Research Foundation – Flanders

Results Odysseus programme 2024

26/03/2025

Granted TYPE I

Project number	Researcher	Title	Host institution	Granted budget
G0ASD25N	Van Hulse Charlotte	Study of the multi-dimensional hadron structure and formation	VUB	€ 2.524.479
We do not fully understand 95% of our mass and that of the visible universe. Visible matter is made of atoms. The atom's nucleus is made of protons and neutrons, collectively referred to as nucleons, and these nucleons consist of a highly energetic soup of very fast moving and constantly interacting quarks and gluons. Gluons have no mass and quarks a negligibly small one, yet together, through their interaction, they generate most of the mass we can see. Understanding how that occurs is the subject of my proposal. I will use data from the CMS experiment at the Large Hadron Collider at CERN, obtained when protons and nuclei are brought into collision at unprecedented energies. I will look at glancing collisions, where the interacting beam particles do no break up and convert some of their energy into the creation of a new particle, and at head-on collisions where the interacting particles break up and create many new particles. I will also work on expanding measurements we can perform in the future at the new electron-ion collider at BNL, US, where we will use a very precise, point-like probe to study the nucleon. All these studies will allow us to understand the interaction between the quarks and gluons better. In particular, they will teach us how quarks and gluons evolve into the particles we can see in our detectors, where the quarks and gluons are located inside the nucleon, how they move, how they orbit each other and how they generate pressure inside the nucleon.				
G0ASI25N	Beklemishev Lev	Algebraic Structures in Proof Theory	UGent	€ 2.803.631
Proof theory is a branch of logic that studies mathematical models of the fascinating phenomenon of mathematical proof. Central questions of proof theory concern provable and unprovable propositions, consistency of axiomatic systems, comparison of their strength, proof complexity, etc. Currently, proof theory is experiencing a revival due to the development of computer systems and languages that are capable of building proofs of mathematical theorems and verifying computer programs. Traditionally, proofs are represented as strings of symbols built according to certain fixed rules. However, such representations in practice are not humanly readable and their construction and analysis is a complicated combinatorial task. The aim of this project is to develop mathematical tools that would allow us to represent provability at a more abstract structural level. This will make the methods of proof theory largely syntax-independent, will help us to focus on the essential features of proofs, to simplify and sharpen the methods of proof-theoretic analysis. It will also strengthen the ties of proof theory with the other branches of logic and mathematics such as algebra and topology. With				

this approach we are going to tackle one of the most challenging problems in proof theory – the problem of natural ordinal notations. We also expect to solve or to make radical progress on several long-standing open problems concerning formal arithmetic, provability logic, and reflection principles.				
G0ASM25N	Brysbaert Ann	ODYSSEIA – Organic Data Yields in Aegean Bronze Age material culture. Scientific, Sensory, Ethnographic, Experimental, and Iconographic Approaches to human-environment interactions through crafting	KU Leuven	€ 2.896.295
ODYSSEIA aims to radically revise our understanding of how Aegean people in the 2nd millennium BCE related to their physical environment. For this, we will investigate the socio-economic roles of their organic materials in a world known for its elite conspicuous consumption of durable materials and richly decorated palaces. We will achieve this via a multidisciplinary survey of a wide range of organic materials and objects of faunal and floral origins. In order to reconstruct the workflows of how these organic objects have been produced but also used, our holistic and novel methodology combines Aegean and Egyptian iconography, Bronze Age and later texts, ethnographic and experimental studies, 3D modelling, and scientific analyses of archaeological remains. Based on the workflows and how these intersect, their labour cost rates will aid in completing a seasonal labour calendar. The calendar, based on optimal socio-economic work patterns spread over the year's seasons, and on pre-industrial agricultural subsistence activities, will redress the socio-economic and political imbalances in the power between elites and others in the 2nd millennium BCE. It will also form a flexible model for future demographic studies. It will complement existing labour data on Late Bronze Age Aegean inorganic workflows. The calendar will render visible both organics and a fuller range of Bronze Age people interacting with them, and it will result in a comprehensive, gendered taskscape narrative.				
G0ASQ25N	Zandawala Meet	Wired to feed: synaptic and neuropeptidergic connectivity governing feeding-state transitions in flies and ticks	KU Leuven	€ 3.238.289
One of the main challenges in biology is understanding how the brain enables animals to adapt to changing conditions. Neuropeptides and peptide hormones (NPHs) are crucial molecules produced by the brain that help animals adjust their behavior and body functions to changing environments and internal conditions. These molecules work at different speeds and across various parts of the body, playing a vital role in influencing animal behavior. Even though we now have detailed maps of the brain circuitry in smaller animals like flies and worms, predicting specific behaviors is challenging without considering how NPHs affect the brain's flexibility. A key question in this field is how and when NPHs regulate changes in behavior and body functions when animals shift between different states, such as going from feeling full to hungry. My research aims to explore this in both fruit flies and ticks, focusing on how NPHs influence feeding related behaviors by developing and using cuttingedge methods. This research will help us understand the broader effects of NPHs and provide insights into human disorders linked to hormonal imbalances, such as diabetes, obesity, and depression.				

