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Real-time tracking and stabilization of cavity-coupled atomic gases JULIAN WOLF, JOHANNES ZEIHER, JOSH ISAACS, JONATHAN KOHLER, DALILA ROBLEDO, DAN STAMPER-KURN, University of California, Berkeley — Ultracold atoms dispersively coupled to optical cavities are an ideal testbed for studying quantum measurement and control. Through sensitivity to the atomic state, an optical field in cavity can apply coherent backaction, modifying the dynamics of an atomic ensemble. In addition, photons leaving the cavity carry information about the real-time dynamics of the atomic ensemble. Here, we show how tracking of the dispersive cavity shift enables the non-invasive study of the time evolution of the atom number. We track the real-time evolution of the atom number during evaporative cooling in a cloud of laser-cooled atoms. The minimally-invasive measurement allows for extracting two-time atom number correlation functions, which provide further insight into the evaporation dynamics. Using feedback, we demonstrate the preparation of atomic ensembles with sub-Poissonian shot-to-shot atom number fluctuations. In a different set of experiments, we investigate dynamics of the collective spin of an atomic ensemble. Tracking the real-time energy exchange between light and spin reveals autonomous stabilization of the spin to the cavity drive. Our results illustrate the interplay of measurement and feedback in optical cavities and pave the way for future studies of feedback-stabilized atomic systems.

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