Abstract Submitted
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Fluctuation theorems and an arrow of time for weak spin measurements of an ultracold gas[1] MAITREYI JAYASEELAN, SREENATH K. MANIKANDAN, ANDREW N. JORDAN, NICHOLAS P. BIGELOW, University of Rochester — When a quantum system undergoes not projective but weak measurements, the dynamics followed by the system are in general symmetric under time-reversal. Yet, as the quantum system is monitored and information about its state is obtained, the quantum mechanical wavefunction is seen to undergo irreversible collapse to one of the eigenstates of the observable being measured. Fluctuation theorems quantify the emergence of irreversibility from microscopically reversible dynamics such as when quantum systems are weakly measured. Here we show the emergence of irreversibility in weak measurements of spin state performed on an ultracold atomic cloud. A coherent two-photon Raman process prepares the atoms in a superposition of spin states in a pseudo-spin-1/2 system. A time-of-flight Stern–Gerlach process with variable strength subsequently correlates atomic spin state (our observable) with spatial position (our readout). The spatial distribution of the coherent atomic cloud thus serves to provide an ensemble average of weak spin measurements on the cloud in a single shot. We demonstrate the existence of a strictly positive average arrow of time that emerges as our measurement strength is varied, and we characterise the irreversibility of such spin-state measurements in our system.

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