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Measuring the rate of isotropization of quark-gluon plasma using rapidity correlations

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We propose that rapidity dependent momentum correlations can be used to extract the shear relaxation time τ_π of the medium formed in high energy nuclear collisions. The stress-energy tensor in an equilibrium quark-gluon plasma is isotropic, but in nuclear collisions it is likely very far from this state. The relaxation time $\tau\pi$ characterizes the rate of isotropization and is a transport coefficient as fundamental as the shear viscosity. We show that fluctuations emerging from the initial anisotropy survive to freeze-out, in excess of thermal fluctuations, influencing rapidity correlation patterns. We show that these correlations can be used to extract τ_π. In [1] we describe a method for calculating the rapidity dependence of two-particle momentum correlations with a second order, causal, diffusion equation that includes Langevin noise as a source of thermal fluctuations. The causality requirement introduces the relaxation time and we link the shape of the rapidity correlation pattern to its presence. Here we examine how different equations of state and temperature dependent transport coefficients in the presence of realistic hydrodynamic flow influence the estimate of τ_π. In comparison to RHIC data, we find that the ratio $\tau_\pi/\nu \approx 5-6$ where $\nu = \eta/sT$ is the kinematic viscosity. We further make predictions for Pb-Pb collisions at the LHC.
[1] S. Gavin, G. Moschelli, C. Zin, Phys. Rev. C 94, 024921 (2016).

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