

Brussels, 18 December 2013

Examples of ERC Synergy Grant projects 2013 –

Was Einstein right? A black hole camera to test relativity theory

European astrophysicists on the BlackHoleCam project aim to create the first accurate image of a black hole. Their research will test the predictions of current gravitational theories, including Einstein's theory of General Relativity, which has survived almost 100 years of extensive testing. The Synergy Grant will allow the three scientists to bring together their specialised expertise in a highly challenging collaborative project.

The scientists want to capture an image of Sagittarius A*, the presumed supermassive black hole at the centre of our galaxy, with a mass of around 4 million times the mass of the Sun. What makes this challenging is that black holes are notoriously elusive. With a gravitational field so large that light cannot escape from their horizons, they are virtually impossible to see. So how can we catch them on camera?

The BlackHoleCam group plans to compose an image of the shadow of the event horizon – the border around a black hole which light can enter, but not leave. Matter pulled into this region generates electromagnetic radiation, including high-frequency radio waves. These waves will be picked up by receivers in radio telescopes around the world and combined to create a composite image of Sagittarius A*. In this way they want to build a global "Event Horizon Telescope", together with their international partners. In addition, the group wants to use the same telescopes to find and measure pulsars, highly accurate natural clocks in space, around Sagittarius A*. This will allow them to determine the deformation of space and time caused by black holes with extreme precision. The results will be compared to detailed supercomputer simulations to ultimately determine whether Einstein was actually right. 100 years on, some of the most exotic predictions of General Relativity may finally be tested.

Principal investigators:

Heino Falcke, Radboud University Nijmegen and ASTRON, The Netherlands Michael Kramer, Max-Planck-Institut für Radioastronomie, Germany and University of Manchester, UK:

Luciano Rezzolla, Goethe University Frankfurt and Max-Planck-Institut für Gravitationsphysik (Albert-Einstein-Institut), Germany

Project title: BlackHoleCam: Imaging the Event Horizon of Black Holes (BlackHoleCam)

ERC funding: EUR 14 million





The 'phosphorous' diplomacy

Phosphorous, also known as the "Devil's element" or "P", is a scarce but essential resource on Earth. For instance, it is present in DNA structure, cell membranes, enzymes and bones. It is also used in fertilizers, thus supporting the food demand of an ever growing population. Unfortunately it is a finite resource and there is no synthetic way of creating it. In contrast to carbon (C) and nitrogen (N) which are available abundantly, P reserves are limited in most natural environments, and the trend is likely to continue in the next century. These constraints have already triggered some geopolitical disputes.

The IMBALANCE-P project gathers an interdisciplinary team of top researchers, based in four distinct research institutions, to study the on-going shifts in C:P:N balance in different ecosystems and the impact for life on Earth (for instance on biodiversity). The team will conduct a novel experiment in the French Guianese tropical rainforest where they will study the relationship between N:P availability ratios. The researchers will also look at the effects of future P shortages on food security and will help to design future scenarios for food production under limited P resources, and effective policy actions.

This collaboration across multiple and diverse disciplines is unique – including experts in eco-physiology, metabolomics, atmospheric physics and chemistry, remote sensing, economy and agriculture. The global implications of limited P resources have never been studied in such an integrated way. The contribution of the team to the establishment of a science-based P diplomacy will be highly valuable to life, society and the preservation of the planet.

Principal investigators:

Josep Penuelas, Centre for Ecological Research and Forestry Applications, Spain; Ivan Janssens, University of Antwerpen, Belgium;

Philippe Ciais, Université de Versailles Saint-Quentin-en-Yvelines, France;

Michael Obersteiner, International Institute for Applied Systems Analysis, Austria.

Project title: Effects of phosphorous limitations on Life, Earth system and Society

(IMBALANCE-P)

ERC funding: EUR 13.6 million





A sight for sore eyes: New techniques for improved vision

Over 50 million patients in the EU and the US suffer from low vision, with costs of visual impairment in the EU alone estimated at over EUR 500 billion. The HELMHOLTZ project, which brings together two leading research institutes, aims at developing prototypes for new non-invasive imaging technologies for ophthalmology. These prototypes should help to treat age-related diseases such as genetic diseases, age-related macular degeneration, glaucoma or diabetic retinopathy.

By using state-of-the art techniques, in particular the ultrafast doppler imaging, the team will provide 4D functional maps of the visual system, especially for the central part of the human retina called the "macula". They will also explore the cellular structure of the eyes' photoreceptors and the alterations in pressure and blood flow in the retina, the optic nerve and the choroid (a micro vasculature irrigating the retina).

What makes this project innovative is that it merges the expertise of clinician-scientists on the one hand with physicists on the other. Initial trials are foreseen to test these new technologies against current methods. As the retina is "the most approachable part of the brain", the group imagines that its results could expand to other research areas, such as neuroscience and the treatment of neurodegenerative diseases.

Principal investigators:

José-Alain Sahel, Fondation Voir et Entendre, Institut de la Vision (UPMC, Inserm, CNRS), France :

Mathias Fink, Fondation Pierre-Gilles de Gennes, Institut Langevin (ESPCI, CNRS), France. **Project title:** Holistic Evaluation of Light and Multiwave applications to High resolution imaging in OphtaLmic Translational research: revisiting the HelmholtZian synergies (HELMHOLTZ)

ERC funding: EUR 11.9 million





The Internet of tomorrow: Privacy, Accountability, Compliance and Trust

The Internet, originally only used to browse through texts and exchange emails, has undergone intense changes in the last ten years. It is today a global multimedia platform used by billions of participants. These users have matured from consumers of information to content publishers, political activists or trade partners. In the meantime, the Internet's extraordinary growth has created new threats (such as tracking of user profiles or identity theft). Fraud auctions on e-Bay, cases of non-compliance with EU law on Facebook or false rumours originating from the web are commonly reported in the media.

The imPACT project addresses the key challenges of the Internet today by focusing on four aspects: privacy, accountability, compliance and trust (PACT). The idea is to give users more control over their personal information: actions should be linkable to responsible actors in cases of misbehaviour (and only then); regulations should be set up and monitored to ensure compliance; and users should be able to assess the reliability of information in the Internet in order to know where to place trust.

To accomplish these goals, leading computer scientists from different disciplines, are working as a single team for the first time. During their project, they will cooperate with outside experts in law, social sciences, and economics, to understand and master the different roles, interactions, and relationships of users and their joint effect on the four PACT properties. The group wishes to present their research at top-tier conferences and produce a steady stream of publications in the best journals of their research fields. They will also produce and freely distribute prototype software and measurement data from field trials with Internet services. The researchers have hopes of attracting the attention of major industrial players and governments - and working with them to tackle future challenges of the Internet together.

Principal investigators:

Michael Backes, Saarland University, Germany;

Peter Druschel, Max Planck Institute for Software Systems, Germany;

Rupak Majumdar, Max Planck Institute for Software Systems, Germany;

Gerhard Weikum, Max Planck Institute for Informatics, Germany.

Project title: imPACT: Privacy, Accountability, Compliance and Trust in Tomorrow's Internet

(imPACT)

ERC funding: EUR 9.3 million

