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Non-equilibrium dynamics and collectivity in ultra-relativistic proton-nucleus collisions

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The experimental observations of anisotropic flows in proton-proton and proton-nucleus collisions at RHIC and LHC energies has stimulated a big interest in these small systems as a new study area for the formation and evolution of the quark-gluon plasma. We investigate the effects of non-equilibrium dynamics in such systems by comparing a microscopic nonequilibrium transport approach, the Parton-Hadron-String-Dynamics (PHSD), with a macroscopic 2D+1 viscous hydrodynamical model, VISHNew, that describes a locally approximately equilibrated medium. The initial conditions for the hydro evolution are taken from PHSD at different starting times in order to study its impact on the subsequent evolution of the short-lived QGP created in proton-nucleus collisions, investigated in terms of energy density, viscous corrections, spatial and momentum eccentricities. The latters have been linked to the development of collective flows, whose origin is high-multiplicity proton-nucleus collisions is still under debate. We address this issue also by means of a new and more differential observable, the transverse spherocity, which classifies final-state event topologies and allows to isolate hard and soft effects. The investigation of such quantity in both transport and hydro frameworks permits to gain further insights into the mechanisms responsible for the QGP-like effects in small systems.

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