Making big 'Schroedinger cats': Quantum research pushes boundary by testing micro theory for macro objects

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Since Erwin Schroedinger's famous 1935 cat thought experiment, physicists around the globe have tried to create large scale systems to test how the rules of quantum mechanics apply to everyday objects.

Researchers at the University of Calgary recently made a significant step forward in this direction by creating a large system that is in two substantially different states at the same time. Until this point, scientists had only managed to recreate quantum effects on much smaller scales.

Professor Alex Lvovsky and associate professor Christoph Simon from the Physics and Astronomy department together with their graduate students revealed their findings in a world leading physics research journal, *Nature Physics*.

Understanding Schroedinger's cat

In contrast to our everyday experience, quantum physics allows for particles to be in two states at the same time – so-called quantum superpositions. A radioactive nucleus, for example, can simultaneously be in a decayed and non-decayed state.

Applying these quantum rules to large objects leads to paradoxical and even bizarre consequences. To emphasize this, Erwin Schroedinger, one of the founding fathers of quantum physics, proposed in 1935 a thought

experiment involving a cat that could be killed by a mechanism triggered by the decay of a single atomic nucleus. If the nucleus is in a superposition of decayed and non-decayed states, and if quantum physics applies to large objects, the belief is that the cat will be simultaneously dead and alive.

While quantum systems with properties akin to 'Schroedinger's cat' have been achieved at a micro level, the application of this principle to everyday macro objects has proved to be difficult to demonstrate.

"This is because large quantum objects are extremely fragile and tend to disintegrate when subjected to any interaction with the environment," explains Lvovsky.

Photons help to illuminate the paradox

The breakthrough achieved by Calgary quantum physicists is that they were able to contrive a quantum state of light that consists of a hundred million light quanta (photons) and can even be seen by the naked eye. In their state, the "dead" and "alive" components of the "cat" correspond to quantum states that differ by tens of thousands of photons.

"The laws of quantum mechanics which govern the microscopic world are very different from classical physics that rules over large objects such as live beings," explains lead author Lvovsky. "The challenge is to understand where to draw the line and explore whether such a line exists at all. Those are the questions our experiment sheds light on," he states.

While the findings are promising, study co-author Simon admits that many questions remain unanswered.

"We are still very far from being able to do this with a real cat," he says. "But this result suggests there is ample opportunity for progress in that

direction."

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