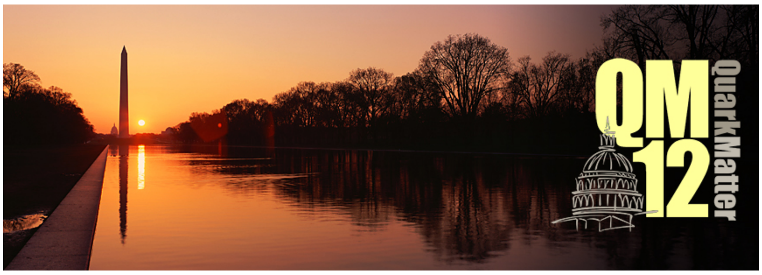

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New method for measuring longitudinal fluctuations and directed flow in ultrarelativistic heavy ion collisions

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Recently significant effort is made to study azimuthal flow asymmetries in ultra-relativistic heavy ion reactions. At finite impact parameters the directed flow and the elliptic flow were dominant observables for many years.

In head-on collisions there would be no reason to have an azimuthal or longitudinal asymmetry, nevertheless, new observations for the higher harmonics show [1] that even in central collisions there is a strong azimuthal asymmetry in the emitted hadrons, and this asymmetry arises from transverse fluctuations of the initial state. In addition in head-on collisions the third harmonic of the azimuthal distribution, v_3, exceeds the second one, v_2, and becomes the dominant harmonic component in accordance with large fluctuations. The fact that high harmonics, measured up to v_8, survive the fluid dynamical expansion indicates that the QGP fluid is almost perfect, and does not absorb high-harmonics.

Fluctuations must also appear in the longitudinal direction, especially in peripheral reactions where the projectile and target spectators may not be exactly the same size. As a first step of our study, we estimate the Event-by-Event (EbE) c.m. rapidity fluctuations using a method based on Zero Degree Calorimeters (ZDC)s. In peripheral reactions one can check if significant correlation between the EbE c.m. rapidities measured in the TPC and via the ZDCs do exist. This then leads to the possibility to separate the flow characteristics arising from collective global asymmetries and from random fluctuations.

The first v_1 measurements at LHC [2] were also arising dominantly from random fluctuations as both the even and odd rapidity combinations gave the same result. As a second step, with the aim to determine the global asymmetry component of the directed flow v_1, we propose that the participant system Event-by-Event shifted from the Lab. c.m. frame to the measurable participant c.m. rapidity EbE, thus removing or minimizing the effect of random longitudinal fluctuations. Then following the global asymmetry the "odd" component of the directed flow can be separated and identified using this method.

This new method [3] enables us to separate fluctuating and the global symmetry components in the flow, which is important for the odd harmonics, especially for v_1 and v_3. Thus one can study experimentally the rotation effect [4] and the possible occurrence of the Kelvin-Helmholtz instability [5] in the globally symmetric component of the collective flow.

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