Physikalisches Kolloquium
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"What does a single atom reveal to its observer?"

Abstract:
The evolution of quantum mechanics has followed the critical analysis of "gedanken" experiments. Many of these concrete speculations can become implemented today in the laboratory - thanks to now available techniques. A key experiment is concerned with the time evolution of a quantum system under repeated or continuing observation. Here, three problems overlap: 1. The microphysical measurement by a macroscopic device, 2. the system's temporal evolution, and 3. the emergence of macroscopic reality out of the microcosmos.

A well-known calculation shows the evolution of a quantum system being slowed down, or even obstructed, when the system is merely observed. An experiment designed to demonstrate this "quantum Zeno effect" and performed in the late eighties on an ensemble of identical atomic ions confirmed its quantum description, but turned out inconclusive with respect to the very origin of the impediment of evolution.

During the past years, experiments on individual electrodynamically stored and laser-cooled ions have been performed that unequivocally demonstrate the observed system's quantum evolution being impeded. Strategy and results exclude any physical reaction on the measured object, but reveal the effect of the gain of information as put forward by the particular correlation of the ion state with the detected signal. They shed light on the process of measurement as well as on the quantum evolution and allow an epistemological interpretation.