Bizarre "quantum" behavior noted in device large enough to see

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A device large enough to be seen with the unaided eye has been made to show "quantum" behavior, a possibility that previously applied only to much smaller objects, physicists say.

Quantum behavior is a set of seemingly nonsensical rules that scientists have found to apply most clearly at atomic and smaller size scales. Here, objects behave —as they present themselves in experiments—in paradoxical ways, for instance, as though they were in two places at once, or possessed of other mutually contradictory properties.

Because no physicist has yet found clear and widely agreed-upon ways to avoid such conclusions, this strange picture of reality must be taken more or less as a given in experiments at the quantum realm.

The bizarre effects fade away at larger sizes because as more particles are added into a system, the seemingly absurd individual behaviors blend together and effectively cancel each other out.

Now, though, a group of physicists report that observably "quantum" behavior can be restored to a thing large enough to see with the naked eye, under special circumstances.

The object must be drastically cooled until it reaches a so-called "quantum ground state," where all vibrations due to heat are eliminated, according to the researchers, Andrew Cleland of the University of California, Santa Barbara, and colleagues.

The group made a vibrating device akin to a tiny drum, with a very high oscillation speed — over 6 billion oscillations per second. They then cooled the "quantum drum" to one-fortieth of a degree above the theoretically minimum temperature attainable anywhere, called absolute zero. The resonator, about a twenty-fifth of a millimeter wide, was also linked electrically to a well-understood quantum device, called a superconducting quantum bit or "qubit."

The scientists then used the qubit to stimulate the resonator to produce the smallest possible unit of vibrational energy, called a phonon, producible by the device. They further transferred this energy repeatedly between the resonator and qubit.

Because a phonon behaves in certain ways as both a wave and a particle, it exhibits a property called wave-particle duality similar to that found in other objects at the quantum realm. Examples include particles of light, called photons.

The setup implies that the researchers have achieved "quantum control" over the apparatus, they said.

Physicist Markus Aspelmeyer of the University of Vienna, who was not involved in the research, agreed. Cleland's group has achieved "control [of] macroscopic [visible] mechanical objects in their smallest possible state of motion," he explained in an article in the March 18 issue of the research journal *Nature*. "Success in achieving that goal heralds a new generation of quantum experiments."

Cleland and colleagues, whose own findings are published in the same issue of the journal, said they also demonstrated in their device the possibility of some of the paradoxical behavior heretefore seen only in the sub-microscopic quantum realm.

They managed to place the resonator in a state called superposition, in which the system is "both excited and not excited at the same time," that is, both moving and stationary, said Cleland in an email. "This is not the same as half of an excitation, as the excitations are indivisible."