FONDAZIONE BRUNO KESSLER
MAGAZINE

Winning quantum photonics

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Trento research toward an integrated quantum simulator awarded by IEEE

A research team from the **Laboratory of Nanoscience at the University of Trento's Department of Physics**, coordinated by Lorenzo Pavesi, and the **Center for Sensors and Devices** at Fondazione Bruno Kessler, led by **Mher Ghulinyan** and **Georg Pucker**, have won **first prize** for the best oral contribution on quantum photonics at the international Quantum Computing and Engineering conference organized by IEEE in Montreal, Sept. 15-21, 2024.

IEEE Quantum Week represents the world's most important conference where the latest research and industry developments on quantum technologies are presented and discussed, particularly toward the development of quantum computers.

The technical contribution of researchers from Trentino, presented by Stefano Azzini, a professor in the Department of Physics at the University of Trento, falls into the category of photonic quantum technologies, i.e. those based on the use of the quantum properties of light. In particular, they demonstrated the possibility of being able to integrate, on a chip made of a semiconductor material (silicon-based), all the devices necessary to operate a quantum simulator at room temperature.

"We can imagine a quantum simulator as a technology similar to a mechanical planetarium. *In a small-scale mechanical planetarium, the revolutionary motion of the various planets around the sun – described by the laws of classical mechanics – is shown in the right speed ratios by a system of mechanical wheels of different sizes and with different gearing. Similarly, the photonic quantum simulator under development in Trento is based on controlling quantum properties of light to reproduce the behavior of physical systems whose operation follows the laws of quantum mechanics, such as the hydrogen molecule. In fact, simulating quantum systems with traditional (classical) computers generally requires resources that increase exponentially with the size of the system itself. In contrast, simulating quantum systems with technologies that share the same nature makes it possible to break down these barriers. This is of great importance, for example in pharmaceutical or energy research. The award-winning research represents an important step toward the development of a quantum*

simulator that is portable and can operate at room temperature (while all technologies to date are bulky and require very low temperatures, about -270 C)," Azzini explained.

The award-winning work started in late 2020 in the context of the European project Epiqus, led by FBK with scientific head Mher Ghulinyan and involving in the partnership, in addition to the two Trento groups, laboratories from universities and research centers in Austria, Germany, Spain and South Korea.

Along with **Mher Ghulinyan** and **Georg Pucker**, this project included the collaboration of **Martino Bernard** and **Gioele Piccoli** – researchers at the Integrated and Quantum Optics unit – I@QO and **Fabio Acerbi**, researcher at the Custom Radiation Sensors CRS unit, both part of FBK's Center for Sensors & Devices.

UniTN press release

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