



**European Research Council**  
Established by the European Commission

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## **- Examples of ERC Consolidator Grant projects 2014 -**

### **Beyond Einstein: revolutionary ideas about gravity and the dark universe**

What is the exact nature of our dark universe? It is generally thought that today's universe is filled with a dark energy that is fuelling its expansion. But this conclusion could be a simple misunderstanding of how gravity works on cosmological scales; the universe might not be expanding as we think it is. Dr Catherine Heymans has been awarded an ERC Consolidator Grant to undertake a ground-breaking gravity experiment on some of the largest scales observed in the universe. The project will challenge the most advanced theoretical frameworks, going beyond the theory of Einstein to bring about a revolution in our understanding of gravity and the dark universe. Dr Heymans will call fundamental physics into question by moving gravity experiments out to the largest scales and confronting widely accepted theories with completely new ideas about gravity based on the best available data. The research team will examine the effect gravity has on both the motion of galaxies and light in the same region of space. The evidence collected will be particularly compelling owing to the high quality of the data from the European Southern Observatory. The ultimate goal of the project is to perform a high precision experiment to inspire and confront new theories about how gravity works and thus better understand the dark universe.

ERC grantee: Catherine Heymans

Host institution: Institute for Astronomy, University of Edinburgh, UK

ERC project: Global Lensing Observations to Go Beyond Einstein (GLOBE)

ERC funding: € 2 million

### **Solving puzzles of dyslexia and autism**

In Europe, an estimated one hundred million people are impaired in their communication abilities. Current neuroscience research typically associates communication abilities with the cerebral cortex – the outer layers of the brain. But this ignores the complex sensory processing machinery beneath these outer layers. Prof. Katharina von Kriegstein has been awarded an ERC Consolidator Grant to research the role of subcortical sensory structures in human communication impairments, and to find out how dysfunctional interaction between the subcortical sensory structures and the cortex can cause such disorders. Her project will reveal the principles of how the subcortical sensory structures process dynamic auditory and visual communication signals. This will entail using recently developed ultra-high resolution neuroimaging, designing a mathematical model to understand the physical mechanism of subcortical sensory response properties, and influencing the brain while observing it with cutting-edge techniques. Not only will the research be at the forefront of an emerging field of investigations, but Prof. von Kriegstein's project will also resolve long-standing puzzles about the nature of two of the most common hereditary communication deficits: developmental dyslexia and autism spectrum disorders.

ERC grantee: Katharina von Kriegstein

Host institution: Humboldt University Berlin, Germany

ERC project: The tiny and the fast: The role of subcortical sensory structures in human communication (SENSOCOM)

ERC funding: € 2 million



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### **Maps of drug resistance**

It is well known that when treating an infection, bacteria can become resistant to the prescribed drug. The bacteria can also become cross-resistant to multiple other drugs at the same time too. What remains largely unexplored, however, is the evolution of the reverse effect: how frequently and why does resistance to one drug lead to increased sensitivity to other drugs? Dr Csaba Pal has been awarded an ERC Consolidator Grant to study the evolution of drug resistance, and how collateral sensitivity to other drugs could potentially improve future therapeutic strategies to mitigate resistance evolution. The research feeds into wider questions about the governing rules and molecular mechanisms of similar natural trade-offs frequently observed but little understood. Specifically, it will address whether bacteria resistant to multiple antibiotics become hypersensitive to certain aspects of our innate immune system, what the evolutionary mechanisms of drug resistance are, and if evolutionary trade-offs between bacteria and drugs are predictable. By elucidating the underlying principles of resistance evolution, researchers hope to facilitate the production of novel anti-resistance drugs and perhaps even create experimental maps of cross-resistance and collateral sensitivity as a unique resource for better informed decisions in medicine.

