Simulation of trapped atoms statistics using an interactive lattice automaton model

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We present a novel approach to simulate the statistics of trapped atoms. Our method can handle large samples far from thermal equilibrium, which are not easily treated by other methods such as Molecular Dynamics. The model considers a three-dimensional harmonic trap with angular frequencies which are multiple of each other, in such a way that the classical orbits are closed. Each orbit is associated with a cell and filled with atoms. The cells compose a lattice with interaction points where energy and momentum preserving collisions can exchange atoms. Once this interactive lattice is setup by a Monte-Carlo algorithm, the cells are initially populated with atoms and then left to evolve as an automaton. An ergodic mixing is introduced, redistributing atoms among the cells within the same energy range. This mixing is repeated every few hundred automaton cycles. This interactive lattice automaton (ILA) produces the expected Maxwell-Boltzmann distribution for a classical interaction rule, as shown in Fig. 1. Results for evaporative cooling in a trap are going to be presented. The ILA evolution is carried out in parallel by means of a cluster of workstations using the MPI communication protocol. Extensions of the model, such as the inclusion of Bose-Einstein statistics, are underway.

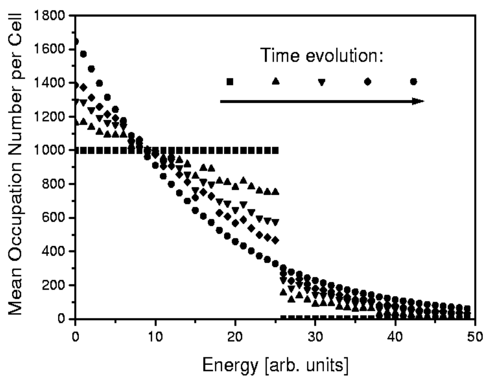

Figure 1: The dynamics towards a Maxwell-Boltzmann distribution, when the ILA was initialized with a, far-from-equilibrium, Fermi-Dirac-like distribution. The automaton ran 10^4 cycles, with an ergodic mixing every 500 cycles. Total number of cells is 10^4. See text.

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