QUARK MATTER 2015
Sep. 27 – Oct. 3, 2015 Kobe, Japan

Contribution ID: **162** Type: **Poster**

Collective flow in event-by-event partonic transport plus hydrodynamics hybrid approach

Tuesday, 29 September 2015 16:30 (2 hours)

Complete evolution of the strongly interacting matter formed in ultra-relativistic heavy-ion collisions is studied within a coupled Boltzmann and relativistic viscous hydrodynamics approach [1]. For the initial non-equilibrium evolution phase, we employ A MultiPhase Transport model that explicitly includes event-by-event fluctuations in the number and positions of the participating nucleons as well as of the produced partons with subsequent parton transport. The ensuing near-equilibrium evolution of quark-gluon and hadronic matter is modeled within the (2+1)D relativistic viscous hydrodynamics. (1) We probe the role of parton dynamics in generating and maintaining the spatial anisotropy in the pre-equilibrium phase. Substantial spatial eccentricities ε_n are found to be generated in the process of parton production from initial NN collisions. (2) For ultra-central heavy-ion collisions, the model is able to explain qualitatively the unexpected hierarchy of the flow coefficients $v_n(p_T)$ $(n = 2 - 6)$ observed at LHC. (3) We find that the results for $v_n(p_T)$ are rather insensitive to the variation (within a range) of the time of switchover from AMPT parton transport to hydrodynamic evolution. (4) The usual Grad and the recently proposed Chapman-Enskog-like single-particle distribution functions are found to give very similar results for $v_n(p_T)$ $(n = 2 - 4)$. (5) The model describes well both the RHIC and LHC data for $v_n(p_T)$ at various centralities, with a constant shear viscosity to entropy density ratio 0.08 and 0.12, respectively. (6) The event-by-event distributions of $v_{2,3}$ are in good agreement with the LHC data for mid-central collisions. The linear response relation $v_n = k_n\varepsilon_n$ is found to be true for $n = 2, 3$, except at large values of ε_n, where a larger value of k_n is required, suggesting a small admixture of positive nonlinear response even for $n = 2, 3$.

[1] R.S. Bhalerao, A. Jaiswal, S. Pal, arXiv:1503.03862

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Session Classification: Poster Session

Track Classification: Initial State Physics and Approach to Equilibrium