Thermalization after an ionic potential quench in the Ionic Hubbard Model

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Abstract

Questions as to how closed quantum systems approach equilibrium after a quench are of great current interest, all the more so because of experiments in cold atom systems. Here we study the consequences of an ionic potential quench in the Ionic Hubbard Model (IHM) on a Bethe lattice using non-equilibrium DMFT. The system is quenched from a staggered charge density order(ionic potential \( \Delta \neq 0 \)) to a uniform state(\( \Delta = 0 \)) for different values of the interaction \( U \). We find that the staggered occupancy decreases rather fast from its initial value(\( \Delta \neq 0 \)) to the final zero staggered occupancy (which is the equilibrium staggered occupancy when \( \Delta = 0 \)), but in an oscillatory fashion. Similar fashion is observed for double occupancy, but at large time they oscillate around the final Hamiltonian double occupancy at the given \( U \) for the corresponding final effective temperature at equilibrium. At large times(\( t > 5.0 \ h/J \), where \( J \) is the nearest neighbor hopping amplitude) these oscillations can be well fitted by a function of the form \( A\cos(\omega t + \phi)\exp^{-\Gamma t/\hbar^{\alpha}} + c \). As one increases \( U \) the frequency of the oscillation(\( \omega \)) is almost constant(\( \approx 4J/\hbar \)) for both observables. For staggered occupancy the rate of decay of the oscillations, \( \Gamma \) and \( \alpha \) increases with increasing \( U \). But for double occupancy the rate of decay of the oscillations, \( \Gamma \), increases with increasing \( U \), where as \( \alpha \) decreases. When \( U = 0 \) \( \alpha \approx 1.5 \) and \( \Gamma \approx 0.0 \) for both. We also find that none of the three fitting parameters (\( \omega, \alpha, \Gamma \)) depend on the initial staggered potential. It remains a challenging question to understand the microscopic origins of these parameters.