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Characteristics of early time gluon fields in relativistic heavy ion collisions

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We present some analytic results that describe the gluon field, or glasma, that exists at very early times after a collision of relativistic heavy ions at proper time $\tau = 0$. We use a Colour Glass Condensate approach, and perform an expansion in τ. We show that the expansion to order τ^6 can be trusted to about $\tau = 0.05$ fm/c. We calculate the transverse and longitudinal pressures and show that for $\tau < 0.05$ fm/c they move towards their equilibrium values of one third of the energy density. We study the spatial eccentricity of the plasma, and the Fourier coefficients of the azimuthal momentum distribution. Our results for the Fourier coefficients are larger than expected, which contradicts the usual assumption that anisotropy is mostly generated during the hydrodynamic evolution of the plasma. We find a significant correlation between the elliptic flow coefficient and the eccentricity, which indicates that the spatial inhomogeneity introduced by the initial geometry is effectively transmitted to the azimuthal distribution of the gluon momentum field, even at very early times. This result is interesting because correlations of this kind are characteristic of the onset of hydrodynamic behaviour. We also calculate the angular momentum of the glasma and obtain results that are many orders of magnitude smaller than the initial angular momentum of two ions colliding with non-zero impact parameter. This indicates that most of the angular momentum carried by the valence quarks is not transmitted to the glasma. The result is significant because it contradicts the picture of a rapidly rotating initial glasma state, but agrees with the current lack of experimental evidence for a global polarization effect in the hyperons and vector mesons produced in heavy ion collisions.

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