Research Foundation – Flanders

Results Odysseus programme 2022

29/03/2023

Granted TYPE I

Project number	Researcher	Title	Host institution	Granted budget
G0DBG23N	Coulembier Kevin	Universal geometry and tensor categories	UGent	€ 2.445.000
This project will exploit recent surprising advances in category theory to develop radically new theories generalising classical geometry, carrying greater potential for various applications. More concretely, this project will make progress in the fields of 'generalised geometry' and 'tensor categories' by establishing new connections between the two. During the last century, developments in particle physics led to a generalised notion of symmetry or geometry, known as 'super symmetry' or 'super geometry'. An independent parallel development in mathematics saw this super symmetry also appearing in the theory of tensor categories. Recent breakthroughs in the latter theory by the principal investigator and his collaborators have uncovered the existence of an infinite new family of tensor categories which we will use to develop new notions of geometry, further generalising super geometry. This project will develop these geometries via a new universal approach, apply them in the ongoing study of tensor categories and open new possibilities for further applications in areas as diverse as cryptography, algebraic topology or theoretical physics.				
G0DCB23N	Prinzie Peter	Emerging Adulthood: The Time of Your Life	UGent	€ 4.045.100
We're happy, free, confused and lonely at the same time. It's miserable and magical (Taylor Swift, “22”). Emerging adulthood is a critical juncture in human life with unique challenges that are mastered successfully by most people but not by all. First, this project will describe how individual differences in personality and parenting are related to heterogeneity in (mal)adjustment during emerging adulthood. I expect that the interplay of (changes in) personality and parenting is meaningfully related to a variety of important developmental outcomes. Second, I also aim to explain heterogeneity in (mal)adaptation in emerging adulthood by examining crucial mediating and modifiable psychological processes explaining these relations. I expect that emotion regulation and identity commitment are key mediators. The integration of a lifespan (macro-time level) perspective and a dynamic systems (moment-by-moment micro-time level) perspective measuring within-person variability will greatly extend our understanding of why young adults progress along different trajectories. Finally, I aim to predict successful transition to emerging adulthood by developing, implementing and evaluating an RCT intervention focusing on emotion regulation or identity using Virtual Reality, aimed to facilitate a successful transition to emerging adulthood. Ultimately, results from this project can provide young people tools that help them to experience emerging adulthood as the time of their life.				

Granted TYPE II

Project number	Researcher	Title	Host institution	Granted budget
G0DCE23N	Bardi Lara	The effect of social interaction on individual cognition	UGent	€ 841.108

Over the last decade, an increasing amount of work has revealed how individual cognition is influenced by the presence of others, irrespective of whether others' perspectives and mental states are relevant to our current. Not only do we rapidly identify others in our environment, but we seem to spontaneously track others' perspectives and mental states without being aware of it. Although evidence for this phenomenon have been accumulated at the level of behavior, the neural mechanisms supporting the effect of others on individual cognition are far from being understood. The project will use a combination of various neuroscientific methods, including electrophysiology, neuroimaging and brain stimulation to understand how and why the presence of others affect the way we perceive and represent the world around us. Going a step forward, we will try to gain insight into the functional role of the other's influence on individual cognition. The project will answer the following question: Do the presence of a second observer directly impact individual perception? Are mental states of others represented in a similar why as our own mental states? Does implicit tracking of others promote learning during childhood? The results of the project will have a great impact in developmental psychology, in the field of education and in the clinical field with implications that transcend the basic science.

G0D9323N	Barros Ignacio	New birational invariants and the geometry of moduli spaces	UAntwerpen	€ 800.304

Algebraic geometry is the study of algebraic varieties. Moduli spaces are universal varieties, they parameterize all varieties of a certain kind. We aim to develop a better understanding of the new birational invariants measuring irrationality in the context of moduli spaces. Moduli theory is central in modern algebraic geometry with uses that go beyond mathematics. We investigate important moduli spaces from the point of view of birational geometry. We put special focus on recently constructed moduli spaces such as those of hyperkähler varieties with a Lagrangian fibration as well as strata of differentials, where almost nothing is known about their birational complexity. Determining if a variety is 'rational' (as simple as it can be) is a famously hard problem. On the opposite side, when a variety is of 'general type' (as complicated as it can be) not much is known about how to distinguish them from each other. Most moduli spaces fall into this category. In the last five years, a new set of invariants known as 'measures of irrationality' have attracted special interest. They will play a crucial role in understanding the geometry of moduli spaces and their complexity. We study these questions on concrete recently constructed collections of moduli spaces that have deep connections with modular forms and dynamics.

