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 continued our work on the evolution of the energy momentum tensor at early times in a heavy ion collisions. Previously, we had derived an expansion of the classical gluon field around the time of collision (t=0) in the color glass condensate model for fixed color sources ρ_i in the colliding nuclei. In order to compare with observables one needs to calculate the expectation value of those results under variations of the sources ρ_i. This comes about because the nuclei are on average color neutral even locally, $\langle\rho_i\rangle=0$. However, during the collision, which happens on time scales much faster than the time needed to reorder degrees of freedom inside the nucleus, the actual sources are “snapshots” of fluctuations frozen during the very short time of interaction.

The expectation values can be reduced to evaluations of n-point correlation functions of gluon fields and covariant derivatives inside a single nucleus, $\langle A(x)A(y)\ldots\rangle$ etc., within the McLerran-Venugopalan framework. We have computed a hierarchy of correlation functions which allows us to express the energy momentum tensor at early times in a simple series which only depends on the coupling constant and the saturation scales of the two nuclei. This energy momentum tensor can be used as input for a further hydrodynamic evolution of the fireball.