivering groundbreaking research.		需咨询NSFC项目联系人
295	Materials Engineering	Biomimetic eXtremely-Birefringent Organic Optical Materials and devices	WEIZMANN INSTITUTE OF SCIENCE		Organic crystals, Planar optics, Extreme birefringence	Man-made organic optics relies almost exclusively on amorphous polymers. These cheap, readily processable and highly versatile materials, however, offer a relatively low refractive index, dramatically limiting their ability to generate the high-index contrast necessary for producing scattering layers, photonic crystals and efficient dielectric reflectors. We here propose to establish a new class of novel organic crystalline optical materials and devices by drawing inspiration from the highly birefringent high-index organic molecular crystals nature has to offer, such as those found in dielectric reflectors, photonic crystals and photonic glasses that take part in structural coloration and vision. The crystal structure of these materials, is based on a planar arrangement of hydrogen bonded molecules, which are weakly bound by van-der Waals bonds and weaker hydrogen bonding. The BoX-BOOM project aims to identify new cheap, functional and environmentally benign organic crystalline optical materials inspired by this structural motif, exhibited in biological systems, and to develop ways to grow them in a controllable manner as thin films using surface guided growth. The grown material will in turn be used in new types of optical elements and devices for a broad range of applications such as flat polarization optics, transparent dielectric metamaterials and birefringent volume holograms, all exploiting the high index and extreme birefringence of these materials. Work performed within the BoX-BOOM project will also shed light on the relationship between crystal structure and optical properties of this family of materials, setting the stage for identification of new high-index organic crystalline compounds and a range of applications taking advantage of this new thin-film optical technology.		需咨询NSFC项目联系人

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296	Individuals, Markets and Organisations	Rural Structural Transformation in Developing Countries	FUNDACIO PRIVADA BARCELONA GRADUATE SCHOOL OF ECONOMICS	https://sites.google.com/site/andregroeger/erc	Developing countries, structural transformation, rural communities, agricultural productivity, farm investment, factor allocation, labor reallocation, skill selectivity, migration, climate change, agricultural adaptation, rural development	A key feature of economic development is structural transformation characterized by spatial and sectoral labor reallocation out of agriculture. Despite clear evidence of rural-urban migration flows in developing countries, recent contributions show persistently lower productivity in agriculture compared to other sectors and large disparity in agricultural productivity across space. This points to the key question of this proposal: “why do so many workers remain in agriculture”? There is a pressing need for reliable answers to this question as rural areas host large shares of the population, facing high agricultural risk and poverty incidence. Any effective poverty eradication policy, such as those envisioned by the UN’s Sustainable Development Goals, must therefore necessarily focus on rural development. RUSTDEC will obtain novel answers to this key question by combining innovative micro panel data from Sub-Saharan Africa and Southeast Asia with an array of geospatial data on rural areas, exogenous variation in agricultural productivity, and quantitative theoretical models. The project employs remote-sensing and computer vision methods for generating community data as well as quasi-experimental and structural estimation techniques for rigorous causal estimation to pursue three major objectives: (i) provide first evidence on the role of dynamic adjustments in agricultural production for explaining the agricultural productivity gap and the magnitude of factor (mis-)allocation; (ii) dissect the microeconomic anatomy of spatial and sectoral labor reallocation and skill selectivity within and across rural communities; and (iii) identify the historic and future impact of climate change on agricultural production, adaptation, and rural development and its implications for the productivity gap. These objectives address three well-defined gaps in the literature, each going beyond the specific state-of-the-art and with the potential of generating ground-breaking impact.	Developing countries, structural transformation, rural communities, agricultural productivity, farm investment, factor allocation, labor reallocation, skill selectivity, migration, climate change, agricultural adaptation, rural development	需咨询NSFC项目联系人
