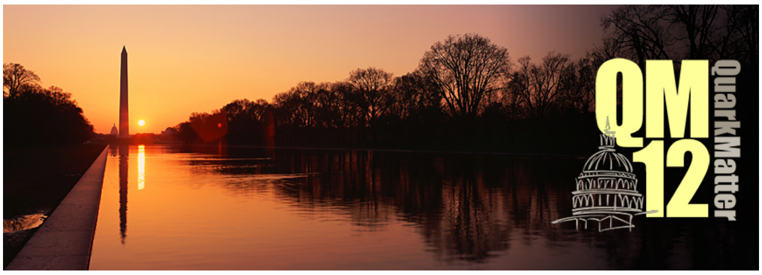


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# Relativistic Fluctuating Hydrodynamics and its Application to Heavy Ion Collisions

*Thursday 16 August 2012 16:00 (2 hours)*

To investigate the physics of the strongly interacting system of quarks and gluons under extreme conditions, heavy-ion collision experiments are performed at Large Hadron Collider (LHC) and Relativistic Heavy Ion Collider (RHIC). One of the major discoveries was that elliptic flow $v_2$ was comparable with an ideal hydrodynamic prediction and, as a result, that a new paradigm of strongly coupled quark-gluon plasma (QGP) was established. Recently, the higher harmonics $v_n$ ($n > 2$) are systematically observed at RHIC and LHC and attract a lot of theoretical and experimental interests. Initial state fluctuations turned out to be important to explain these higher harmonics.

In addition to initial state fluctuations, thermal fluctuation during the space-time evolution of the QGP also plays an important role in event-by-event simulations. We first formulate the relativistic fluctuating hydrodynamics in the context of the second order causal theory. Finite relaxation time for dissipative current is required to make hydrodynamic equation consistent with causality. Instead of introducing the relaxation term itself, one can define a kernel function (or a retarded Green function) such that constitutive equation becomes convolution of the kernel function including relaxation as well as dissipation and the corresponding thermodynamic force. One can also introduce a noise field as thermal fluctuation of the dissipative current like in the Langevin equation. Thus the constitutive equation becomes no longer a deterministic equation, but a stochastic equation. The power spectrum of the noise fields is intimately related to the kernel function via the fluctuation-dissipation relation and, consequently, noise becomes colored noise rather than white one due to the finite relaxation time. We then implement the colored noise together with viscous kernels in numerical simulations of relativistic hydrodynamics and perform simulations on an event-by-event basis to see effects of thermal fluctuation on the dynamics of heavy ion collisions. This framework is beyond the conventional second order dissipative hydrodynamics and, thus, will become important in the upcoming era of the precision QGP physics by means of high-energy heavy ion collisions.

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