

Many-body dynamics with three-body loss in an optical lattice

Abstract:

Cold atoms in optical lattices offer new possibilities to probe quantum many-body phenomena that are difficult to observe in solid-state systems. They also exhibit only weak dissipative processes, resulting in long coherence times. This allows new aspects of coherent many-body physics to be probed in an experiment, such as the formation of long-lived metastable states or the study of time-dependent many-body dynamics.

In this context, we study the effects of three-body loss processes for atoms in the lattice. Such losses can give rise to effective three-body interactions, which dynamically suppress the probability of three particles occupying a single lattice site. This counter-intuitively leads to a decrease in the effective rate of loss as the real collisional loss rate is increased. The resulting effective three-body interactions also have important potential applications in the engineering of many-body states (e.g., Pfaffian-like states related to the quantum Hall effect and colour superfluid states involving a three-species mixture of fermions). The loss processes can be described by a many-body master equation, which we simulate in one dimension by combining quantum trajectories methods with the time-dependent density matrix renormalisation group algorithm.