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University of Bonn participating in two ERC Synergy Grants

The University of Bonn has been successful twice in the funding line for the Synergy Grants from the European Research Council (ERC) with other partners. The GravNet project is building a global detector network to search for high-frequency gravitational waves. The CeLEARN project coordinated by the Max Planck Institute for Neurobiology of Behavior – CAESAR aims to decode how single cells learn from their environment. The ERC uses Synergy Grants to support research groups in which different skills, knowledge, and resources are brought together in order to tackle ambitious research questions. The projects will receive several million euros of support in the next six years.

The GravNet project is located between particle and gravitational wave physics and aims to build a global network of detectors that specifically searches for high-frequency gravitational waves. The detector network could help solve one of the great unsolved questions of modern physics: detecting dark matter. “High-frequency gravitational waves could, for example, be produced during the merging of what are known as primordial black holes. Our global detector network would then be able to detect such signatures,” says GravNet spokesman Prof. Dr. Matthias Schott from the Physical Institute at the University of Bonn. “And precisely these black holes are ideal candidates for dark matter.”

As part of the ERC project, the researchers will develop the first detectors for the planned network and install them in Bonn, Mainz, and Frascati. “Our detectors are based on what are known as cavity resonators in strong magnetic fields, in which high-frequency gravitational waves would trigger a very small electrical signal,” explains Matthias Schott. “Such signals are so small that they can only be detected with modern quantum technologies.”

The ambitious undertaking is only made possible by the ERC Synergy Grant program, which supports groups of up to four principal investigators offering different skills and resources in order to work on a large-scale research question. “Experimental infrastructures on site and expertise from the fields of cryogenic and magnetic technologies, quantum sensors, theoretical physics, data analysis, and extremely low-noise electronics are required to make GravNet a reality,” says Schott, who is also a member of the transdisciplinary research areas (TRA) “Modelling” and “Matter” at the University of Bonn. As part of GravNet, Prof. Schott thus cooperates with Prof. Dmitry Budker from the University of Mainz, Prof. Diego Blas from the Institut de Física d'Altes Energies (IFAE), Spain, and Dr. Claudio Gatti from the Laboratori Nazionali di Frascati (INFN-LNF), Italy. GravNet will be supported with around 10 million euros over six years; around 2.4 million euros will go to the University of Bonn.

Cells that learn

“CeLEARN: Learning in Single Cells Through Dynamical Internal Representations,” coordinated by Dr. Aneta Koseska at the Max Planck Institute for Neurobiology of Behavior – CAESAR in Bonn, aims to reveal an astounding concept: that single cells are capable of learning from their environment. This initiative was honored with a prestigious ERC Synergy Grant for Dr. Koseska, Alexander von Humboldt Professor Dietmar Schmucker from the University of Bonn, Prof. Jordi Garcia-Ojalvo from Pompeu Fabra University in Barcelona, and Prof. Jeremy Gunawardena from Harvard Medical School in Boston.

“We believe that cells are not just passive units that execute predefined programs,” says Dr. Koseska, Leader of the Lise Meitner Group ‘Cellular Computations and Learning.’ “Instead, they actively process information, form internal models of their environment, and use these models to make context-dependent decisions – very similar to learning.”

The research will concentrate on a wide range of model organisms, including bacteria, single-celled eukaryotes, neuronal cell culture models, and neurons in the brain of the fruit fly Drosophila melanogaster. “By examining such different organisms, we hope to uncover fundamental principles that control learning at a cellular level,” explains Dr. Garcia-Ojalvo.

One of the project’s aims is to investigate how individual neurons form axonal branches and switch them off again. “Understanding how neurons create precise connections is crucial for decoding the functioning of nervous systems,” says Dr. Schmucker. “We want to find out how individual neurons learn to form these connections despite the complexity and variability of their environment.”

The interdisciplinary team of leading scientists has combined expertise covering information theory, dynamic systems, cell biology, and neuronal development. “A broader and general definition of learning at a cellular level combines various levels of biology, from single-celled organisms to complex neuronal networks, and offers a basis for answering fundamental biological questions,” says Dr. Gunawardena. “CeLEARN” will be supported with over 11 million euros over six years.

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