# A unified semi-classical model of nucleon-induced pre-equilibrium reactions

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## Abstract

We present a semiclassical description of the nucleon-nucleon collision cascade that permits the modeling of typical cascade and exciton descriptions of the process, as well as intermediate ones. We base our model on the usual concepts of particles above the Fermi energy and holes below it. We treat each configuration of particles and holes explicitly and consider transitions induced by energy conserving two-body collisions. The transitions can thus increase or decrease the number of particles and holes by two or leave the number the same. In order to simulate the usual semi-classical models, we make use of the idea of a class of configurations, which consists of those configurations having the same number of particles and holes. By varying the rate of transitions between configurations of the same class, we can reproduce the extreme limits of no intraclass transitions or intraclass equilibrium, assumed in cascade and exciton type models, respectively. We compare the two limiting cases with a natural model, in which the intraclass transitions are treated on an equal footing with the others. We find that the cascade type model and the natural one yield very similar nucleon emission spectra and multiplicities. The exciton type model also yields fairly similar results, when a hole is frozen at the Fermi surface. However, its emission spectrum tends to be slightly harder and the multiplicity lower.

Although the microscopic description of the interaction chain can be written in the form of a master equation, the number of configurations is usually quite large and direct solution of the equations is not possible in general. We use a Monte Carlo simulation method to obtain solutions.