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The influence of pre-equilibrium dynamics on heavy-ion collision observables

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In order to bracket the importance of the pre-equilibrium stage on relativistic heavy-ion collision observables at RHIC and LHC energies, we compare simulations in which the pre-equilibrium stage is modeled by free-streaming partons with others where it is modeled fluid dynamically. The first (second) case implements the assumption of extremely weak (strong) coupling in the initial collision stage. We introduce a switching time parameter for the duration of the weakly coupled stage; after this time the system is assumed to stay in the strongly coupled hydrodynamic stage (with a specific shear viscosity that we can vary) until freeze-out. Based on event-by-event simulations of fluctuating initial conditions, we first study observables (radial, elliptic and triangular flow) systematically as a function of the switching time from free-streaming to viscous hydrodynamics ("thermalization time"), leaving other parameters fixed. We then perform a three-dimensional simultaneous parameter fit of the switching time, specific shear viscosity and freeze-out temperature by comparing the numerical results with a set of 5 experimental observables, for four different types of initial conditions. We find that the strongest constraint on the thermalization time does not come of anisotropic flow measurements, as previously thought, but from the mean transverse momentum of hadrons with different masses (i.e. radial flow). First results from a campaign that includes bulk viscous effect and a hadronic afterburner to describe the freeze-out stage, with particular focus on the mass-ordering of the elliptic and triangular flow for protons and Lambda hyperons which is incorrectly described by VISHNU without pre-equilibrium flow, will also be shown.

References: Jia Liu, Chun Shen, U. Heinz, Phys.Rev. C 91 (2015) 064906; and additional work to be published

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