Einstein-Podolsky-Rosen paradox seen in multi-particle system for the first time

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April 27 (UPI) -- For the first time, physicists have observed the quantum mechanical Einstein-Podolsky-Rosen paradox in a multi-particle system. University of Basel scientists detailed the feat in a new paper published Friday in the journal Science.

The Einstein-Podolsky-Rosen paradox began as a 1935 thought experiment designed to contradict the Heisenberg uncertainty principle, which claimed it was impossible to simultaneously measure a particle's position and momentum, the two components of spin.

In a 1935 paper, however, Albert Einstein, Boris Podolsky and Nathan Rosen showed precise measurements of a particle's position and momentum was possible under certain circumstances. Their thought experiment relied a pair of entangled systems, A and B -- systems with strongly correlated properties.

Their entanglement allows scientists to predict the position and momentum of a particle in system B using the measurements of system A, even if the two systems are physically separated. The paradox is that scientists measuring system A can't make more precise predictions about system B than the scientists directly measuring system B.

In recent decades, scientists have translated the EPR paradox using light or individual atoms. But now, researchers at the University of Basel and the Swiss Nanoscience Institute have observed the paradox in a system featuring hundreds of atoms.

Scientists began their experiment by using lasers to cool the atoms to just above absolute zero. In their frigid state, atoms follow the laws of quantum mechanics and form a Bose-Einstein condensate, in which the atoms constantly collide and become entangled.

The physicists measured the spin rates in spatially separate portions of the condensate. High-resolution imaging allowed the scientists to simultaneously measure the spin correlation between the separate regions and the position of individual atoms. The results showed the measurements of one region could be used to predict the measurements of the other.

"The results of the measurements in the two regions were so strongly correlated that they allowed us to demonstrate the EPR paradox," lead study author Matteo Fadel, a PhD student at Basel, said in a news release. "It's fascinating to observe such a fundamental phenomenon of quantum physics in ever larger systems. At the same time, our experiments establish a link between two of Einstein's most important works."

Scientists believe the EPR paradox could be used to develop more accurate atomic sensors and as well as imaging technologies for electromagnetic fields.