The initial state of high energy nuclear collisions

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At asymptotically large energies hadrons and nuclei essentially appear as black disks with a large saturated gluon density. This state has been termed the color glass condensate and a rich literature about this phenomenon has been produced in recent years. For heavy ion collisions at RHIC and LHC this concept is believed to be very important. It governs the initial state of high energy nuclear collisions. One of the main questions in the field of heavy ion physics is how the colliding color glass evolves into a thermalized quark gluon plasma. In an ongoing effort with several collaborators R.J.Fries is working on two aspects of this question.

(a) The McLerran-Venugopalan (MV) model was one of the first formulations of the color glass condensate. It uses the large gluon occupation numbers to justify a quasi-classical treatment of the gluon field. For nuclear collisions, no analytic solution to all orders in the coupling or the sources is known. In a recent publication [1] it has been shown that the field equations can be solved recursively using an expansion in the proper time tau in the forward light cone. One of the outcomes has been the rediscovery of the strong longitudinal color fields immediately after the collision. This work is being continued. Currently the first few coefficients in the recursion are evaluated in detail. The goal is to obtain a space-time map of the energy momentum tensor at very early times in the collision.

(b) Immediately following (a) is the question what can be learned about the initial energy density, pressure and flow in the plasma after thermalization. This is important to reliably determine the initial conditions for a further hydrodynamic evolution of the system. Currently techniques are being developed to derive constraints for the plasma phase from the initial phase of strong gluon fields.

Preliminary results have been reported at the Quark Matter 2006 Conference [2].

[1] R. J. Fries, J. Kapusta, and Y. Li, nucl-th/0604054.
[2] R. J. Fries, nucl-th/0702026.