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News Release

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Success at the European Research Council for TUM Scientists

Ten million euros for forward-looking research projects

Six researchers from the TU München are to receive substantial ERC grants: Prof. Annette Menzel (€1.5M) plans to investigate the impact of extreme weather events on ecosystems. Prof. Christian Pfleiderer (€2.2M) hopes to exploit magnetic vortices for enhanced data processing. Prof. Rüdiger Westermann (€2.3M) is developing a visual language for data uncertainty arising from scientific measurements and simulations. Prof. Andreas Bausch (€1.5M) intends to gain a better understanding of self-organization processes within living cells. Prof. Florian Greten (€1.5M) is examining the influence of chronic inflammation on colon cancer, and Dr. Pierre Thibault (€1.5M) is working on a high-resolution X-ray imaging technique.

The Starting Grants and Advanced Grants provided by the European Research Council (ERC) are much sought after, and thousands of applications are received every year. Applications are permitted from all areas of research; however the majority relate to physics, engineering and life sciences. In the context of its Seventh Framework Programme, the European Union has made a total of 7.5 billion euros available for these grants over a period of five years.

The Impact of Extreme Events on Ecosystems

Cyclones, heat waves, and flooding – the frequency and severity of such extreme weather events has increased measurably in recent decades. While a single weather event cannot be taken as evidence of climate change, the increased rate of events can clearly be traced back to the greenhouse effect, which is exacerbated by human activity. A continuing rise in extreme events is to be expected into the future – with potentially drastic effects on ecosystems in the form of frost and drought damage, forest fires, and storms. Prof. Annette Menzel's "E3 - Extreme Event Ecology" project aims to examine the past, current, and future impacts of multiple extreme events on vegetation. The ERC grant for the interdisciplinary team of mathematicians, geo-ecologists, and biologists will enable a bridge to be built between physical extremes and their biological impacts. New statistical methods will be used to describe multifactorial events in their time-space structure, including non-stationary time series.

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Prof. Menzel wants to use this data to develop new concepts for risk evaluation, as well as for adapting vegetation to extreme weather events, that are multidisciplinary, multi-methodological, and comprehensive in terms of time frames.

Prof. Annette Menzel is Professor for Ecoclimatology at TUM's Science Center in Weihenstephan and a member of TUM's Institute for Advanced Study. Her main research interest is the interaction of atmosphere and biosphere. The fields of application range from the capture and complex description of relevant parameters in different land use systems, through the detection and classification of the effects of climate change on terrestrial ecosystems and human health, to extreme event risk analysis. Prof. Menzel was one of the authors of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), which was awarded the Nobel Peace Prize in 2007. She is to receive an ERC Starting Independent Researcher Grant to the value of some 1.5 million euros.

Magnetic Vortices for Information Technology

Prof. Christian Pfleiderer of the Chair for Experimental Physics E21 at the TUM Physics Department is to receive an ERC grant for investigating stable magnetic vortices, which were recently discovered by his team. The five-year project, "Topological Spin Solitons for Information Technology," will receive 2.2 million euros and will focus on which materials and structural classes display these novel magnetic properties. In this quest, Pfleiderer will use scientific tools at the TUM's Heinz Maier-Leibnitz neutron source (FRM II). He will also seek to identify the physical properties involved and the potential for applications in information technology and other fields. It is hoped that magnetic vortices will enable faster, more efficient data processing than ever before.

Prof. Christian Pfleiderer works in the field of experimental solid state physics. His research is devoted to a systematic search for new material properties arising through strong electronic correlations. Some examples of this are new forms of magnetism, unconventional superconductors, and anomalous metallic states. The experimental methods used in these studies comprise single-crystal growth of intermetallic compounds under ultra-clean conditions, the measurement of transport and volume properties under extreme conditions, and a wide spectrum of neutron-scattering methods. Prof. Pfleiderer will receive an Advanced Grant amounting to around 2.2 million euros.

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Visualizing Uncertainty

Numerical data generated by physical measurements or numerical simulations are generally subject to uncertainties, whether through errors in the data capture process, the underlying physical models, or the calculation methods used. Consequently, it is important to be aware that the information contained in the data is never exact, and that data analysis without this awareness may lead to erroneous interpretations and false assumptions. It is not generally possible to eliminate the uncertainty, but its potential effect on relevant data structures can be visually represented, and this is the focus of Prof. Rüdiger Westermann's project. His vision is to use stochastic modeling of uncertainty to calculate the possible variations of relevant features in high-dimensional data and to provide the user with an intuitive representation using computer graphics techniques. This will require the development of a visual language that permits the quantitative analysis of uncertainties using graphic and textual elements. Such a technology has the potential not only to establish a completely new mode of visual data exploration, but also to have considerable influence on how physical measurements and numerical simulations are performed in the future. If the visual representation can show researchers where uncertainties lie in measurements or simulations, it will be easier for them to tackle problem areas, and to adapt the measuring and simulation methods used. The quantitative analysis of the reliability of data generation processes is another central challenge of Prof. Westermann's project. He is to receive an ERC Advanced Grant of approximately 2.3 million euros.

