How the quantum Zeno effect impacts Schroedinger's cat

June 16 2017

Credit: Washington University in St. Louis

You've probably heard about Schrödinger's cat, which famously is trapped in a box with a mechanism that is activated if a radioactive atom decays, releasing radiation. The act of looking in the box collapses the atom's wave function—the mathematical description of its state —from a "superposition" of states to a definite state, which either kills the cat or let's it live another day.

But did you know that if you peek into the cat box frequently—thousands of times a second—you can either delay the fateful choice or, conversely, accelerate it? The delay is known as the quantum Zeno effect and the acceleration as the quantum anti-Zeno effect.

The quantum Zeno effect was named by analogy with the arrow paradox conceived by the Greek philosopher Zeno: At any given instant of time, an arrow in flight is motionless; how then can it move? Similarly, if an atom could be continually measured to see if it is still in its initial state, it would always be found to be in that state.

Both the Zeno and an the anti-Zeno effects are real and happen to real atoms. But how does this work? How can measurement either delay or accelerate the decay of the radioactive atom? What is "measurement," anyway?

The physicist's answer is that in order to obtain information about a quantum system, the system must be strongly coupled to the environment for a brief period of time. So the goal of measurement is to obtain information, but the strong coupling to the environment means that the act of measurement also necessarily disturbs the quantum system.

But what if the system was disturbed but no information was passed to the outside world? What would happen then? Would the atom still exhibit the Zeno and anti-Zeno effects?

Kater Murch's group at Washington University in St. Louis has been exploring these questions with an artificial atom called a qubit. To test the role of measurement in the Zeno effects, they devised a new type of measurement interaction that disturbs the atom but learns nothing about its state, which they call a "quasimeasurement."

They report in the June 14, 2017, issue of *Physical Review Letters* that quasimeasurements, like measurements, cause Zeno effects. Potentially the new understanding of the nature of measurement in quantum mechanics could led to new ways of controlling quantum systems.

More information: P.?M. Harrington et al. Quantum Zeno Effects from Measurement Controlled Qubit-Bath Interactions, *Physical Review Letters* (2017). DOI: 10.1103/PhysRevLett.118.240401

Provided by Washington University in St. Louis