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

Contribution ID: **154** Type: **Poster**

Constraining the validity of hydrodynamic approaches by using a new exact solution of the Boltzmann equation

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

Relativistic hydrodynamics plays an important role in the quantitative description of the space-time evolution of the strongly coupled QGP created in Ultrarelativistic Heavy-Ion Collisions. Thus, it is necessary to have under control the physical assumptions made in the hydrodynamical modelling. In this work we present a new exact solution to the relativistic Boltzmann equation. This solution describes a system undergoing boost-invariant longitudinal and azimuthally symmetric radial expansion for arbitrary shear viscosity to entropy density ratio. The resulting solution is invariant under the $SO(3)_q \otimes SO(1,1) \otimes Z_2$ group symmetry. We test the efficiency of various hydrodynamic approximation methods by comparing the evolution of the moments of the exact solution (such as energy density and shear viscous tensor) with the corresponding solutions of the macroscopic hydrodynamic equations. In addition, we briefly discuss the phase-space evolution of this new exact solution and the physical constraints on its applicability.

References:

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Session Classification: Poster Session

Track Classification: Collective Dynamics