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Diffusion of Single Cs Atoms in a Bath DANIEL MAYER, MICHAEL HOHMANN, FARINA KINDERMANN, TOBIAS LAUSCH, FELIX SCHMIDT, ARTUR WIDERA, University of Kaiserslautern — Studying the dynamics of single impurities in a many-body system of ultracold gases allows deducing insights on diffusion processes and non-equilibrium behavior at a microscopic level in a broad parameter range. First, we experimentally observe the non-equilibrium dynamics of single Cs atoms impinging on an ultracold Rb cloud and detect the effect of individual collisions. We render the friction coefficient of a modified Langevin equation velocity dependent and thereby extend the validity range to light impurities which yields excellent agreement with our data without free parameters. We further show that the gas temperature can be retained from the Cs atoms, suggesting their use as local, non-destructive probes for a quantum many-body system. Finally, we couple single Cs atoms in a periodic potential to a bath of near-resonant photons and study the ensuing diffusion. Analyzing diffusion traces of single atoms we observe marked non-Brownian features not detectable in standard ensemble properties and find a surprisingly slow timescale on which ergodicity is established in the system. Our results might shed light on the interpretation of similar phenomena in single-particle tracking experiments in life science.

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