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Title: To catch and reverse a quantum jump mid-flight

Abstract: Quantum physics differs fundamentally from classical physics in that the measurement of a quantity cannot always give certain results, even in the ideal case where both the preparation and the measurement of the system is perfect. This idea is epitomized in the phenomenon of quantum jumps, first hypothesized by Bohr in his description of the radiation emitted by an excited hydrogen atom, and now routinely observed in the laboratory on a single quantum entity. Quantum jumps are fundamentally random: the time at which they occur cannot be predicted. However, modern measurement theory stipulates that it is possible to obtain an advance warning signaling the imminent occurrence of the jump, before its full completion. Consequently, it is possible to reverse the jump if it is initiated by a coherent drive. We have successfully caught and reversed jumps [1] by implementing the indirect QND measurement of a superconducting artificial atom that undergoes a transition from its ground state G to a dark state D. This is achieved by monitoring the occupancy of an auxiliary bright level B coupled to G through a Rabi drive. Our experimental results, in agreement with the predictions of quantum trajectory theory with essentially no adjustable parameters, provide new ground for the exploration of real-time intervention techniques in the control of quantum systems, such as early detection of error syndromes for computation and sensing. More generally, our results provide support to the point of view that a single system under continuous, efficient observation is characterized by a time-dependent wave-function inferred from the record of previous measurement outcomes, and whose meaning is that of an objective, generalized degree of freedom.