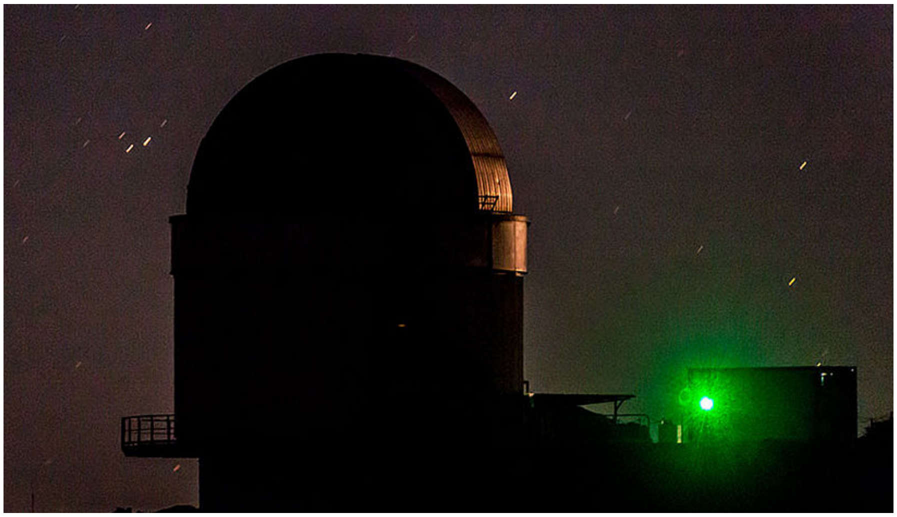
Old light confirms quantum entanglement

Editorial staff (uni: view) | August 21, 2018



A source of entangled photons sends at night from a mobile quantum physical laboratory on La Palma light particles to receiving stations. (© Massimo Cecconi)

With the help of the billion-year-old light of two quasars, physicists from the University of Vienna and the Austrian Academy of Sciences have once again demonstrated the validity of quantum mechanics and one of its strange-looking phenomena.

Albert Einstein was not fond of the quantum physical phenomenon of entanglement. Entangled particles can not physically be described as single particles with defined states, but only as a whole system. Even if they are very far away from each other, changes to a particle - such as a measurement - instantly affect the partner. No information is exchanged between the two particles.

Everything "haunted"?

Because this can not be explained with classical physics, Einstein dismissively classified the phenomenon as "spooky". Nevertheless, the effects of entanglement have been demonstrated in countless experiments. However, with some imagination, loopholes can be found, as the entanglement can be explained classically, that is, not by quantum physics - for example, through unknown influences.

For example, theoretically, the particles or the measuring devices could already have been influenced before the experiment in order to achieve this result. This could affect the random number generators used in interlacing experiments, for example. They provide a random sequence of zeros and ones to unpredictably switch between two different measurement arrangements.

"Free-choice" hatch holes closed

To **close** this "free-choice" loophole, the physicists invented imaginative experiments. An international team of researchers invited more than 100,000 people worldwide in a hands-on experiment to enter a random sequence of zeros and ones that were used to tune their gauges. Last year, the Viennese physicists used light from 600 light-years away stars for the fair settings - so an influence would have had to take place already 600 years ago.

Light from two quasars

Now, Zeilinger's team went one step further in cooperation with international colleagues. With two telescopes on the Canary Island of La Palma, they caught the light of two quasars. These brightly glowing nuclei of active galaxies are located in two opposite directions in the universe about eight or twelve billion light-years from Earth. The color of the individual light particles, which was determined during the formation of the quasars and varies between red and blue, controls the measurement settings of previously generated entangled particles.

Mit dem acht bzw. zwölf Milliarden Jahre alten Licht der beiden Quasare wollten die Physiker sicherstellen, dass die Entscheidung darüber, wie die verschränkten Teilchen gemessen werden, völlig unabhängig von den Forschern und ihrer Umgebung getroffen wird. "Das von Menschen, der Erde und fast unserer gesamten Vergangenheit völlig unabhängige Licht aus dem All ist dafür ideal geeignet", erklärte Erstautor Dominik Rauch vom Institut für Quantenoptik und Quanteninformation der Österreichischen Akademie der Wissenschaften und der Universität Wien in einer Aussendung.

Milliarden Jahre altes Licht

Es sei das erste Mal, dass Milliarden Jahre altes Licht zum Nachweis der Quantenverschränkung genutzt wurde. "Die Wahrscheinlichkeit, dass es verborgene Einflüsse gibt, die eine zur Quantenmechanik alternative Erklärung der Verschränkung liefern, liegt damit bei nahezu Null. Die Wahl der Messeinstellung hätte für unsere Versuchsanordnung lange vor der Entstehung der Erde erfolgen müssen", sagte Zeilinger. (APA/red)

The publication "Cosmic Bell test using random measurement settings from high-redshift quasars" (authors: Dominik Rauch, Johannes Handsteiner, Armin Hochrainer, Jason Gallicchio, Andrew S. Friedman, Calvin Leung, Bo Liu, Lukas Bulla, Sebastian Ecker, Fabian Steinlechner Rupert Ursin, Beili Hu, David Leon, Chris Benn, Adriano Ghedina, Massimo Cecconi, Alan H. Guth, David I. Kaiser, Thomas Scheidl and Anton Zeilinger) appeared on August 20, 2018 in Physical Review Letters.

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Faculty of Physics of the University of Vienna

Press release of the OEAW

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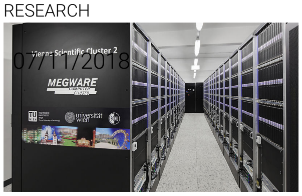

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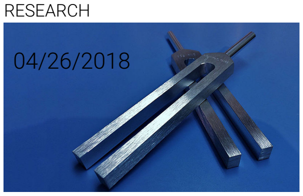

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