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Effects of initial state fluctuations in relativistic heavy ion collisions

Relativistic heavy ion collisions allow one to create ultra-dense and hot systems, which can undergo a confinement-deconfinement phase transition, leading to the creation of a new state of matter called quark-gluon plasma (QGP). The evolution of such a system is commonly divided into three different stages: 1) an initial stage, which describes the first moments of the collision, i.e. from the time when colliding nuclei pass through each other till the time when local equilibration (or at least some pressure isotropization) is established; 2) an intermediate stage, which usually describes the evolution of QGP using relativistic fluid dynamics; and 3) a final stage or freeze-out, in which the produced hadrons will freely move to the detectors. Each of these stages should be described with the most suitable approach.

More than 20 years ago, at the beginning of the RHIC era, an Effective String Rope Model was proposed to calculate initial state in nucleus-nucleus ultra-relativistic collisions for further 3+1D relativistic fluid dynamical evolution. The big advantage of this initial state, in comparison to others available at that time, was that it reflected correctly not only the energy-momentum, but also angular momentum conservation laws. Consequently, such an initial state for non-central ultra-relativistic heavy ion collisions may lead to overall rotation of the reaction volume or/and to a large vorticity of the collective flow, which can manifest itself via polarization of emitted particles. This is supported by the observations of global polarization of Λ and $\overline{\Lambda}$ hyperons at non-zero impact parameter in Au+Au collisions at RHIC reported by STAR collaboration.

In the last two decades with the construction of high energy colliders, such as the Large Hadron Collider at CERN, as well as with the development of new detectors and new data storing and analyzing methods, the study of heavy ion collisions event-by-event has become possible. Thus, to perform an analysis of the simulated collisions in a modern "event-by-event" mode such an initial state model has to be modified.

Abstract

I will present the Generalized Effective String Rope Model in which the fluctuations in the initial state are taken into account following the Glauber Monte Carlo approach. As we will see, the initial state fluctuations lead to principal differences in the initial state comparing to an "averaged" one.

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