# Quantum transport of cold atoms between atomic reservoirs

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The progress in experimental techniques of handling ultracold atomic gases has opened a new research direction called atomtronics [1]. Currently, atomtronics scopes various fundamental and applied studies on engineering devices analogous to those of solid state electronics. Moreover, besides mimicking semiconductor devices cold atoms allow us to use not only Fermi but also Bose carriers and have a precision control and tunability of physical parameters, such as the interatomic interaction and tunneling rate. In particular, a large number of studies in this field address transport of cold atoms between two or more contacts (atomic reservoirs) attached to a device [2] (see figure. ).

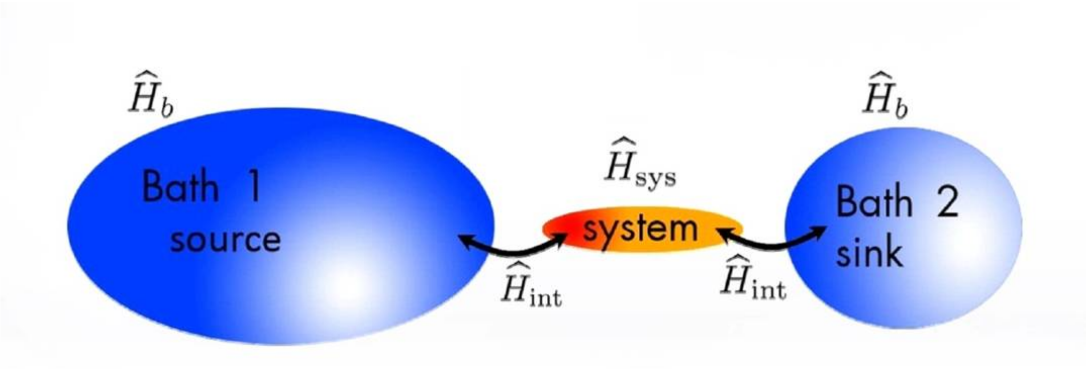


Figure 1: Schematic representation of atomic current transport through the channel connecting two atomic reservoirs acting as a particle source and sink.

The presence of the good particle reservoir is an important part of such a device. In the first part of the present work, the properties of the atomic reservoir acting as a particle source for the atomtronics devices were theoretically investigated. It was shown that one of the ways to construct the effective model of the reservoir is the condition of Quantum chaos leading to the self-thermalization phenomenon [3, 4]. As an atomic reservoir model we suggested to employ either the Bose-Hubbard model for Bose atoms or the Sachdev-Ye-Kitaev model for Fermi atoms.

In the second part, the results concerning conductivity and quantum transport of cold Bose atoms in quasi-one-dimensional optical lattices were presented. When there is no interaction between particles the result is known as the Landauer-Büttiker equation for bosonic carriers [5], where the stationary current is proportional to the difference in the reservoir particle densities and independent of the length of the optical lattice. However, in the presence of interatomic interactions it is an open question whether the system is conducting or becomes insulating. We showed that in the case of a small difference in the particle densities there is a transition from the ballistic transport regime, where the stationary atomic current is independent of the lattice length, to the diffusive regime, where the stationary current is inversely proportional to the system size [6].

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# References


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