297	The Social World and Its Diversity	Leveraging Early Adolescence for Development: Longitudinal and Experimental Evidence from Ghana	UNIVERSITAT DE BARCELONA		child and adolescent development; survey; Ghana; social-emotional skills; academic skills	Early adolescence is a key window for human development. Strategic timing of interventions during this life stage may seize opportunities and prevent risks; bolster the impact of earlier investments; and ease damages from previous adversity. Yet evidence on whether such programs can fulfil this potential, for which children, and through which channels, is scant, especially in low-resource settings, where 90% of the world’s 1.2 billion adolescents live. I will tackle these gaps by relying on a cohort of ~2,500 children approaching early adolescence. In 2015, this sample participated in a trial evaluating quality preschool education in Ghana and has been followed-up since: the program improved child development through middle childhood. I will re-randomise this sample at 12 years to test a parenting skills program to enhance early adolescent development through improved parenting support and parent-adolescent interactions. Children and parents will be re-interviewed when children are 13, 15, and 17 years through mixed-method data collection. Outcomes include adolescent social-emotional and academic skills, health (including stress biomarkers), and adult-life transitions. This data will allow testing dynamic complementarities between interventions during early childhood and early adolescence, or whether interventions in adolescence might compensate for earlier adversity in the short- and longer-term. Methodologically, these questions can be convincingly studied only if data are available for the same individuals over time, and if variations in exposure to early childhood and early adolescence programs are exogenously driven. This is the first study that addresses both requirements, providing a breakthrough. Heterogeneity by child gender and socioeconomic status, and mechanisms are further research foci. LEAD’s high-risk components are well-balanced by my in-depth knowledge of the field, methods, and study context, with high potential for scientific and societal impact.	child and adolescent development; economics; Ghana; social-emotional skills; academic skills	需咨询NSFC项目联系人

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298	The Human Mind and Its Complexity	The acquisition of new meanings through novel word learning	UNIVERSITA' DEGLI STUDI DI MILANO-BICOCCA	https://braveewword.unimib.it/	novel words; distributional semantics; psycholinguistics	We learn new words almost on a daily basis: as adults, a new element is introduced in our vocabulary every other day. With new words, we also learn about new objects and ideas - in most cases new words are not simply additional labels to be applied to familiar objects: they connote meanings that are unknown to the speaker of a language. However, when we experience, as adults, an unfamiliar word, typically its referent is not immediately available in the same context. How then can language, by itself, constitute such a reliable instrument for the acquisition of novel meanings? What do we exploit to induce new meanings on the basis of an unfamiliar sequence of sounds or graphical elements? BraveNewWord addresses these questions in an innovative multidisciplinary perspective, combining cutting-edge proposals from computational linguistics and empirical investigation techniques from experimental psychology and cognitive neuroscience. BraveNewWord posits three main sources for lexically-driven meaning acquisition: linguistic context, word structure, form-meaning mapping. The project advances a computational framework that models these mechanisms through data-driven, psychologically plausible distributional systems trained on examples of natural language usage. The quantitative characterizations and algorithmic definitions offered by these models constitute, in turn, the basis for BraveNewWord large-scale empirical investigation, involving both behavioral (reaction times, mouse-tracking trajectories, diachronic language changes) and neuroscience data (event-related potentials, neuroimaging). With its innovative perspective and advanced computational and empirical approach, BraveNewWord will constitute a non-incremental contribution to understanding how human speakers use new lexical information as a mean for enriching their semantic system, and provide a ground-breaking perspective on the cognitive processes relating language and thought.	cognitive modelling; computational psycholinguistics; distributional semantics	需咨询NSFC项目联系人
