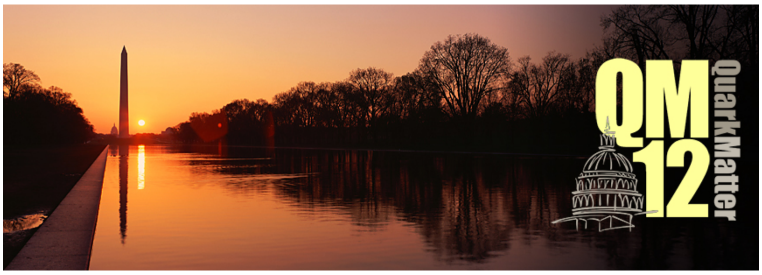

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Imprinting quantum fluctuations on hydrodynamic initial conditions

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The precise value of the QGP kinematic shear viscosity eta/s is a question of intense topical interest. Viscous hydrodynamic simulations are a tool for extracting this information from experiment. The key observables are the anisotropic flow coefficients v_n which (i) can be measured very precisely and (ii) are very sensitive to eta/s which controls the "conversion efficiency" v_n/ecc_n for turning initial fireball eccentricities of harmonic order n into final flows of the same harmonic order.

Both ecc_n and v_n fluctuate strongly from collision to collision. These event-by-event fluctuations have a key influence on the measurements [1] and must be properly taken into account when extracting eta/s. Until recently, most initial-state models accounted only for the shape and density fluctuations arising from the fluctuating positions of the nucleons in the colliding nuclei. This leads to fluctuations in the location of the newly produced matter, and thus of the initial energy density profile of the expanding fireball and its eccentricities ecc_n, but does not account for additional quantum fluctuations in the quark and gluon fields inside the nucleons that lead to fluctuating numbers of secondary particles per nucleon-nucleon interaction. Several recent papers have addressed the implementation of these quantum fluctuations in the hydrodynamic initial conditions for the expanding collision fireball.

Starting from the Monte Carlo Kharzeev-Levin-Nardi (MC-KLN) model for generating fluctuating initial profiles for the gluon saturation momentum Q_sat(x_T) in the transverse plane, we have developed a Monte Carlo algorithm that uses a Gaussian Random Field (GRF) generator [2] to generate a distribution of gluonic energy densities centered at the value corresponding to the field Q_sat(x_T), but fluctuating around this profile with the two-point covariance function derived in [3] from the Glasma model. To ensure that the energy density is everywhere positive the GRF is mapped to an appropriate negative binomial distribution (NBD) with the same variance. NBD fluctuations have been recently shown to arise naturally from the Glasma model and to describe the measured multiplicity distributions in pp collisions at the LHC. The resulting density profile features "hot spots" as in the MC-KLN model overlaid with a fluctuating field texture characterized by an intrinsic length scale 1/Q_sat(x_T).

We show that inclusion of these additional gluonic quantum field fluctuations leads to only a small (few percent) increase of the initial eccentricities ecc_n in central collisions and to almost negligible effects at larger impact parameters. These findings disagree with some of the results reported in [4], and we will discuss possible origins for this discrepancy. Our results imply that an earlier extraction of the QGP shear viscosity from a combined analysis of elliptic and triangular flow data from Pb-Pb collisions at the LHC [5] is robust.

References

[1] Zhi Qiu and U. Heinz, "Event-by-event shape and flow fluctuations of relativistic heavy-ion collision fireballs," Phys. Rev. C84, 024911 (2011).

[2] X. Emery and C. Lantuejoul, "TBSIM: A computer program for conditional simulation of 3-dimensional Gaussian random fields via the turning bands method," Computers and Geosciences 32, 1615 (2006).

[3] B. Muller and A. Schafer, "Transverse energy density fluctuations in the Color Glass Condensate Model," arXiv:1111.3347 [hep-ph].

[4] B. Schenke, P. Tribedy and R. Venugopalan, Fluctuating Glasma initial conditions and flow in heavy ion collisions," arXiv:1202.6646 [nucl-th]; F. Gelis, T. Lappi and L. McLerran,Glittering Glasmas," Nucl. Phys. A

828, 149 (2009); A. Dumitru and Y. Nara, “KNO scaling of fluctuations in pp and pA, and eccentricities in heavy-ion collisions,” Phys. Rev. C85, 034907 (2012).

[5] Z. Qiu, C. Shen and U. Heinz, “Hydrodynamic elliptic and triangular flow in Pb-Pb collisions at sqrt(s)=2.76ATeV,” Phys. Lett. B707, 151 (2012).

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