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The sudden expansion of interacting fermions in one-dimensional optical lattices

Abstract:
Experiments with ultracold atomic gases loaded into optical lattices offer unique possibilities to study the non-equilibrium dynamics of strongly interacting many-body systems. Substantial work has been devoted to interaction quenches, with a focus on questions such as relaxation, thermalization, or the time-evolution of correlations. Quantum quenches of the confining potential give rise to an expansion of the particle cloud and thus finite particle currents (see e.g., [1]). In this talk, I will discuss this set-up for the case of fermions described by the Hubbard model. First, I will present time-dependent DMRG results for the time-evolution of density profiles [2] and I will show that for sufficiently small initial densities, the cloud's radius grows linearly in time, i.e., \( R = V t \). This allows us to interpret \( V \) as the expansion velocity and we have fully clarified its dependence on initial conditions such as density and interaction strength. Second, I will demonstrate that for large initial particle densities, metastable states can emerge in the transient dynamics due to the presence of doublons [3]. Finally, I will discuss the time-evolution of correlations and momentum distribution functions, and I will suggest an interpretation of their behavior in terms of ground-state reference systems [4].