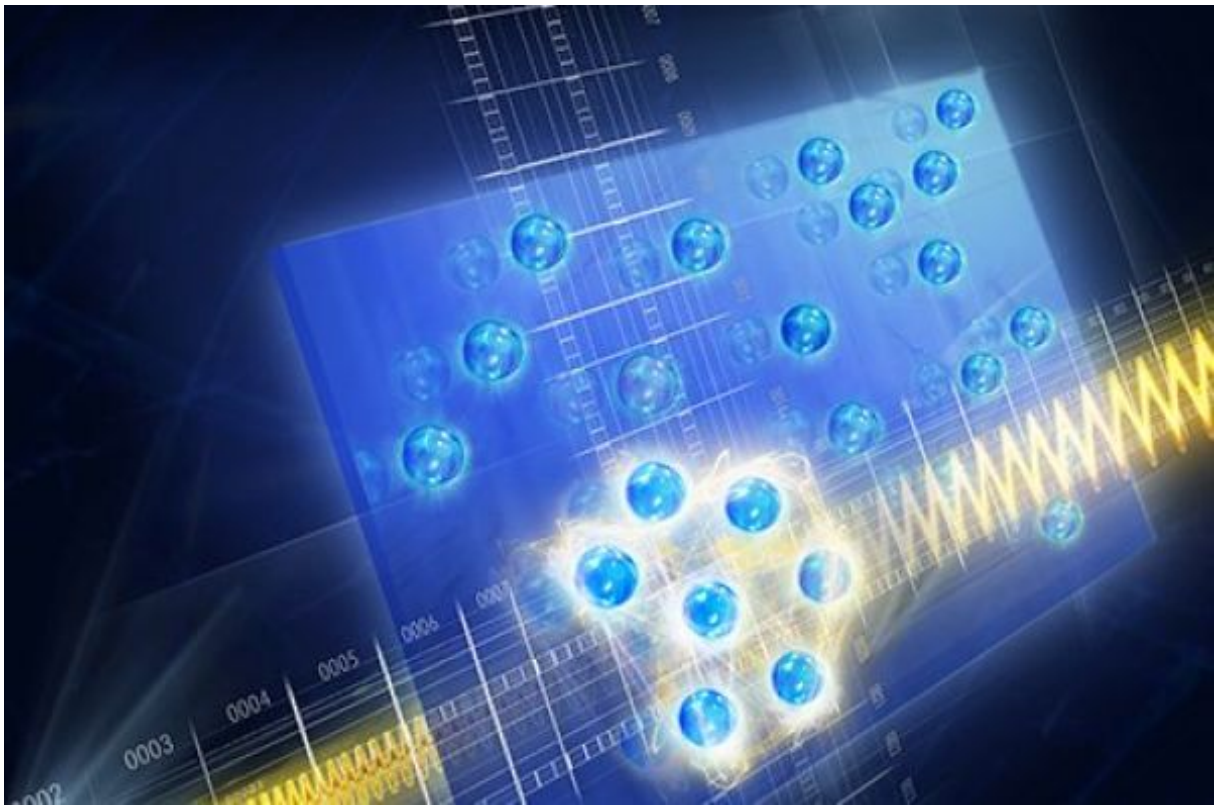


Entanglement Becomes Easier to Measure

Researchers from Innsbruck, Munich and ICFO develop a new protocol to detect entanglement of many-particle quantum states using a much easier approach.

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In Quantum Theory, interactions among particles create fascinating peculiar correlations that cannot be explained by any means known to the Classical World. Entanglement is a consequence of strange probabilistic rules of quantum mechanics and seems to permit a peculiar instantaneous connection between particles over long distances that defies the laws of our macroscopic world, a phenomenon that Einstein referred to as "spooky action at a distance".

Entanglement is a mysterious concept but there is little doubt that it contributes to provide super-powers to quantum systems. It indeed allows to obtain more precise measurements in

the field of quantum metrology, to perform faster computations in the field of quantum computations, and to characterize exotic phases in the field of quantum matter.

Developing protocols to detect and quantify entanglement of many-particle quantum states is thus a key challenge for current experiments since detecting entanglement becomes very difficult when many particles are involved.

In a study recently published in Nature Physics, researchers Dr. Philipp Hauke, a former ICFOnian, and Dr. Peter Zoller from the Institute for Theoretical Physics at the University of Innsbruck, in collaboration with Dr. Markus Heyl, from the Technische Universitat München and Dr. Luca Tagliacozzo, formerly a researcher of the Quantum Optics Theory researc group led by ICREA Prof. at ICFO Maciej Lewenstein and now Chancellor?s Fellow at th University of Strathclyde, have found a new way to detect certain properties of many-particl entanglement independently on the size of the system.

By using the standard measurements techniques available in the laboratories they have proposed a new detection protocol for entanglement, and have shown that by using it one can easily extract information about entanglement in many body systems. For instance, in the case of neutral atoms trapped in optical lattices, their protocol can be implemented by performing ordinary laser spectroscopy. Their protocol allows to measure the Quantum Fisher information, a reliable witness for genuinely multipartite entanglement.

The experimental measure of entanglement in many body quantum systems opens a new observational window in the world of quantum matter and will allow to better understand the role of quantum mechanical entanglement in many-body systems and their exotic emerging properties.