Prof. Rüdiger Westermann holds the Chair for Computer Graphics and Visualization at the TU München. His research interests are in practical computer science, in the fields of scientific visualization and numerical real-time simulation. His specific research focus is in the development of efficient algorithms for interactive data exploration and physical simulations in virtual environments, and their implementation in many core architectures.

Development of Colon Cancer

The results of research conducted in recent years have shown that chronic inflammations significantly increase the risk of cancer. Using the example of colon cancer, Prof. Florian Greten and his research group have managed to identify important molecular mechanisms that are responsible for this link. In the current project, the scientists are studying the role of reactive oxygen and nitrogen radicals during the development of colorectal cancer. Using the ERC grant funds, they now wish to find out how the accumulation of these reactive oxygen and nitrogen radicals in different cell types affects the development and advance of colon carcinoma, and

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whether a tumor-promoting function or a tumor-inhibiting function is more dominant. They will conduct their research using genetically modified mouse strains in which the specific effects in inflamed cells can be distinguished from those in tumor cells. It is quite likely that different effects may be observed in the function of the particular cell type in question. The researchers hope that the results will yield fundamental insights into the molecular mechanisms of tumor development, which will in turn allow new strategies to be developed for the prevention and treatment of colon carcinoma.

Prof. Florian Greten is Professor of Molecular Gastrointestinal Oncology. He has been based at the Institute for Molecular Immunology at Klinikum Rechts der Isar since 2011 and already has received numerous awards and distinctions for his services to cancer research. Last year alone, he was the recipient of four prestigious research prizes: the Johann Georg Zimmermann Prize, the Theodor Frerichs Award of the German Society for Internal Medicine, the AIO Science Award of the German Cancer Society (DKG) and the Dr. Emil Salzer Prize for Cancer Research of the German Cancer Research Center (DKFZ). Prof. Greten is to receive an ERC Starting Grant in the amount of some 1.5 million euros.

Bustling Activity inside the Cell

The interior of living cells is interlaced with a fine network called the cytoskeleton. This is made up of many protein fibers (filaments) and fulfills a number of tasks. On the one hand, the cytoskeleton must be sufficiently dynamic so that cells can move; on the other, it must be sufficiently stable so that cells can reorganize and then divide. From a biophysical point of view, these aspects stem from a self-organization process that is guided by actin-binding proteins (ABPs). These proteins are highly specialized and may regulate the construction and deconstruction of certain filaments, crosslink and bundle them, and control cell division. In order to understand this very complex biological system, scientists are trying to emulate it in model systems. Prof. Andreas Bausch and his team now plan to increase the complexity of their models in clear steps, with the financial help of the ERC grant. By so doing, they hope to gain a better understanding of the functional units and thus the self-organization of the cell. The focus of the project will be to recreate active processes such as reorganization and cell division using motor proteins and to understand them in quantitative terms. The insights gained into the life and functions of cells will also deliver insights into new treatment options for a variety of illnesses.

Prof. Andreas Bausch holds the Chair for Cellular Biophysics at TUM. His research is devoted to the quantitative understanding of the mechanical properties of the cytoskeleton and the microscopic mechanisms of self-organization. A further research

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focus is the identification and physical characterization of new biomimetic materials. Prof. Bausch is to receive an ERC Starting Grant worth around 1.5 million euros.

X-Ray Images from the World of Bacteria

X-ray images comprise an important aid in the medical world, but their resolution using conventional techniques is limited. In fact, X-ray radiation allows, in purely physical terms, high-resolution microscopy that reaches into the nanometer range. One of the greatest hurdles, however, is the production of appropriate optical systems. Using a procedure described as X-ray ptychography, Dr. Pierre Thibault's team of researchers at TUM have developed a procedure that provides ultrahigh-resolution images of the bacterial world without the use of lenses. The ERC Starting Grant will enable Dr. Thibault's group to continue their work in the field of coherence-based X-ray microscopy of biological samples at TUM. A central focus will be the application of this technique to new issues in the life and materials sciences.

Dr. Pierre Thibault is a scientist at the Chair for Biomedical Physics at TUM. His research interests span a number of disciplines including X-ray physics, biomedical imaging, inverse problems, and computer science. The algorithmic approaches that he developed early in his career have now become standard in the field of X-ray imaging. Before moving to TUM, the Canadian scientist worked in the USA and Switzerland. Dr. Thibault is to receive an ERC Starting Grant of approx. 1.5 million euros.

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