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**Non-equilibrium Steady-State Behavior in a Scale-Free Quantum Network** JIANSHI ZHAO, CRAIG PRICE, QI LIU, NATHAN GEMELKE, The Pennsylvania State University — We describe the nonequilibrium dynamics of a cold atomic gas held in a spatially random optical potential and gravity, subject to a controlled amount of dissipation in the form of an extremely slow dark-state laser cooling process. Reaching local kinetic temperatures below the 100nK scale, such systems provide a novel context for observing the non-equilibrium steady-state (NESS) behavior of a disordered quantum system. For sufficiently deep potentials and strong dissipation, this system can be modeled by a self-organized version of directed percolation, and exhibits power-law decay of phase-space density with time due to the presence of absorbing clusters with a wide distribution of entropy and coupling rates. In the absence of dissipation, such a model cannot apply, and we observe the crossover to exponential loss of phase-space density. We provide measurements of the power-law decay constant by observing the non-equilibrium motion of atoms over a ten-minute period, consistent with $\gamma = 0.31 \pm 0.04$, and extract scaling of the absorbed number with dissipation rate, showing another power-law behavior, with exponent $0.5 \pm 0.2$ over two decades of optical excitation probability.

Nathan Gemelke
The Pennsylvania State University

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