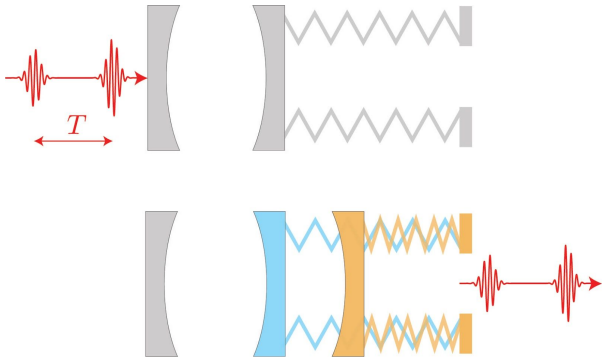
Painting Schrödinger's Cat with a Single Photon

A fundamental postulate of quantum mechanics states that an object can be prepared in a "superposition" of two or more different states which, classically, are incompatible. Superposition states of individual particles, such as a photon or an electron that is in two places at once, are routinely created and well understood. A long-standing question is whether one can bridge the gap between quantum and classical physics by preparing macroscopic objects in superposition states — as in the celebrated thought experiment of Schrödinger's cat, which is both alive and dead. Surprisingly, this can be accomplished with the aid of only a single photon, in a scheme proposed by Emily Davis and collaborators in *Physical Review Letters*.

Davis and collaborators propose a scheme for converting a superposition state of a single photon into a superposition state of a more macroscopic object, such as a mass on a spring that is simultaneously extended (alive) and compressed (dead). A photon hitting a spring normally has very little effect. However, its effect can be enhanced by placing a mirror on the spring and adding a second opposing mirror — then the photon bounces back and forth, hitting the mirror and spring millions of times before escaping. To make the spring extend and compress at once, we have to play another trick: fire the photon at the mirrors in a superposition of two pulses separated by a time T. The photon then kicks the spring into an oscillation whose phase (extending or compressing) depends on when the photon struck — leaving the mirror and spring in a "Schrödinger's Cat" state. The same scheme generalizes to preparing a wider range of macroscopic quantum states simply by shaping the frequency and intensity of a laser pulse. By manipulating the laser light much like an artist wields her paintbrush, the physicist may freely shape the quantum state.



Top: A mirror is mounted on a spring and placed facing a second mirror. A photon in a superposition of two pulses (red) is fired at the mirrors. *Bottom:* Superposition state of the mirror on a spring both extending (blue) and compressing (orange) after being kicked by the photon at two different possible times.

Reference

E. Davis, Z. Wang, A. Safavi-Naeini, and M. Schleier-Smith, "Painting Non-Classical States of Spin or Motion with Shaped Single Photons." To appear in *Physical Review Letters*.

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