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The 90th HENPIC seminar by Prof. Yi Yin (尹伊), Institute of Modern Physics, CAS (中科院近代物理所)，Feb.13, 2020, Thursday, 10:30am (Beijing time)

Title: Pre-hydrodynamics and pre-hydrodynamic response

Abstract:

We propose a new scenario characterizing the transition of the quark-gluon plasma (QGP) produced inheavy-ion collisions from a highly non-equilibrium state at early times toward a fluid described by hydrodynamics at late times. In this scenario, the bulk evolution is governed by a set of slow degree of freedom (d.o.f.), after an emergent time scale □Redu , when the number of modes that govern the bulk evolution of the system is reduced. These slow d.o.f are "pre-hydrodynamic" in the sense that they are initially distinctfrom, but evolve continuously into, hydrodynamic d.o.f in hydrodynamic limit.This picture is analogous to the evolution of a quantum mechanical system thatis governed by the instantaneous ground states under adiabatic evolution, andwill be referred to as "adiabatic hydrodynamization". We shall illustrate adiabatic hydrodynamization using a kinetic description of weakly-coupled Bjorken expanding plasma. We first show the emergence of □Redu due to the longitudinal expansion. We explicitly identify the pre-hydrodynamic d.o.f. for a class of collision integrals and find that they represent the angular distribution (in momentumspace) of those gluons that carry most of the energy. We use the relaxationtime approximation for the collision integral to show quantitatively that thefull kinetic theory evolution is indeed dominated by pre-hydrodynamic d.o.f..We elaborate on the criterion for the dominance of pre-hydrodynamic modes andargue that the rapidly-expanding QGP could meet this criterion. Based on thisdiscussion, we speculate that adiabatic hydrodynamization may describe thepre-equilibrium behavior of the QGP produced in heavy-ion collisions. Finally,we will discuss the excitations during "adiabatic hydrodynamization"stage by considering the medium ' s response to an energetic moving parton. A preliminary study suggests that some of thoseexcitations are similarly to but distinguishable from sound waves.

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