Contribution ID: **353** Type: **Oral**

The onset of fluid-dynamical behavior in relativistic kinetic theory

Wednesday 8 February 2017 16:30 (20 minutes)

Relativistic hydrodynamics is the main theoretical framework used to describe the quark-gluon plasma produced in ultra-relativistic heavy ion collisions and, possibly, proton-proton and proton-ion collisions. Therefore, understanding the physical assumptions that enter in the hydrodynamical modeling of heavy ion collisions is crucial. Especially, it is essential to elucidate the reason behind the onset of fluid-dynamical behavior at the very early stages of the collisions.

In this contribution, we investigate the onset of hydrodynamic behavior for a gas of massless particles undergoing Bjorken expansion, a proxy for the dynamical evolution of the quark-gluon plasma produced in heavy ion collisions. In this scheme, we demonstrate that the Chapman-Enskog series, i.e., a gradient expansion in the hydrodynamic variables, has zero radius of convergence and cannot be used to consistently derive relativistic hydrodynamics [1]. On the other hand, we show that the method of moments, traditionally employed to derive Israel and Stewart's theory of hydrodynamics, converges and can be used to systematically improve the applicability of fluid-dynamical theories [2]. We further discuss what are the extended theories of hydrodynamics that emerge from higher-order truncations of the method of moments and how they can help in the description of heavy ion collisions.

[1] G.S. Denicol and J. Noronha, arxiv:1608.07869

[2] G.S. Denicol and J. Noronha, to appear soon.

Preferred Track

New Theoretical Developments

Collaboration

Not applicable

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Session Classification: Parallel Session 8.3: Collective Dynamics (III)

Track Classification: New Theoretical Developments