Control of Bound-Pair Transport by Periodic Driving
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Simple many-body Hamiltonians, such as Heisenberg or Hubbard, comprise a hopping term $-JH_h$, where $J$ is an exchange coupling strength, in the absence of particle interactions. If such a system is driven by a spatially-linear oscillating field, we have a total Hamiltonian:

$$H(t) = -JH_h + B \sin \omega t \sum_j j \hat{c}_j^\dagger \hat{c}_j,$$

where $B$ and $\omega$ are the amplitude and frequency of the field, respectively, and $\hat{c}_j^\dagger$ and $\hat{c}_j$ are the creation and annihilation operators, respectively. For $B, \omega \gg J$, the exchange strength takes an effective value [1]: $J_{\text{eff}} = J J_0(B/\omega)$, where $J_0$ denotes an ordinary Bessel function. This effect is known as Coherent Destruction of Tunneling (CDT). It was implemented experimentally with ultracold atoms in shaken optical lattices [2]. The effect is closely related to another transport effect termed Dynamic Localization (DL) [3], although there is no requirement for $B$ or $\omega$ in DL.

We investigate those effects in a Heisenberg XXZ ferromagnetic chain, which adds an interaction term to the Hamiltonian (1):

$$H(t) = -\frac{J}{4} \sum_{n=1}^{N} \left[ 2 \left( \sigma_n^+ \sigma_{n+1}^- + \sigma_n^- \sigma_{n+1}^+ \right) + \Delta \sigma_n^z \sigma_{n+1}^z \right] + B \sin \omega t \sum_{n=1}^{N} n \sigma_n^z / 2$$

For large anisotropy $\Delta$, which means strong interactions, the eigenstates of the XXZ model divide into two classes: magnon-like scattering states, where the spins propagate separately, and bound states, where the pair of spins propagates together. We show that the effects act selectively on the two types of states. Especially in the DL regime, one can spatially separate a mixture of the two components into magnon and bound-pair wavepackets and control the relative direction and speed of them [4].

References