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Non-Equilibrium Dynamics of an Atomic Gas Coupled to a Synthetic Thermal Body CRAIG PRICE, QI LIU, JIANSHI ZHAO, NATHAN GEMELKE, Pennsylvania State University — One takes for granted that thermal equilibrium can be established between two bodies by bringing them into physical contact with one another - viewed externally however, any statistical reservoir must therefore interact in ways such that the exchange of conserved quantities satisfy basic constraints which define the equilibrium it and any attached bodies reach. We describe the experimental construction of a "synthetic thermal body," engineered by controlling the spatio-temporal modulation of nominally conservative optical, radio-frequency, and microwave couplings of a ^{87}Rb neutral atomic gas carrying hyperfine-spin to a spin-dependent spatially and temporally disordered bath. We measure the out-of-equilibrium response through its resultant diffusive motion, extracting drift and diffusion parameters, and making comparison to the Einstein-Smoluchowski and generalized fluctuation-dissipation relations. We discuss new limits on temperature and density for direct cooling by suitably engineered baths, by simultaneously avoiding the constraints of photon-recoil and density-dependent losses from light-assisted collisional processes in traditional laser cooling, and discuss new avenues in quantum simulation by coupling atomic gasses to statistically-generated and open environments.

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