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Dynamical control of many-body interactions in lattice fermion systems

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An experimental realization of lattice fermion systems using cold atoms trapped in an optical lattice allows us to study nonequilibrium dynamics of interacting fermions in an ideal situation. It is of particular interest how one can control physical properties of interacting fermions by driving the system with external fields. In particular, we focus on sinusoidal (ac) fields, which can be applied to the system by shaking the lattice potential. Here we analyze the time evolution of the fermionic repulsive Hubbard model nonadiabatically driven by ac fields using the nonequilibrium dynamical mean-field theory with the quantum Monte Carlo method.

The results show that the double occupancy, a measure of the effective interfermion interaction, decreases for ac fields of small amplitude. This can be interpreted as an effective reduction of the hopping parameter (i.e. relative amplification of the repulsion) with ac drives. Strikingly, as one increases the amplitude the double occupancy goes beyond the noninteracting value (0.25), which implies that the repulsive interaction is effectively converted to an attraction. We will discuss the physical mechanism of the dynamically controlled many-body interaction, and argue a possibility of ac-field-induced superconductivity (superfluidity) with the effective attraction.

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