Contribution ID: **56** Type: **Poster**

Effective kinetic description of event-by-event pre-equilibrium dynamics in high-energy heavy-ion collisions

Monday, 21 May 2018 18:30 (0 minutes)

We develop a macroscopic description of the space-time evolution of the energy-momentum tensor during the pre-equilibrium stage of a high-energy heavy-ion collision. Based on a weak coupling effective kinetic description of the microscopic equilibration process (\‘a la “bottom-up”), we calculate the non-equilibrium evolution of the local background energy-momentum tensor as well as the non-equilibrium linear response to transverse energy and momentum perturbations for realistic boost-invariant initial conditions for heavy ion collisions. We demonstrate how this framework can be used on an event-by-event basis to propagate the energy momentum tensor from far-from-equilibrium initial state models, e.g.\ IP-Glasma, to the time τ_{hydro} when the system is well described by relativistic viscous hydrodynamics. The subsequent hydrodynamic evolution becomes essentially independent of the hydrodynamic initialization time τ_{hydro} as long as τ_{hydro} is chosen in an appropriate range where both kinetic and hydrodynamic descriptions overlap. We find that for $\sqrt{s_{NN}} = 2.76$ TeV central Pb-Pb collisions, the typical time scale when viscous hydrodynamics with shear viscosity over entropy ratio $\eta/s = 0.16$ becomes applicable is $\tau_{\mathrm{hydro}} \sim 1$ fm/c after the collision.

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Session Classification: Poster Session