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Reaction mechanisms for deuteron production in HICs within a transport approach

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We discuss about formation of deuterons in hadronic matter by means of a microscopic description of inelastic many-body scattering processes. The dominant reactions $dN \leftrightarrow NNN$ and $d\pi \leftrightarrow NN\pi$ which are characterized by measured cross sections $\sigma \simeq 200\, mb$, much larger than subdominant $d\pi \leftrightarrow NN$ process, have been fully implemented within a kinetic approach by solving the collision integral in terms of covariant scattering rate.
We adopt the theoretical formulation of baryon-antibaryon production by three-meson fusion and apply to the case of deuteron including also its weak-bound properties in terms of the quantum wave function of the proton-neutron pair interacting through effective nuclear potential.
We investigate the validity of detailed balance within a BUU-type model simulating deuteron reactions in infinite nuclear matter at equilibrium and using proper parametrization of hadronic cross sections on the experimental measurements.
After that, we implement the same mechanisms within the Parton–Hadron–String Dynamics (PHSD) transport approach to calculate multiplicity and transverse momentum spectra of deuterons at mid-rapidity in $Pb + Pb$ collisions at the energy range of SPS and compare to available experimental data. Finally, we discuss about future development of our model to the novel Parton–Hadron–Quantum-Molecular Dynamics (PHQMD) framework to study the impact of different dynamical description and the use of clusterization algorithms.

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