Researchers explore quantum entanglement

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Albert Einstein called quantum entanglement—two particles in different locations, even on other sides of the universe, influencing each other—"spooky action at a distance."

Einstein made the comment while criticizing quantum mechanics as incomplete—the phenomenon of quantum entanglement seems to be at odds with Einstein's theory of relativity.

"Eighty years after Einstein, quantum physics is still so mysterious that there are many different interpretations of its physical meaning. All the interpretations agree on what is going to be observed in any given experiment, but they each tell different stories of how these observations come about," says Christoph Simon with the Department of Physics and Astronomy in the Faculty of Science at the University of Calgary.

Simon and his colleague, Boris Braverman from the Massachusetts Institute of Technology have shown this spooky action at a distance in research published today in *Physical Review Letters*. The paper proposes a way in which the effect can be shown experimentally.

"We consider spooky action at a distance in the framework of an interpretation from the English physicist David Bohm who posited that every quantum particle has a well-defined position and velocity," says Simon.

"If the two particles are entangled, then performing an action on one has an immediate effect on the other and our paper shows how this effect can be demonstrated in an experiment with entangled photons."

Entangled photons present an exciting new method of secure communications—it's impossible for people to listen in. But this phenomenon can't be used for communication faster than the speed of light (what physicists call superluminal), allowing quantum physical systems to obey Einstein's theory of relativity, which posits that things can't communicate faster than light.

There is either no explanation for this—it's magic and somehow there are the same outcomes on each side—or the communication between photons is superluminal, which is problematic given the theory of relativity. "There has to be a way out," says Simon.

"Different pairs of particles coming from the same source have slightly different positions and velocities," he says. "If you observe just one of the two particles from a pair, you can't be sure if a variation in its velocity, say, is due to the long-distance influence of its partner, or whether it is just a statistical fluctuation. In this way the peaceful coexistence of quantum physics and relativity is preserved."

Provided by University of Calgary

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