Quantum transport on lattices: A story of bosons, fermions, and spins

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Quantum transport in lattices is a major field of study nowadays. It has been probed that a lattice compose by harmonic oscillators connected to two thermal baths at different temperatures behaves ballistically in any dimension [1]. On the other hand, if the lattice is composed by spins it is ballistic only in the one dimensional case [2, 3]. In the simplest two-dimensional spin lattice, a ladder, it has been numerically probed the existence of both ballistic and non-ballistic channels [4].

In this contribution I show that both fermionic and bosonic uniform d-dimensional lattices can be reduced to a set of independent one-dimensional chains [5]. This reduction leads to the expression for ballistic energy fluxes in uniform fermionic and bosonic lattices. By the use of the Jordan-Wigner transformation we can extend our analysis to spin lattices, proving the coexistence of both ballistic and non-ballistic subspaces in any dimension and for any system size. We then relate the nature of transport to the number of excitations in the homogeneous spin lattice, indicating that a single excitation always propagates ballistically and that the non-ballistic behaviour of uniform spin lattices is a consequence of the interaction between different excitations.

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