Granted TYPE II

Project number	Researcher	Title	Host institution	Granted budget
G0ARS25N	De Schepper Sebastiaan	Understanding the Immune Response driving Peripheral Synucleinopathy in Parkinson's disease	UAntwerpen	€ 968.272
Parkinson's disease (PD) is a rapidly growing neurological disorder that primarily affects movement, leading to symptoms like slowed movement and tremors, but it also impacts other tissues and organs, including the gut and bladder. The disease is marked by the abnormal clumping of a protein called alpha-synuclein (α-Syn). Scientists believe that these clumps may start forming in parts of the body, such as the gut, long before they appear in the brain, contributing to the progression of the disease. New research suggests that particular cells of the immune system, termed 'macrophages', might play a crucial role in how these α-Syn clumps spread from the body to the brain. These macrophages normally help keep the gut healthy, but may start malfunctioning, leading to the buildup and spread of α-Syn clumps. My project aims to uncover how these gut immune cells interact with α-Syn and how this interaction might drive the disease from the gut to the brain. By studying the proteins involved in this process and the role of the immune system, this research hopes to identify new ways to detect PD early and develop treatments that could prevent or slow down its progression. This research is crucial because it addresses a largely unexplored area of PD—how the disease may start outside the brain. Understanding this could open up new avenues for diagnosing and treating PD much earlier than currently possible, potentially improving the lives of those at risk.				
G0ASL25N	Klingbeil Olaf	Cancer Associated Plasticity Targeting and Understanding Regulators of Expression in Pancreatic Ductal Adenocarcinoma	KU Leuven	€ 968.272
Cancer is among the leading causes of death in Europe, including Flanders. Resistance to therapy is one of the leading challenges of cancer therapy. This resistance can arise due to genetic changes in cancer cells or because cancer cells can be diverse and adaptable. Recent research suggests that tumor cells can hijack transcriptional states of normal development meant to help cells survive stress and repair injuries. However, we still do not fully understand how these changes in so-called cell states and the transition between them happen. Pancreatic ductal adenocarcinoma (PDAC) is one of the deadliest human cancers, and cell state plasticity is a significant contributing factor to this disease's aggressiveness, which is supported by our previously published data. A challenge in nominating cancer cell vulnerabilities is paralog redundancies. Paralogs are gene duplications acquired during evolution. To overcome this challenge, I have developed a powerful high-throughput genetic method (CRISPR) to look through gene redundancies and identify previously overlooked vulnerabilities of cancer cells. Using this methodology and additional functional genomic approaches described in this proposal, the central goals are to understand how and why cancer cells undergo these recurring cell state changes during the development therapy resistance and to identify vulnerabilities of cell-state transitions of PDAC.				

G0ASO25N	Dassonneville Ruth	Social groups, political thinking, and vote choices	KU Leuven	€ 902.233
Foundational studies in voting behaviour have shown that individuals' vote choices largely reflect the social groups they belong to and identify with. This work has also provided insights into the social characteristics that historically influenced voters and how connections between social groups and parties were formed. Specifically, scholars have highlighted the role of labor unions and churches in linking voters to parties based on class and religion. However, these established facts—that class and religion strongly guide the vote choice and that connections between social groups and parties emerge through the work of organizations—are now heavily debated. While evidence suggests that voting behaviour still reflects group memberships and identities, our understanding of *which* group memberships matter today, and *how* they gain political significance, remain unclear. The SOCIOVOTE research project will provide answers to these important questions by proposing a new theoretical framework for understanding how group memberships become politicized and influence vote choices. Through three research axes, SOCIOVOTE will explore which group memberships become important identities for voters and examine the roles of group norms, organizations, and party communication in linking these groups to political parties.				
G0ASU25N	Soares Pereira Joana Maria	Integrative deep learning to decode the origins, evolution, and unknown functions of the Protein Universe	KU Leuven	€ 968.260
Proteins are crucial macromolecules essential to all forms of life, facilitating everything from cell communication and metabolism to defence mechanisms and even offensive strategies. Thanks to large-scale genome sequencing efforts, we now have access to the amino acid sequences of billions of proteins. However, despite these vast numbers, the functions of a large fraction of them remain unknown. In this project, we will develop advanced tools to predict the roles of these uncharacterized proteins, leading to new biological discoveries and potential breakthroughs in medicine, biotechnology, and protein engineering. By representing the diversity of all known proteins as a vast "universe", and inspired by methods used for classifying different cell types in biological tissues, we will develop deep learning models that can map and predict the functions of various regions within its landscape. We will then apply them to the entire catalogue of known proteins across the tree of life, and investigate the evolution of novel protein families linked to prokaryotic defence, resistance and metabolism. With this, we will about not-hitherto described biological processes and shed light into mechanisms that nature exploits to create and evolve new protein functions. This will have a profound impact in basic protein research, but will significantly help protein function prediction and annotation efforts, as well as protein de novo design and engineering.				
G0ASC25N	Heri Corina	The Legal Temporalities of Climate Change	VUB	€ 968.272
Litigants are increasingly turning to the courts to seek protection against climate change. The resulting cases are highly divisive. Their detractors argue that courts cannot be used to seek legal or social change, including changes to climate policy. These arguments imply that it is "too soon" for these kinds of changes -- that action is not sufficiently urgent, that legal solutions can be sought later on, and that change through law should be incremental. These ideas all have one thing in common: they are inherently ideas about time. Together, they work to slow down and limit the law’s response to climate change. However, when it comes to climate change and its impacts on human rights, litigants and scientists agree that there is no time left to wait for future solutions. Time is, in other words, the crux of designing adequate legal responses to climate change. To examine how the law can rise to this crucial challenge, this				

