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News: Quantum Physics

Cosmic test confirms quantum weirdness

Distant stars as source of randomness constrains loophole in entanglement experiments

By EMILY CONOVER 7:00AM, DECEMBER 5, 2016

COSMIC BELL Scientists used light from stars, including HIP 2876 (shown), to perform a cosmic Bell test, verifying the weird nature of quantum mechanics. The scientists used variations in the color of the light emitted from the star to randomly select measurement settings in the experiment.

Digitized Sky Survey/STScI/NASA, CDS

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The spookiness of quantum mechanics has gone cosmic.

Physicists have used starlight to perform a “Bell test” to verify the strange nature of quantum mechanics. For decades, such tests have repeatedly confirmed quantum physics’s quirks, but the tests contained loopholes. While the major loopholes have already been closed (*SN: 12/26/15, p. 24*), a lingering caveat remained, regarding whether the measurement equipment’s settings were chosen randomly. To tackle that loophole, scientists used the starlight as a source of randomness. Quantum mechanics emerged unscathed, physicists from the United States and Austria reported online November 22 at arXiv.org.

“It’s a very elegant experiment and I think the results are quite beautiful,” says physicist Krister Shalm of the National Institute of Standards and Technology in Boulder, Colo., who was not involved with the measurement. “I think it’s an important loophole to consider.”

But, says physicist Matthew Leifer of Chapman University in Orange, Calif., “I don’t think it's going to radically change anyone’s worldview.” Scientists were already quite convinced of the counterintuitive nature of quantum physics.

Unlike everyday objects, quantum particles can be linked over long distances, behaving as one integrated whole, through a phenomenon called quantum entanglement. A pair of photons, for example, can be created such that their polarization, or the orientation of their electromagnetic fields, must line up. Before they are measured, the photons exist in a kind of limbo, with their polarizations pointing in multiple directions at once. But measure the polarization of one photon, and the result immediately tells the experimenter the state of its partner, even if they are light-years apart.

This strange interconnectedness, or “nonlocality,” has made some scientists uneasy: Albert Einstein famously derided it as “spooky action at a distance.” In the 1960s, physicist John Bell proposed a method to confirm whether quantum particles were really spooky.

In the new work, scientists performed a Bell test, but added a cosmic twist. The scientists produced entangled pairs of photons, separated the two photons by more than a kilometer, and measured both of their polarizations. The measured polarization could be one of two options — for example, it might be either horizontal or vertical. But in the test, the axis along which that polarization is measured is changed for different photons. The scientists might decide to measure at an angle of either 30 degrees or 120 degrees, for example.

If quantum mechanics holds true, the results of the two measurements will be more correlated than in a universe with some nonspooky version of quantum mechanics. But this conclusion demands that the axis along which each photon’s polarization is measured is chosen randomly, and is uncorrelated with the produced photons.

To ensure that no outside influence could have an impact, the scientists used the color of photons produced by two stars, hundreds of light-years from Earth, to assign the measurement axis. Redder light triggered measurement on one axis, and bluer light, another. Any influence that could have affected both the photons and the starlight must have originated about 600 years ago or earlier — an unlikely scenario. The result bolsters the evidence for the bizarreness of quantum physics.

Authors of the study declined to comment, as the paper is undergoing peer review.

Previous Bell tests already provided strong evidence of quantum weirdness in nature. These tests used other methods to generate randomness, even digitizing old movies to create a random string of numbers. Consequently, some scientists have questioned the importance of the new test. “I have to say that I'm not too impressed and surprised by the result,” says physicist Nicolas Gisin of the University of Geneva.

With future tests, scientists could use more distant sources, such as quasars, to push the 600-year time limit back even further. But the loophole is impossible to fully close, says Gisin. “You can always say that everything was determined at the Big Bang.”

Citations

J. Handsteiner et al. A cosmic Bell test with measurement settings from astronomical sources. arXiv:1611.06985. Posted November 22, 2016.

Further Reading

A. Grant. Year in review: Quantum spookiness is real. *Science News.* Vol. 188, December 26, 2015, p. 24.

A. Grant. New experiment verifies quantum spookiness. *Science News.* Vol. 188, September 19, 2015, p. 12.

A. Grant. More tests confirm quantum spookiness. Science News Online, November 13, 2015.

T. Siegfried. Quantum spookiness survives its toughest tests. Science News Online, January 27, 2016.