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Negative absolute temperature for mobile particles and expansion dynamics of interacting bosons in optical lattices SIMON BRAUN, PHILIPP RONZHEIMER, MICHAEL SCHREIBER, SEAN HODGMAN, IMMANUEL BLOCH, ULRICH SCHNEIDER, Ludwig Maximilians University Munich, Max Planck Institute of Quantum Optics Garching — We present recent experiments with ultracold bosonic 39K atoms in an optical lattice, implementing the Bose-Hubbard Hamiltonian. Absolute temperature is usually bound to be strictly positive. However, in systems with an upper energy bound, negative absolute temperature states are possible, where the occupation probability of states increases with their energy. We realized a negative absolute temperature state for motional degrees of freedom which strikingly revealed itself by strong occupation peaks at maximum kinetic energy. We found that the negative absolute temperature state is close to degeneracy and intrinsically stable. Additionally, we investigated the out-of-equilibrium expansion dynamics of interacting bosons in one- and two-dimensional Hubbard systems. We found that the fastest, ballistic expansions occur in the integrable limits. In 1D, these are both the non-interacting and the strongly interacting limit. In 2D, the system expands ballistically only in the noninteracting case, and even small interactions lead to strongly diffusive behavior. In addition we characterized the dimensional crossover between 1D and 2D for these dynamics. We also show recent results on the timescale of the emergence of coherence when crossing the Mott insulator to superfluid transition.

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