Quantum paradox directly observed -- a milestone in quantum mechanics

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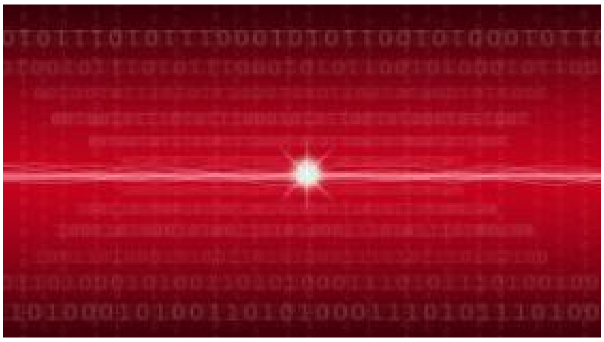

Quantum image

In quantum mechanics, a vanguard of physics where science often merges into philosophy, much of our understanding is based on conjecture and probabilities, but a group of researchers in Japan has moved one of the fundamental paradoxes in quantum mechanics into the lab for experimentation and observed some of the 'spooky action of quantum mechanics' directly.

Hardy's Paradox, the axiom that we cannot make inferences about past events that haven't been directly observed while also acknowledging that the very act of observation affects the reality we seek to unearth, poses a conundrum that quantum physicists have sought to overcome for decades. How do you observe quantum mechanics, atomic and sub-atomic systems that are so small-scale they cannot be described in classical terms, when the act of looking at them changes them permanently?

In a journal paper published in the *New Journal of Physics*, 'Direct observation of Hardy's paradox by joint weak measurement with an entangled photon pair', today, Wednesday, 4 March, authored by Kazuhiro Yokota, Takashi Yamamoto, Masato Koashi and Nobuyuki Imoto from the Graduate School of Engineering Science at Osaka University and the CREST Photonic Quantum Information Project in Kawaguchi City, the research group explains how they used a measurement technique that has an almost imperceptible impact on the experiment which allows the researchers to compile objectively provable results at sub-atomic scales.

The experiment, based on Lucien Hardy's thought experiment, which follows the paths of two photons using interferometers, instruments that can be used to interfere photons together, is believed to throw up contradictory results that do not conform to our classical understanding of reality. Although Hardy's Paradox is rarely refuted, it was only a thought experiment until recently.

Using an entangled pair of photons and an original but complicated method of weak measurement that does not interfere with the path of the photons, a significant step towards harnessing the reality of quantum mechanics has been taken by these researchers in Japan.

As the researchers write, "Unlike Hardy's original argument, our demonstration reveals the paradox by observation, rather than inference. We believe the demonstrated joint weak measurement is useful not only for exploiting fundamental quantum physics, but also for various applications such as quantum metrology and quantum information technology."

More information: Journal paper: www.iop.org/EJ/abstract/1367-2630/11/3/033011/

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