CTP PAS researchers develop universal method to verify quantum devices

Remigiusz Augusiak, PhD, and his collaborators at the Centre for Theoretical Physics of the Polish Academy of Sciences (CTP PAS) have developed an important universal scheme to verify quantum devices. The results, which will soon be published in Nature Physics, establish a key foundation for the future certification of quantum technologies.

The Problem of Trust in Quantum Devices

As quantum computers and quantum communication systems move from the laboratory into the real world, a critical question arises: how do we know a quantum device is actually doing what it claims? Unlike conventional computers, quantum devices are extraordinarily difficult to inspect directly. A technique called self-testing offers an elegant solution: by analysing only the statistical results of measurements, one can verify what a quantum device is truly doing, without opening it up or placing any trust in its manufacturer.

Until now, self-testing methods worked reliably only in limited, idealised scenarios. They struggled with real-world devices that introduce noise and imperfections, and with the more complex types of measurements that advanced quantum technologies require.

A Universal Solution

Augusiak and his team have now presented a scheme that overcomes these limitations. Their approach enables self-testing of any quantum measurement and, consequently, of any quantum state, including mixed states that arise naturally when noise is present. The scheme is built around a configuration known as a star network, a setup that can already be realised in existing experimental laboratories.

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This universality is a significant step forward. Previous methods were, in a sense, tailor-made for specific cases. This new framework provides a single, coherent approach applicable across the full spectrum of quantum states and measurements.

From Cryptography to Quantum Computing

The practical implications of this research span the breadth of emerging quantum technologies. In quantum cryptography, the ability to certify that a device is performing correctly and has not been tampered with is a prerequisite for genuinely secure communications. In quantum computing, verified and trusted measurement protocols are essential for reliable operation.

The work also represents a step towards device-independent quantum information processing, a paradigm in which security and correctness guarantees do not depend on trusting the hardware, but follow directly from the laws of physics.

CTP PAS: Towards a European Quantum Hub

This research reflects CTP PAS's growing commitment to quantum information science and its real-world applications. In the coming years, the Centre aims to become one of the leading institutions in Europe for the design, testing, and certification of quantum technologies, contributing both to fundamental science and to the broader European quantum ecosystem.

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