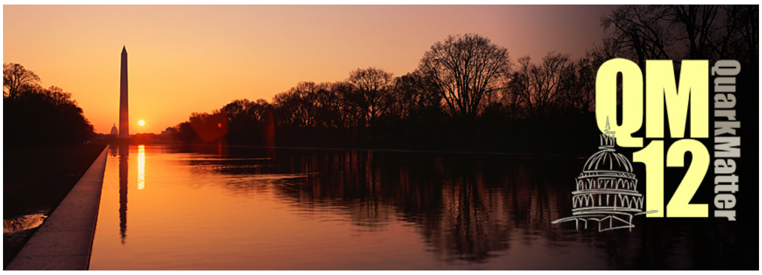

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Turbulent instability in low viscosity quark-gluon plasma

Thursday 16 August 2012 16:00 (2 hours)

Flow asymmetries are in focus of present heavy ion studies. 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. This poses a challenge to separate the flow characteristics arising from collective global asymmetries and from random fluctuations. Here we study flow asymmetries arising from global asymmetries in peripheral collisions.

The dynamical development of collective flow of prefect QGP fluid is studied in a (3+1)D fluid dynamical model for peripheral heavy-ion collisions, with globally symmetric, initial conditions, which take into account the shear flow caused by the forward motion of the matter on the projectile side and the backward motion on the target side. While at $\sqrt{s_{NN}} = 2.76A$\,TeV semi-peripheral Pb+Pb collisions the earlier predicted rotation effect [2] is visible in the calculations, at more peripheral collisions, with high resolution and low numerical viscosity the initial development of a Kelvin-Helmholtz instability (KHI) is observed [3], which alters the flow pattern considerably. On the initial dividing plane a wave develops, and the dividing plane develops into a turning nonlinear wave. The wave develops only in peripheral reactions with very low numerical viscosity. The KHI wave is visible in the reaction plane if we mark the motion of the fluid which was initially on the dividing plane. The direction of the wave is such that it enhances the rotation effect and increases the asymmetry of the global collective $v_1(y)$. The possibility of turbulence in the transverse plane developing from initial fluctuations was also pointed out recently [4].

Although, the predicted rotation effect is not easily detectable due to longitudinal initial state fluctuations, the KHI enhances the flow asymmetry and changes its pattern in peripheral collisions. The present developments suggest that the global collective v_1 flow can be disentangled from random fluctuations. This is necessary to measure the global collective flow in peripheral collisions.

The KHI is very sensitive to the magnitude of the viscosity. Thus if this research is successful the analysis of global collective v_1 flow as a function of beam energy and impact parameter may provide a precision measurement of viscosity and its variation.

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