Dynamics of ultacold fermions in optical lattices: negative absolute temperatures and constant forces

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We investigate the dynamics of ultracold fermionic atoms captured in optical lattice which can be described by the Hubbard model.
Using a simple protocol, we show how and on what time scales *negative* absolute temperature can be realized by reverting the confining potential[1]. For bosonic atoms such negative temperatures can be detected by observing Bose condensation at the *maxima* of the kinetic energy.
Furthermore, we study an atomic cloud in an optical lattice in the presence of a constant force[2] arising, for example, from gravity. Energy conservation implies that the cloud expands symmetrically such that gains of potential energy at the top are compensated by losses at the bottom. Interactions stabilize the necessary heat currents by inducing gradients of the inverse temperature 1/T, with $T < 0$ at the bottom of the cloud. Hydrodynamic equations allow for a precise quantitative analytic description of the expansion which we compare to numerical results from Boltzmann simulations.

[1] Akos Rapp, Stephan Mandt, Achim Rosch, Phys. Rev. Lett. **105**, 220405 (2010).
[2] Stephan Mandt, Akos Rapp, Achim Rosch, preprint, arXiv:1101.4508.