299	The Human Mind and Its Complexity	Empirical and mechanistic foundations for synergistic predictive processing in the sensory brain	BCBL BASQUE CENTER ON COGNITION BRAIN AND LANGUAGE		cognitive neuroscience; predictive processing; bayesian brain; subcortical; auditory pathway	Humans effortlessly process over 200 spoken words per minute in casual conversation. Speech recognition algorithms still fail at this challenging task. Our superior performance stems from our capacity to predict what the speaker may say next. Understanding how the brain uses these predictions to process the sensory input is crucial to understand perceptual function and dysfunction: dyslexia, autism and psychosis have all been linked to an impaired handling of predictions. Hierarchical predictive coding (HPC) is the current leading framework to understand how predictions help us processing sensory inputs. However, HPC is only compatible with the function and organisation of the cerebral cortex. This is a decisive shortcoming: while only cortical stages have the foresight to perform conceptually accurate predictions, only subcortical stations have the temporal properties required to correctly process fast sensory inputs. SynPrePro will reformulate HPC as an integrated theory explaining how cortical and subcortical stages work together to proficiently process fast and complex sensory inputs like speech. I will use a unique experimental-theoretical approach to study the human auditory pathway as a model for sensory pathways in four work packages (WPs). WP1 will use cutting-edge human neuroimaging to unravel the implementation of HPC in the auditory pathway. WP2 will use innovative model-based neuroimaging to identify the mechanisms responsible for the generation of conceptually accurate and temporally precise predictions. In WP3 I will develop a ground-breaking computational model to identify the neural mechanisms implementing HPC in the thalamocortical loop. WP4 will use big-data analytics to disentangle how cortical and subcortical stages work together to swiftly process speech. The outcomes will turn the cortical paradigm of HPC into an integrated theory of cortico-subcortical interactions, revolutionising our understanding of perceptual function and dysfunction.		需咨询NSFC项目联系人

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300	Cultures and Cultural Production	Avatar agency. Moral responsibility at the intersection of individual, collective, and artificial social entities in emergent avatar communities.	UNIVERSITATEA DIN BUCURESTI	https://avataresponsibility.ccea.ro/	avatars, moral responsibility, Large Language Models, agency, experimental moral philosophy	This project investigates how avatar agency impacts practices of ascribing moral responsibility in emergent avatar communities (Metaverse, augmented Metaverse, and Human-Cybernetic Avatar societies). These communities challenge traditional frameworks of agency and moral responsibility. The unprecedented persistent and continuous use of multiple avatars by both humans and organisations, has the potential to permeate prior boundaries of the physical, the augmented and the virtual world. We propose a dynamic normative framework of ascribing moral responsibility that is grounded in a philosophical conceptualisation of avatar agency. This framework considers the way interactions between avatars, individuals, and organisations generate intertwined and mutual ascriptions of moral responsibility, potentially enhancing or, on the contrary, diminishing human agency and responsibility in emergent avatar communities. We construct our approach along five main objectives: 1) to clarify avatar agency and related responsibility pertaining to individual, organisational, and artificial members of emergent avatar communities; 2) to delineate the way avatar agency enhances or restrains individual agency and responsibility; 3) to correlate the way interactions between social entities in avatar communities generate mutually enhancing (or perhaps decreasing) ascriptions of moral responsibility to all participants; 4) to evaluate the extent in which the ethical characteristics of the community environment can generate normative attributions of responsibility; 5) to project normative evaluations of blaming and praising practices in avatar communities. The successful delivery of this ethical framework is an original contribution to the problem of moral responsibility and bears direct implications for future regulation, impacting societal moral practices of accountability and blaming.		需咨询NSFC项目联系人
301	The Study of the Human Past	Expanding our understanding of human evolution through pleiotropy	CENTRO NACIONAL DE INVESTIGACION SOBRE LA EVOLUCION HUMANA	https://www.lesleahlusko.org/the-erc-project-tied2teeth/	evolution, paleontology, quantitative genetics, primates, dentition, human variation, dental	Teeth dominate the fossil and bioarchaeological records because they consist mostly of inorganic material. Consequently, dental anthropology has long been essential in our investigation of the human past. Variation in the anatomy of teeth is instrumental for differentiating species, identifying biological affinities between populations, making inferences about dietary adaptations, and timing key developmental life stages. However, recent advances in genetics, genomics, and developmental biology undermine many assumptions built into anthropologists' study of the dentition by revealing extensive pleiotropy—when one gene influences more than one anatomical structure simultaneously. However, this is not