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# Nonequilibrium Dynamics in Strongly Correlated Electron Systems

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In this thesis we study the Falicov-Kimball model, a simple model of a strongly correlated system, on a one- and two-dimensional hypercubic lattice. We apply a nonequilibrium implementation of the dynamical cluster approximation (DCA) and benchmark it using the numerically exact lattice Monte Carlo method also in a nonequilibrium formulation. We find that the mapping to a periodized cluster introduces a substantial bias and that it is more efficient to simulate the lattice model directly using lattice Monte Carlo from a numerical point of view.

Using DCA we study the effect of short-range correlations on the dynamics of the two-dimensional Falicov-Kimball model on a square lattice after an interaction quench. The model does not thermalize and nearest-neighbor charge correlations in the nonthermal steady state are found to be larger than in a thermal state at the same energy for quenches across the metal-insulator phase boundary. We investigate whether it is possible to describe the trapped state after a quench by a small number of parameters such as an effective temperature or chemical potential. Using the ratio between the lesser and retarded Green's function we find that subbands of the spectral function that correspond to momentum-patches follow a roughly thermal distribution. However, the effective temperature in the energy intervals between these subbands is very hot or even negative, due to effectively different chemical potentials.

Furthermore, we use lattice Monte Carlo simulations to study dynamical properties of the one- and two-dimensional Falicov-Kimball model, and we calculate the spreading of charge correlations in the equilibrium model and after an interaction quench. We find that the spreading velocity reduces with interaction strength at low temperature, while the phase velocity increases. At higher temperature, the Fermi velocity determines the initial spreading of the noninteracting system and the maximum range of the correlations decreases with increasing interaction strength. Charge order correlations in the disorder potential enhance the range of the correlations.

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