G0DBH23N	Hoijtink Marijn	Platform Wars: Technology, Politics and Law on the Automated Battlefield	UAntwerpen	€ 812.370

Platform companies such as Alphabet-Google, Meta en Amazon are central to recent transformations affecting our social relations, business transactions and governmental decisions. These same companies are also increasingly affecting how our wars are 'thought', fought and lived. However, their exact role within warfare remains poorly understood. My project introduces the novel concept of "platform wars" to theorize how platform companies propel new ways of thinking about and organizing political violence. Through my conceptualization of platform wars, I investigate how these emerging corporate-military networks produce new and shared ways of (i) thinking about, (ii) practicing, and (iii) regulating political violence. My project produces innovative conceptual knowledge, but it also delivers rich empirical knowledge on the social interactions between corporate and military actors, and how these shape new technologies and practices of warfighting. This knowledge is highly relevant from a political and ethical-legal perspective and crucial in order to intervene in the future regulation of these technologies and their use in armed conflict.

G0DCR23N	Mondini Sara	The Mosques of Kerala: Artistic Vocabularies in the Identity-Building of Muslim Communities	UGent	€ 938.408

The project aims to study the mosques on the Malabar coast of India in the period that ranges from the initial spread of Islam in this region to the late 19th century. The research promises to be extremely innovative since the production in question has been generally neglected by studies and only some of these structures have been published. From a scholarly perspective, these mosques are of great interest for a variety of reasons: some of them are among the oldest mosques in India; their construction would appear to be connected to the first communities of merchants settled in the region and generally they display a unique style borrowed from other Muslim regions and fused with elements drawn from local vernacular and temple architecture. A full and exhaustive understanding of the monuments in question, from both a stylistic point of view and in terms of the context in which they were erected and developed, would have a remarkable impact on our knowledge of both art-historical scenarios, in the region and in the Islamic world, and socio-religious scenarios, enabling us to understand patronage patterns, socio-cultural dynamics and exchanges across the Indian Ocean. The research would also contribute to preserve these monuments against increasing attempts to destroy or alter them: only by understanding their development over the centuries will it be possible to grasp the redefinition of their patrons' identity and of the religious communities associated with them.

G0DBO23N	Siyushev Petr	Spin-Photon Interface for Quantum Networks	UHasselt	€ 966.008

The goal of the EU is to become a leader in the development of quantum technologies to strengthen the economics. The quantum communication is one of the pillars of this important goal and comprises fundamentally secure communication with distributed quantum computation and sensing. The most promising platform to achieve this goal is color centers in diamond. For example, it has been already shown that nitrogen-vacancy (NV) center coupled to nuclear spins can constitute small quantum register and even can transmit quantum information over kilometer range. NV has very bad optical properties making it extremely hard to use beyond proof-ofprinciple demonstration. Alternative color centers (group-IV defects) offer very good optical properties, however, to fully access their potential, they have to be embedded into nanophotonic cavities. Only then the communication rate can reach the value acceptable for practical use. This proposal aims to develop nanophotonic cavities with deterministically incorporated group-IV defects, thus overcoming current bottleneck for further development of quantum communication networks. The intended approach use advantage of possibility to generate photonic cluster states, which mitigates transmission loss combined with enhance communication rates. This work aim for a hardware for quantum communication infrastructure.

G0DBZ23N	Tewodrose David	Geometric and analytic properties of metric measure spaces with spectral curvature constraints, with applications to manifold learning	VUB	€ 798.608

Geometric analysis is the study of the interplay between the geometric features of a space, like its curvature, its diameter, or the length of its minimal curves, and its analytic features, such as the heat propagation or the frequencies of its vibration. This project focuses on three aspects of geometric analysis. The first one is the study of a class of singular spaces, called Kato limit spaces, obtained as limits of smooth Riemannian manifolds satisfying a uniform spectral constraint on the curvature; such limits appear naturally in geometric evolution problems like Ricci flow or mean curvature flow. The second one is the study of spectral optimization problems on a given smooth manifold; these problems are closely related to the construction of geometrically meaningful representations of the manifold as a subset of a simple ambient space. The third aspect consists in setting up and implementing new machine learning algorithms for datasets whose underlying geometry satisfies suitable geometric constraints.

G0DCM23N	Van Belleghem Steven	Characterizing developmental mechanisms of plasticity and their importance in adaptation to rapid environmental change	KU Leuven	€ 962.508
Understanding the molecular details of how organisms adapt to changing environments remains a prime challenge in biology. Developmental plasticity, which enables organisms to adjust their phenotype in response to environmental cues within a single generation, is particularly important in this process. Although the adaptive significance of such a response is generally recognized, the underlying molecular mechanisms and how they evolve remain highly elusive. Fortunately, novel genome methods enable the study of the mechanisms that orchestrate the development of plastic phenotypes. My aim is to integrate these novel methods into evolutionary studies that test the importance of plasticity in the process of long-term adaptation to changing environments and the resulting genetic adaptation. Specifically, I will test a mechanism by which genetic diversity is masked in populations that plastically express alternative phenotypes and how this plasticity may precede genetic adaptation - a contentious but undemonstrated theory called 'plasticity-led evolution'. I will perform these experiments on the water flea Daphnia, an established model system for plastic development. Understanding genes involved in plasticity and how they interact with the process of genetic adaptation has the potential to offer insights into the very essence of life and to provide various applications in biotechnology, medicine, and mitigation of species loss under extreme environmental change.				
G0DCP23N	Verstraeten Inge	Early signaling upon phosphate-depletion in plants (PiLESS)	UGent	€ 946.106
Local water and nutrient availability require plants to adapt their growth and development accordingly. One of the essential plant nutrients is phosphorus (P). Its availability in soils as organic phosphate (Pi) poses a major challenge for crops. Since P is a limited mineral resource, development of crops that perform better with reduced Pi-input is essential. Previous Pi-starvation studies reveal that plants deploy local and systemic signaling to increase Piuptake and adjust plant growth. A long-term response to low Pi involves modifying gene expression, however, how plants sense low Pi and consequently generate early priming signals to activate this gene expression is much less understood. Understanding the early processes and signals are vital to improving the efficiency of Piuptake, distribution, and ultimately plant architecture. The PiLESS project aims to characterize early Pi-depletion signaling by real-time observations of physiological and molecular responses and biochemical identification of early Pi-signaling components. These novel components will be validated using a multiplexed CRISPR/Cas9 gene-editing approach. Moreover, we will develop a Pi-sensor, applicable in Arabidopsis thaliana, tomato and other crops, to monitor Pi-depletion responses in plants. These insights into the early signaling processes will reveal how plants overcome low Pi-conditions.				