a setback but rather an advantage. In this project, we will use the pleiotropies that involve teeth to open windows to the evolution of human anatomies far beyond the dentition. I will employ three methodological approaches that utilize pleiotropy to probe different aspects of human paleobiology. The first approach will use quantitative genetic analyses to calibrate the extent to which cranial evolution is genetically correlated with dental evolution. In the second approach, we will employ large historical morphological datasets combined with the modern insight from genome-wide-association-studies (GWAS) to explore how the evolution of soft-tissue anatomy may have driven changes in the dentition. Finally, we will turn to the fossil record. Using traits that were defined using a pleiotropic approach, we will test the hypothesis that environmental selection influenced dental variation during two key time periods within the evolution of genus Homo. This project modernizes the study of the human past by incorporating the phenomenon of dental pleiotropy. By combining these three different approaches and a range of time scales, we turn the conundrum of pleiotropy into a powerful tool for studying human evolution.		需咨询NSFC项目联系人

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302	The Study of the Human Past	Network epistemology in practice	TECHNISCHE UNIVERSITAT BERLIN	https://cordis.europa.eu/project/id/101044932	history and philosophy of science, computational humanities, collective knowledge generation, born-digital sources	The present project will contribute to research in the history and philosophy of science through extensive use of state-of-the-art tools from the digital humanities. The project will focus on an investigation of recent research practice in particle physics at the European Center for Nuclear Research (CERN) in order to gain a better understanding of how knowledge is generated and validated in very large scientific collaborations. The main working hypothesis of the project is that collective research processes can be characterized, in epistemologically relevant terms, through a bird's eye view analysis of the collaboration's internal communication. The internal communication will be reconstructed from born-digital documents (e-mails, internal wiki pages, etc.) which accrue in the research practice of the collaboration. Abstracting from the case study, the project will also develop historiographic guidelines that can be transferred to future epistemological studies of modern scientific collaborations. Last but not least, the project will contribute to the philosophy of collective knowledge generation, in particular to recent issues in "network epistemology", by adapting the theoretical models to better fit important real-world cases. Until recently, it was nearly impossible to capture large-scale and complex research processes, such as the ones at CERN, and make them accessible for epistemological analysis. Almost all the studies of the research practice at CERN or similar cases have so far been restricted to the analysis of published articles, selected interviews and participant observation. Accompanied by historiographic guidelines and practical strategies (both of which are lacking at the moment) for best practices in the history and philosophy of science based on born-digital sources, the application of digital tools and computational methods may finally help us attain a maximally comprehensive picture of recent research practice in particle physics and beyond.		需咨询NSFC项目联系人

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303	The Study of the Human Past	Overcoming the frontiers of biomolecular studies on human history and adaptation using palaeoproteomics	KOBENHAVNS UNIVERSITET		palaeoproteomics, human evolution, palaeontology	BACKWARD will address major unsettled debates about African and Asian extinct hominid phylogeny, by developing and deploying a new generation of palaeoproteomic workflows, relying on the most advanced mass spectrometry and bioinformatic solutions currently available. Ancient DNA (aDNA) sequencing revolutionised our knowledge on evolution, migration and admixture of archaic and anatomically modern humans. However, no hominid aDNA older than ~0.4 million years has been retrieved yet. Ancient proteins instead survive much longer than aDNA, enabling molecular-based phylogeny beyond the limits of aDNA degradation. Recently, mass spectrometry (MS)-based ancient protein sequencing, i.e. palaeoproteomics, convincingly demonstrated its transformative value, enabling molecular-based evolutionary reconstructions for species that went extinct millions of years ago. BACKWARD will use palaeoproteomics to address: (i) the phylogenetic relationships among South African early hominins, and (ii) the hominid palaeobiodiversity in Southeast Asia; two topics debated for generations, and further complicated by recent finds. This knowledge will also provide the evolutionary scaffolding needed to correctly identify