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Cooling and Non-equilibrium Motion of an Ultracold Atomic Gas using Synthetic Thermal Bodies CRAIG PRICE, QI LIU, JIANSHI ZHAO, NATHAN GEMELKE, Pennsylvania State University — We describe the non-equilibrium behavior of atomic gases immersed in synthetic thermal environments created by engineered statistical reservoirs of spatio-temporally disordered light. By dynamically modulating the modal distribution of an optical fiber carrying far off-resonant light, optical dipole potentials are created for ^{87}Rb atoms with specified spatial and temporal spectra. Additional coupling to thermal reserviors defined by time-dependent radio-frequency-induced hyperfine spin-couplings offers a wide range of control over thermal excitations. By controlling the statistical properties of the baths, diffusive motion can be tailored in real-time, and transport can be controlled even at ultra-cold temperatures below the photon recoil. The use of an effectively statistical classical body opens new avenues for quantum simulation, and offers opportunities for study of systems governed by effective hamiltonians which are themselves poised near critical points, and the simulation of effectively many-body systems through the non-equilibrium motion of single atoms.

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