G0DDD23N	Wennman Aron	Towards a global theory of orthogonal polynomials and correlation kernels for non-Hermitian random matrices	KU Leuven	€ 849.108

Orthogonal polynomials are classes of polynomials subject to certain orthogonality relations, often in weighted L2 spaces on the line, the plane or along the unit circle. Just as Fourier series may be used to express periodic functions in a simple way, orthogonal polynomials are used to describe the solutions to a variety of problems in mathematics. I am interested in orthogonal polynomials which appear in non-Hermitian random matrix theory, where they describe the correlation structure of an important instance of the 2D Coulomb gas. The Coulomb gas is fundamental in statistical mechanics, where it constitutes one of the simplest "toy models" of matter which is not confined to a lattice. This random matrix model also appears naturally in quantum mechanics, data science, and in the stability analysis of ecosystems, motivating its study also from an applied perspective. While some aspects of 2D Coulomb gases are well understood, intriguing questions concerning tunneling phenomena, emergence and resolution of singularities, and crystallization in low-temperature regimes remain mysterious. The goal of my project is to answer open questions about beautiful patterns formed by the zeros of the orthogonal polynomials, and about the behavior of the Coulomb gas in cases where particle clouds form singularities or collide with obstacles. The research will be carried out at KU Leuven, where many break-throughs have been made in this research field.

G0DCO23N	Yilmaz Atilgan	Essential gene circuits regulating cell state transitions and diseases of skeletal muscle	KU Leuven	€ 859.108

Skeletal muscle makes up the largest tissue mass in the human body. It is also prone to a vast array of genetic and metabolic disorders, as well as physical trauma. In addition, age-related muscle wasting has become an increasingly common health problem in today's aging societies. Therefore, enhacing the regenerative capacity of skeletal muscle is a particularly crucial aim to treat these conditions. A key step towards this goal is to understand how muscle cell identity is established in human and which genes govern this process. Despite the previous efforts showing a handful of key regulators, a comprehensive characterization of gene networks that are essential for muscle cell identity remains elusive. Thanks to the advances in stem cell biology and gene editing technologies, we recently devised stem cell-based experimental tools that we used to identify essential genes for different cell types in early embryonic stages in human. This research proposal aims to utilize this unique and robust experimental platform to identify the essential genes for muscle cell identity and also the genes that modify the severity of the two most common genetic muscle disorders, namely the Duchenne Muscular Dystrophy (DMD) and Myotonic Dystrophy Type 1 (DM1). These studies will provide a comprehensive understanding of how muscle cells are made in human, giving us a better control over the regenerative capacity of this tissue, while also potentially revealing novel drug targets for DMD and DM1.

G0DCA23N	Zekollari Harry	ICE³: Modelling the global multi-century evolution of glacier ICE in 3D	VUB	€ 949.958

Glaciers are key contributors to sea-level rise and are important water resources that supply fresh water to hundreds of millions of people. It is therefore of crucial importance to accurately simulate the future evolution of these precious ice bodies. Despite recent progress in modelling the global evolution of glaciers, existing simulations suffer from vast uncertainties related to (i) model input, (ii) a simplified representation of glacier processes, and (iii) an important mismatch between the timescales over which models are calibrated (multi-annual to decadal) and those over which the future glacier projections occur (century timescale). ICE³ will revolutionise the regional- to global-scale modelling of glaciers, by (i) strongly reducing uncertainties in model input through innovative inversion of climatic information, (ii) developing new approaches to model glacier processes in 3D, and (iii) for the first time simulating past glacier evolution globally over centennial time scales with an ice-dynamic model. These improvements will culminate in new global glacier evolution projections under a range of future emission scenarios, which will in turn inform the next generation of sea-level rise and water availability projections. While redefining the landscape of largescale glacier modelling, ICE³ will also ensure that the novelties it produces are incorporated in climate change impact models to guide policy makers and practitioners in adapting to a changing environment.