and correlate the series of processes that defined human brain expansion and reorganization. BACKWARD will also screen large sets of morphologically non-informative isolated fossil fragments of bones and teeth, to identify the species and sex of the organism from which they originated. Some of these solutions will be commercially re-purposed to deliver superior performance in public and private analytic laboratories for diagnostics in forensic medicine, and in the food or pharmaceutical industry. As a key BACKWARD feature, the unique contribution provided by each participating institution will be integrated in a strong partnership to transform palaeoanthropology, palaeontology, palaeoecology and archaeology once again, as aDNA did over the last twenty years.	mass spectrometrist, palaeontologist, palaeoanthropologist	需咨询NSFC项目联系人

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304	Human Mobility, Environment, and Space	Is there a PERENNIAL future of agriculture?	LUNDS UNIVERSITET	https://www.lucsus.lu.se/research/research-themes/land-use-governance-and-development/perennial-agriculture	agriculture, domestication, novel perennial grain, political economy	PERENNIAL will investigate whether a shift from annual to perennial grain crops as the basis for food production is possible, and identify the major opportunities and obstacles for such a “perennial revolution”. Since the Neolithic Revolution the world food system has been dominated by annual crops (cereals, legumes, and oil seeds) covering 70% of global croplands. The use of annual plants disrupts agro-ecological processes every season, resulting in soil erosion, nutrient losses, and greenhouse gas emissions from machinery and soils. The costly practices of managing annuals, including a strong dependence on herbicides and mineral fertilisers, partly explain the high indebtedness and low returns in agriculture. A shift from annual to perennial grains that are planted once and harvested for many consecutive years, could revolutionise agriculture and revitalise rural society. It could solve problems associated with annuals and increase the potential for adaptation to climate change. Advances in plant breeding have shown that a shift to perennials is possible within a few decades, but it would challenge powerful vested interests. To investigate the prospects of a perennial revolution, we will: a) conduct a systematic critique of the current political economy of agriculture, b) suggest desirable, viable, and achievable perennial alternatives to annual monocultures, and c) develop a strategy for change. We complement social science expertise with that of plant breeding, agro-ecology, soil, and plant science. Social Fields Theory is applied to study the political economy of agriculture including the politics of seeds and agrochemicals and Soil Health theory to suggest alternatives. We then incorporate ecological feedbacks to develop an Agricultural Treadmill Theory and apply Transition Theory to study social change. Using mixed methods, we will conduct discourse analysis, network analysis, and modelling at multiple scales including farms, river basins, and jurisdictions.		需咨询NSFC项目联系人
305	Synergy	The Cultures of the Cryosphere. Infrastructures, Politics and Futures of Artificial Cooling	TECHNISCHE UNIVERSITAT DARMSTADT	https://cryocultures.org	humanities, social sciences, food, environment, biomedicine, data studies, infrastructure, cooling, cryopreservation, sustainability,	Artificial cooling fundamentally shapes the world in which we live. Since the onset of the Cold War, cooling and freezing technologies have become increasingly vital for a wide array of everyday practices, from nutrition, health and reproduction to dwelling, telecommunication, scientific research and economic productivity. A global system of cold storages, cold chains and air-conditioned spaces has become an energy-intensive yet barely considered planetary infrastructure: an “artificial cryosphere”. Artificial cold has drastically restructured life both on a biological and social level, yet the far-reaching impact of this technology is still largely unexplored and unresearched. Recent studies estimate that global cooling demand will increase five-fold by 2050, dramatically exceeding our future energy budget and urgently calling for change. CultCryo argues that avoiding the impending global cooling crisis will be impossible if we do not understand how the planetary infrastructure of artificial cold is deeply interwoven in cultural practices. Thus, in order to analyze the constitution of “ cryogenic cultures”, we will undertake four interdisciplinary multi-sited case studies in the domains of food supply, air conditioning, biomedicine and computing. We develop innovative approaches using mixed-methods rooted in the history of technology, geography, digital history of concepts, ethnography and the philosophy and ethics of technology. Breaking ground for an innovative interdisciplinary field of research, CultCryo will provide the first geographical mapping of the cryosphere, a historical reconstruction of its emergence, an ethnographic account on its cultural constitution, and a philosophical analysis and ethical assessment of its underlying norms and values. Thereby, we develop a corpus of urgently needed knowledge to critically analyze a pressing global phenomenon while also identifying alternatives towards a more sustainable future of artificial cold.	history, philosophy, science and technology studies, geography, anthropology, cultural studies, language technology, data studies,	需咨询NSFC项目联系人

