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Unravelling the secrets of brain folding: UNFOLD research project at Max-Planck-Zentrum für Physik und Medizin receives prestigious ERC Synergy Grant

Physicist and veterinarian Prof. Dr. Kristian Franze, Research Group Leader at the Max-Planck-Zentrum für Physik und Medizin (MPZPM) and Director of the Institute for Medical Physics and Microtissue Engineering at the Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), has been awarded an ERC Synergy Grant. The grant, worth a total of 10 million euros, will support interdisciplinary research in the field of brain folding over the next six years.

A special feature of the brains of large mammals with higher cognitive functions is that they exhibit folding of the cerebral cortex. Conversely, folding anomalies can be used in the clinical diagnosis of cognitive disorders. Despite the relevance of cortical morphology to clinical diagnostics, the causes and consequences of cortex folding are still little understood. Prof. Dr. Kristian Franze, whose previous research on the interaction of mechanics and the nervous system is considered groundbreaking, together with an international team of three other scientists from the Institute for Neurosciences CSIC-UMH (Spain), the University of Liège (Belgium) and the Pasteur Institute (France), aims to fill this scientific gap in the ERC-funded research project UNFOLD.

"We hypothesize that the folding of the cerebral cortex in mammals emerges from a dynamic interplay between mechanical and molecular processes and has a significant impact on the architecture and function of the brain," says Prof. Kristian Franze. He and the interdisciplinary team of researchers are using a multidisciplinary strategy to disprove the previous assumption that cortical folding in mammals is an epiphenomenon, i.e., the result of a process without further functional consequences.

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UNFOLD combines a variety of experimental and computational approaches, including genomics, – the collection and analysis of DNA sequences from a genome, cell biology, mechanics of

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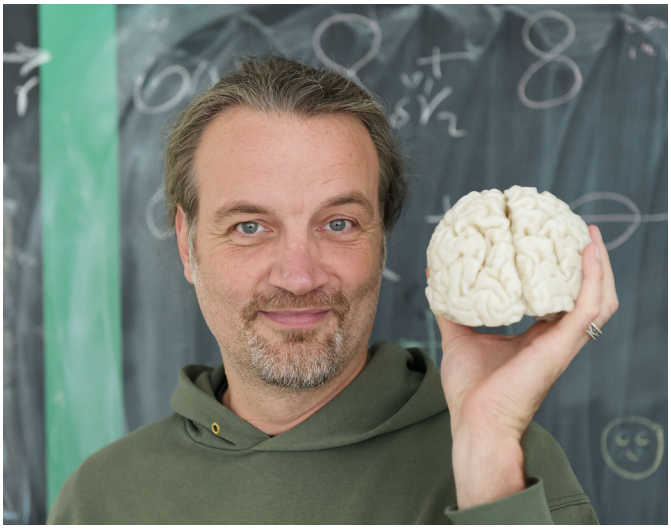
brain development and computational modelling. The team will apply in vitro, in vivo and in silico approaches to brain tissue from strategically selected animal models and humans. Initially, the researchers aim to map the molecular, cellular and mechanical processes accompanying cortex folding. Subsequently, they will modify these processes and study the consequences of their manipulation on brain folding and neuronal connections. In this way, the scientists hope to identify the key mechanisms leading to cortical folding and elucidate their dynamic interactions. The consequences for the function of neuronal circuits and the behavior of the animals will then be deciphered. The project integrates approaches from a wide range of natural and life sciences in a way rarely undertaken before. Unravelling the dynamic interactions between molecular, cellular and mechanical processes will not only provide unprecedented insights into brain development, but also reveal cellular and mechanical interactions which may be relevant to many other developmental and disease processes.

Prof. Kristian Franze, who has been awarded an Alexander von Humboldt Professorship and was Professor of Neural Mechanics at the University of Cambridge in the UK before moving to Erlangen, is excited about the diverse interdisciplinary collaborations at the MPZPM: "The conditions for my research group and especially for UNFOLD in Erlangen are simply great, – performing research together with physicists, biologists, physicians and engineers. A fresh wind is blowing here and there is a completely new understanding of interdisciplinary scientific research. UNFOLD, the director believes, will bridge the gap between physics and the life sciences, lead to new insights into normal and pathological brain development and pave the way for a new field of research in integrated neurobiology with potential applications in modern medicine.

The MPZPM was conceived in 2013 by the Max Planck Institute for the Science of Light as a joint center of the Max Planck Society, the FAU and the University Hospital Erlangen. Made possible by €60 million in funding from the Bavarian state government, the center will move into its new research building on the North



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Campus and in the immediate vicinity of the University Hospital in 2024. With almost 6000 m^2 of floor space, the new MPZPM building will provide laboratory and office space for around 180 researchers. The building will also house a facility for in vivo studies, a clean room for lab-on-chip development and a state-of-the-art microscopy center. Scientists from the disciplines of biology, physics, mathematics and medicine are currently carrying out basic research on biological processes and biomedical issues from a physical perspective, using state-of-the-art, novel physical measurement methods and theoretical approaches at various locations in Erlangen. In particular, they focus on the interactions of cells with their immediate physical environment.

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The Max-Planck-Zentrum für Physik und Medizin is conceived as a joint effort between the Max Planck Institute for the Science of Light (MPL), the Friedrich Alexander University (FAU) and the FAU University Hospital in Erlangen. The new scientific center aims to apply advanced methods from experimental physics and mathematics to basic biomedical research with an emphasis on the intercellular microenvironment.

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