project will identify and analyse the temporal assumptions underlying human rights law, and the law more generally. By making them explicit and identifying alternatives, the project produces new ideas about central issues such as the possibilities and limits of the law, its treatment of scientific evidence, historical responsibility for emissions, and the protection of current and future generations. The impact of this project will extend beyond academia, to a broader audience that includes legal practitioners and the general public.				
G0ASY25N	Lerose Alessio	Disentangling strongly-interacting quantum many-body dynamics: Novel classical and quantum simulation strategies	KU Leuven	€ 844.333
The quest for organizing principles, baseline properties, and microscopic simulations of quantum matter far from equilibrium underpins various research front lines in theoretical physics — from heavy-ion collisions, to intensely driven strongly-correlated materials, down to the dynamical behavior of atomic-molecular-optical systems and its ties to quantum technologies. This project will push the frontier of science forward in these key interlaced directions: - We aim at a long sought-after classification of non-equilibrium states of quantum matter and dynamical phase transitions that closely mirrors the successful classification of quantum phases of matter in equilibrium. This will be achieved by replacing spatial quantum correlations and entanglement in the system's ground state, with temporal quantum correlations and entanglement in a suitable new object -- the system's "influence matrix". - We develop an efficient numerical solution of an important class of strongly correlated condensed matter systems, which will allow us to understand the far-from-equilibrium responses of materials and ultracold atoms. - Starting from a recent breakthrough for simulating quantum field theories using neutral-atom or superconducting-qubit quantum processors, we aim at the first ab-initio simulation of enigmatic aspects of high-energy nuclear collisions, precluded to computers, using this frontier technology.				
G0AT025N	Pontrelli Sammy	Stability incurred by enzymatic diversification	KU Leuven	€ 968.272
As the need for carbon capture technologies grows, emerging strategies focus on promoting phytoplankton growth to drive carbon-rich particles to ocean depths. A less explored approach involves accelerating the formation of marine dissolved organic carbon (DOC), a vast reservoir of molecules that resist microbial degradation for millennia. However, the key challenge is understanding how these molecules form. A clue is that a large portion of DOC is polysaccharides, which phytoplankton produce and consume daily as storage molecules. Could these rapidly cycled molecules be transformed into forms that resist microbial degradation, and how? I hypothesize that during the daily turnover of storage polysaccharides, promiscuous enzymes mistakenly convert them into alternative, hard-to-degrade forms. These molecular "accidents" are expelled and contribute to the stable DOC pool. I have preliminary data of an enzyme chemistry that inadvertently modifies algal storage polysaccharides. My expertise in high-throughput metabolomics and enzyme screening will be leveraged to assess whether this chemistry exists in abundant marine phytoplankton and whether these accidental molecules resist microbial degradation. This will provide proof of concept for enzyme-driven DOC production that my lab will explore long-term. Further, by identifying species with high levels of this enzyme activity, we could promote their growth in natural or engineered systems to optimize carbon capture technologies.				

G0AT525N	Laplace Eva	Understanding Stellar Hearts: from Binaries to Supernovae and Gravitational-Wave Sources	KU Leuven	€ 812.864

The death of stars is not the end of their remarkable existence. When stars end their lives, their hearts continue to exist in a different, exotic form, known as a compact remnant: black holes, neutron stars, and white dwarfs. Understanding the exact origin of these objects is one of the most pressing scientific questions in astrophysics today. With the discovery of gravitational waves (GWs), ripples through space-time from merging binary compact remnants predicted by Einstein, we now have a new way to study these extreme objects. To make breakthroughs in understanding the properties of stellar remnants and the GWs they generate, it is crucial to study the binary stellar hearts that form them. With this ambitious Odysseus II project, we will use advanced numerical simulations to constrain the physics of stellar hearts in binary systems. We will research
1) how the structures of stellar hearts change through cosmic ages and how it affects GW sources,
2) the explosion and implosion signatures of binary stellar hearts, and
3) how stellar heartbeats change when stars are in binaries.
This Odysseus II project will provide funding for three PhD students and build strong synergies within the Institute of Astronomy (IvS) of KU Leuven by bridging the topics of Asteroseismology, Binary Evolution, and Gravitational-Wave Progenitors. It will help develop the newly-founded Leuven Gravity Institute and establish KU Leuven as a world-leading center for gravitational-wave astrophysics.