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306	Synergy	Material Minds: Exploring the Interactions between Predictive Brains, Cultural Artifacts, and Embodied Visual Search	CHRISTIAN-ALBRECHTS-UNIVERSITAET ZU KIEL		social archaeology , cognitive archaeology	Do the worlds we build alter our own minds and the ways we process information? Do the material structures of our settlements, buildings, roads, and artefacts actively change patterns of thought and attention, so that understanding change in these 'material codes' becomes part and parcel of understanding the emergence of the modern mind? To answer these questions XSCAPE brings together a unique team from archaeology, vision science, and cognitive philosophy. Using a carefully curated set of materials, spanning a range of cultures and a wide sweep of historic and contemporary settings, we aim to test, for the first time, the hypothesis of materiality-driven cognitive change. To this end we will use a new synergistic methodology that combines multiple real-world case studies with state-of-the-art visual neuroscience, and simple agent-based simulations. The practical core of the project comprises a series of 41 different world-wide case studies. Together, these will constitute the largest ecological experiment on embodied visual perception ever attempted. A successful Pilot Study (described in detail in the main text) using eye-tracking analysis as applied to the visual exploration of archaeological artefacts already demonstrates the scientific and practical feasibility of our approach. For the simulations, we will use the emerging paradigm known as 'active inference' which describes a principled means of linking perception, attention, and actions (including eye-movements) with cognitive change and learning. This will deliver insights into the fundamental principles that may be guiding materiality-driven cognitive change. Using this unique combination of archaeological materials, visual neuroscience, and simulation- based studies, XSCAPE will deliver the first fully-integrated framework for understanding the potent yet ill-understood cycles by which we humans make and transform the landscapes, practices, and artefacts that make and transform our minds.	archeology anthropology paleoecology	需咨询NSFC项目联系人
307	Synergy	On intelligenCE And Networks	UNIVERSITE PARIS DAUPHINE	https://oceanerc.com	federated learning, Bayesian sampling, privacy, adaptive decision making, adversarial behaviours	Until recently, most of the major advances in machine learning and decision making have focused on a centralized paradigm in which data are aggregated at a central location to train models and/or decide on actions. This paradigm faces serious flaws in many real-world cases. In particular, centralized learning risks exposing user privacy, makes inefficient use of communication resources, creates data processing bottlenecks, and may lead to concentration of economic and political power. It thus appears most timely to develop the theory and practice of a new form of machine learning that targets heterogeneous, massively decentralized networks, involving self-interested agents who expect to receive value (or rewards, incentive) for their participation in data exchanges. OCEAN will develop statistical and algorithmic foundations for systems involving multiple incentive-driven learning and decision-making agents, including uncertainty quantification at the agent's level. OCEAN will study the interaction of learning with market constraints (scarcity, fairness), connecting adaptive microeconomics and market-aware machine learning. OCEAN builds on a decade of joint advances in stochastic optimization, probabilistic machine learning, statistical inference, Bayesian assessment of uncertainty, computation, game theory, and information science, with PIs having complementary and internationally recognized skills in these domains. OCEAN will shed new light on the value and handling of data in a competitive, potentially antagonistic multi-agent environment, and develop new theories and methods to address these pressing challenges. OCEAN requires a fundamental departure from standard approaches and leads to major scientific interdisciplinary endeavors that will transform statistical learning in the long term while opening up exciting and novel areas of research.	optimization, decision-theory, approximate Bayesian inference, scalable MCMC	需咨询NSFC项目联系人