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FAU is set to become a beacon in quantum research

In recognition of our outstanding expertise in quantum research: a consortium consisting of eleven researchers from Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU) will receive roughly three million euros in funding by 2025. The new lighthouse project Quantum Measurement and Control for the Enablement of Quantum Computing and Quantum Sensing (QuMeCo) will ignite basic research into quantum computing, sensing and imaging, combining physics and electrical engineering in new ways in the field of light and matter.

"FAU has already become well established in the area of quantum research thanks to a number of projects from our newly acquired professorship for Applied Quantum Technology, to the latest Humboldt professorship, to the collaborative research center 'Quantum Cooperativity of Light and Matter," states FAU President Prof. Dr. Joachim Hornegger. "The funding provided to the lighthouse project QuMeCo as part of the Bavarian quantum initiative Munich Quantum Valley further underlines our leading position." Bavaria's science minister Markus Blume elaborates, "We specifically intend to support interdisciplinary projects involving several universities that are capable of laying the foundation for pioneering innovations in the future. Innovations that exceed the boundaries of our imagination at the current time, but that will have a positive impact on us and future generations. The innovative topic of quantum technology underlines the visionary nature of the High-Tech Agenda Bavaria introduced by Bavarian Minister President Dr. Markus Söder. With the Munich Quantum Valley as its epicenter, the State of Bavaria is an internationally recognized top location for quantum technologies."

Connecting physics and electrical engineering

QuMeCo bundles the unique expertise of FAU in the area of the physics of light and matter with its expertise in electrical engineering, as reflected in the aims of the project. One of its goals is to lay the foundations for the next generation of superconducting quantum computers. "We are not only concerned with the performance and robustness of the qubits themselves," explains Prof. Dr. Christopher Eichler from the Department of Physics on behalf of the consortium. "We are also developing innovative selection procedures that do not disturb the highly sensitive system, but allow computing operations to be continued even whilst the results of the measurements are still being analyzed." The researchers also hope to optimize quantum control and error correction using machine learning and artificial neural networks.

A particular challenge for quantum computing is posed by electronic control systems. The consortium aims to develop microwave circuits that are located as close as possible to the quantum chips. Active elements require an extremely low power input in order to rule out undesired interactions with the qubits at the same time as enabling rapid control pulses to be processed in a matter of nanoseconds. An innovative laboratory is to be established in Erlangen for the purpose of characterizing circuits such as these at extremely low temperatures. Eichler: "With experimental set-ups such as these, we at FAU will have a decisive influence on furthering interdisciplinary research at the interface between electrical engineering and physics."

The third focus is on quantum sensors and imagery. The researchers are experimenting with novel quantum light sources and detectors, and using the special characteristics of entangled photons to investigate new technologies. They are also using color centers as highly sensitive quantum sensors to depict electrical and magnetic fields and electro-chemical and photo-chemical reactions of molecules at an entirely new level of optical resolution. As a result, researchers can gain insights into spectrums that are otherwise extremely hard to access, for example in order to gain a better understanding of biological processes leading up to the formation and spread of tumors. A further potential application is optimizing electrolytes or ionic fluids in order to increase the efficiency and lifespan of battery cells.

An Erlangen contingent in the Munich Quantum Valley

Eleven professors from FAU are involved in QuMeCo: Maria Chekhova, Christopher Eichler, Stephan Götzinger, Michael Hartmann, Florian Marquardt, Kai Phillip Schmidt and Joachim von Zanthier representing the area of light and matter from the Department of Physics and Roland Nagy, Martin Vossiek and Robert Weigel from the Department of Electrical Engineering (EEI). The project is embedded in existing research structures: it is closely connected, for example, to the Max Planck Institute for the Science of Light and the Fraunhofer Institutes for Integrated Circuits (IIS) and Integrated Systems and Device Technology (IISB). QuMeCo will also have close ties to the future Center for Applied Quantum Technologies (CAQT) in Erlangen.

The lighthouse project is part of the Munich Quantum Valley, an initiative aimed at promoting quantum sciences and quantum technologies in Bavaria that is funded by the Free State of Bavaria. Acting as a hub between research, industry, funding providers and the general public, one of the aims of the initiative is to contribute to developing and operating competitive quantum computers in Bavaria. Currently, FAU is the only university outside Munich that is part of the Munich Quantum Valley network.

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