ERC grantee: Csaba Pal

Host institution: Biological Research Centre, Szeged, Hungary

ERC project: Bacterial evolution of hypersensitivity and resistance against antimicrobial peptides (Resistance evolution)

ERC funding: € 1.8 million

### **Making e-voting secure**

Remote online voting is already widely used for professional polls and even for political elections in a few countries. Nevertheless a crucial question remains: how to ensure the security and privacy of e-voting? With his ERC grant, Dr Steve Kremer aims to design techniques to test and prove the security of the underlying mechanisms and limit the risk of piracy of e-voting and more generally of online transactions. His research focuses on cryptographic protocols that are meant to ensure security in a world where the Internet and its applications are in constant evolution. In particular, Dr Kremer wants to develop software able to analyse and verify the systems that aim to protect the anonymity of their user's and their non-traceability, even in cases when personal computers are infected by malware or viruses. The software will automatically detect security and privacy breaches. Dr Kremer's technologies could provide a way to ensure that e-voting protocols are trustworthy. They could then be used as an alternative to the traditional paper ballot in remote voting, and potentially raise citizens' participation in elections. More widely, the software could ensure secured transactions of internet-based services such as home banking, e-commerce or e-government.

ERC grantee: Steve Kremer

Host institution: Institut National de Recherche en Informatique et Automatique (INRIA), France

ERC project: Automated Security Proofs of Cryptographic Protocols: Privacy, Untrusted Platforms and Applications to E-voting Protocols (SPOOC)

ERC funding: € 1.9 million



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### **The persistent negative real effects of debt**

The past decade has been a turbulent time for the world economy, and it continues to be so. The impact of large debt on the economy is a crucial question. What are the real effects of national (private and public) debt on household consumption, savings, firm investment, employment, and on the persistence of economic recessions? What can public policy do to alleviate the negative effects? How can economists quantify the impact borrowing has on employment, for example, when different households and firms take endogenously debt decisions depending on unobservable information to economists? Prof. José Luis Peydró has been awarded an ERC Consolidator Grant to investigate the overall real effects of debt on the economy at large. One of the several research lines will use Spain as a case study, in particular because this country's households and firms accumulated a large amount of debt very quickly in the 2000s. During the period 2002-2008, the distribution of a large part of new public housing in Spain was determined by a lottery, and was thus random. Prof. Peydró will exploit the random nature of this selection by comparing the household consumption and employment of the 'winners' of public housing lottery with that of the 'losers'. In this way, he will be able to quantify the impact of housing debt on consumption and employment, and analyse different public policies aimed to reduce the negative consequences for the economy. This approach is novel in its field and will thus provide a ground-breaking understanding of the theoretical mechanisms of financial crises to be used to inform future public policy.

ERC grantee: José Luis Peydró

Host institution: Pompeu Fabra University, Spain

ERC project: Debt and Persistence of Financial Shocks (PERSISTDEBT)

ERC funding: € 1.3 million

### **What causes harmful behaviour in teenagers?**

Recent studies have found substance abuse, depression, self-harm and suicidal behaviour are on the increase among adolescents. Yet we know very little about the complex interplay of psychosocial and biological factors that causes such harmful behaviour in young people. With an ERC Consolidator Grant and thanks to the unique availability of social registry data in Iceland, Prof. Inga Dóra Sigfúsdóttir will study an entire Icelandic birth cohort to understand harmful adolescent behaviour from both biological and psychosocial perspectives. This mass of survey data granted to the project will provide information about an entire population of children, from pre-birth through toddler and school years and into adolescence. In combination with physiological indicators measured in saliva from a subsample of participants, this survey data will develop new and improved understandings of the causes of harmful behaviour. The research team will investigate, for example, the impact of early life stress on adolescents, the relationship between harmful behaviour and community issues such as deprivation, disrupted families, income, and delinquency, and how support in early adolescence might buffer the effects of early life stress on harmful behaviour later on. This project is expected to contribute to the design of more effective interventions to reduce harmful behaviour among young people, and inspire new discourses surrounding the issue in this field.

ERC grantee: Inga Dóra Sigfúsdóttir

Host institution: Icelandic Centre for Social Research and Analysis, Reykjavik University, Iceland



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ERC project: Multilevel Analysis on the Effects of Stress on Biology, Emotions and Behaviour throughout Childhood (LIFECOURSE)

ERC funding: € 2 million