Emergent Time Scales in Entangled Quantum Dynamics of Ultracold Molecules in Optical Lattices

Abstract

We derive a novel lattice Hamiltonian, the Molecular Hubbard Hamiltonian (MHH), which describes the essential many body physics of closed-shell ultracold heteronuclear molecules in their absolute ground state in a quasi-one-dimensional optical lattice. Using the Time-Evolving Block Decimation (TEBD) algorithm to study entangled dynamics, we demonstrate that, in the case of hard core bosonic molecules at half filling, the MHH exhibits emergent time scales over which spatial entanglement grows, crystalline order appears, and oscillations between rotational states self-damp into an asymptotic superposition. We show that these time scales are non-monotonic functions of the physical parameters describing the lattice. For those who might be less familiar with TEBD, I will provide a qualitative overview of how this algorithm works and when it is useful to solve hard quantum many body problems.