The initial state of high energy nuclear collisions

R. J. Fries and collaborators

At asymptotically large energies the wave function of hadrons and nuclei exhibits a large saturated gluon density. This phenomenon has been called the color glass condensate For heavy ion collisions at RHIC and LHC this concept is believed to be very important, governing the initial state and early time dynamics of the collision. One of the main questions 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) With J. Kapusta (U of Minnesota) and Y. Li (Iowa State U) he has investigated the energy momentum tensor at early times after the collision of two nuclei in the McLerran-Venugopalan model (one model for the color glass condensate). This is based on previous work in which they investigated the classical Yang-Mills equations for the gluon field at asymptotically small times. The energy momentum tensor can be used as input for further hydrodynamic calculations of the fireball.

(b) It is believed that the fireball created in high energy nuclear collisions thermalizes after a rather short time and that ideal relativistic hydrodynamics can be used to describe the evolution of the system after equilibration. However, it becomes more and more clear that dissipative effects from shear and bulk viscosities have to be studied systematically in order to extract quantitative information about the quark gluon plasma from experiment. Together with B. Muller (Duke U) and A. Schafer (U of Regensburg), R. J. Fries started simulations of simple hydrodynamic systems using realistic bulk and shear viscosities for quark and gluon matter. The goal is to investigate off-equilibrium effects on expansion rates and entropy production. With the same collaborators R. J. Fries has also studied the decoherence time of the gluon field in leading order in the coupling constant in the McLerran-Venugopalan model. Together with the results from (a) estimates this is expected to give a complete and consistent set of initial conditions for the hydrodynamic evolution.