Diffusion of single atoms in an optical cavity

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We explore the diffusion of laser-cooled atoms in a high-finesse optical cavity. While single atoms fall through the cavity, the resonator is driven with a weak laser field, and we measure the second-order correlation function of the cavity output field. The diffusive atomic motion significantly changes the photon statistics from that of a coherent state: the atoms mostly experience the dipole force and its fluctuations, and recoil kicks by the spontaneous emission. We identify the contribution of each force via analyzing the correlation function at several frequencies of the driving laser. Furthermore, we add a secondary intracavity dipole field to control the atomic motion, showing a change from the regime of sub- to super-diffusion. We expect that our method could be utilized to understand the motion of chemical or biological molecules.