The initial state of high energy nuclear collisions

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The initial state of nuclear collisions at very high energies is thought to be a phase of QCD called the Color Glass Condensate (CGC). A key problem in our understanding of relativistic heavy ion collisions is the question how this color glass evolves into a thermalized plasma of quarks and gluons (QGP). We have embarked on a project to calculate the energy momentum tensor in nuclear collisions at early times based on a classical description of the color glass condensate (the McLerran-Venugopalan model).

We use an expansion of the classical gluon field around the time of collision (t=0). In the last year we have used previously obtained expressions for the components of the energy momentum tensor for fixed color sources ρ_i in the colliding nuclei and have developed the techniques to compute the expectation value under realistic conditions (the ρ_i cannot be observed and on average $<\rho_i>=0$ since the nuclei are color neutral). We can now evaluate n-point functions of gluon fields, <A(x)A(y)>, <A’(x)A(y)>, <A’(x)A’(y)>, etc. (A’ denotes the gradient of the gluon field) within an infrared-safe generalization of the McLerran-Venugopalan framework. This allows us to finally compute the transverse dynamics of the early gluon field with interesting consequences.

Some of the surprise findings are directed flow (known as v_1 in heavy ion collisions) and global angular momentum emerging from these coherent gluon fields. They add to the radial and elliptic flow from coherent gluon fields which had been identified earlier. We are currently exploring the energy momentum tensor up to 4th order in the early time expansion. This energy momentum tensor will be used as input for a further hydrodynamic evolution of the fireball.