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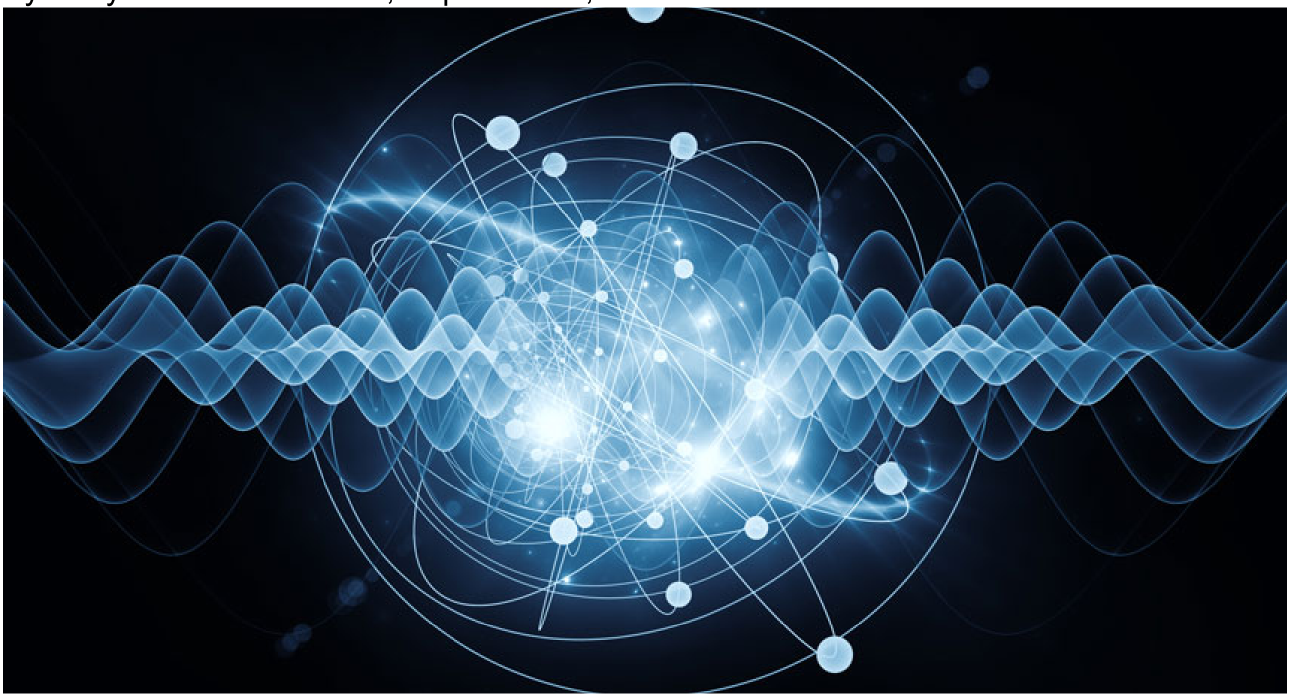
News: Quantum Physics

Minuscule jitters may hint at quantum collapse mechanism

Data match prediction for wave function theory, but more experiments are needed

By Emily Conover 11:05am, September 1, 2017



QUANTUM COLLAPSE Using a miniature vibrating cantilever, scientists are searching for an explanation of how the wave function of a particle collapses to a single place. Excess jittering in the cantilever could provide clues, but other sources of shaking must first be ruled out.

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A tiny, shimmying cantilever wiggles a bit more than expected in a new experiment. The excess jiggling of the miniature, diving board–like structure might hint at why the strange rules of quantum mechanics don't apply in the familiar, "classical" world. But that potential hint is still a long shot: Other sources of vibration are yet to be fully ruled out, so more experiments are needed.

Quantum particles can occupy more than one place at the same time, a condition known as a superposition (*SN: 11/20/10, p. 15*). Only once a particle's position is measured does its location become definite. In quantum terminology, the particle's wave function, which characterizes the spreading of the particle, collapses to a single location (*SN Online: 5/26/14*).

In contrast, larger objects are always found in one place. "We never see a table or chair in a quantum superposition," says theoretical physicist Angelo Bassi of the University of Trieste in Italy, a coauthor of the study, to appear in *Physical Review Letters*. But standard quantum mechanics doesn't fully explain why large objects don't exist in superpositions, or how and why wave functions collapse.

Extensions to standard quantum theory can alleviate these conundrums by assuming that wave functions collapse spontaneously, at random intervals. For larger objects, that collapse happens more quickly, meaning that on human scales objects don't show up in two places at once.

Now, scientists have tested one such theory by looking for one of its predictions: a minuscule jitter, or "noise," imparted by the random nature of wave function collapse. The scientists looked for this jitter in a miniature cantilever, half a millimeter long. After cooling the cantilever and isolating it to reduce external sources of vibration, the researchers found that an unexplained trembling still remained.

In 2007, physicist Stephen Adler of the Institute for Advanced Study in Princeton, N.J., predicted that the level of jitter from wave function collapse would be large enough to spot in experiments like this one. The new measurement is consistent with Adler's prediction. "That's the interesting fact, that the noise matches these predictions," says study coauthor Andrea Vinante, formerly of the Institute for Photonics and Nanotechnologies in Trento, Italy. But, he says, he wouldn't bet on the source being wave function collapse. "It is much more likely that it's some not very well understood effect in the experiment." In future experiments, the scientists plan to change the design of the cantilever to attempt to isolate the vibration's source.

The result follows similar tests performed with the LISA Pathfinder spacecraft, which was built as a test-bed for gravitational wave detection techniques. Two different studies found no excess jiggling of free-falling weights within the spacecraft. But the new cantilever experiment tests for wave function collapse occurring at different rate and length scales than those previous studies.

Theories that include spontaneous wave function collapse are not yet accepted by most physicists. But interest in them has recently become more widespread, says physicist David Vitali of the University of Camerino in Italy, "sparked by the fact that technological advances now make fundamental tests of quantum mechanics much easier to conceive." Focusing on a simple system like the cantilever is the right approach, says Vitali, who was not involved with the research. Still, "a lot of things can go wrong or can be not fully controlled."

To conclude that wave function collapse is the cause of the excess vibrations, every other possible source will have to be ruled out. So, Adler says, "it's going to take a lot of confirmation to check that this is a real effect."

Citations

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Further Reading

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