Initial conditions, transport and hadronization in heavy-ion collisions*

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Introduction

The study of the properties of the Quark-Gluon Plasma (QGP) –formed in heavy-ion collisons– requires to understand how initially nuclei convert to quarks and gluons and how the partonic matter hadronizes again.

Initial conditions

We have developed a relativistic molecular dynamics approach based on the Nambu–Jona-Lasinio (NJL) Lagrangian [1] for the light u, d, s quarks in order to study the hadronization from an initial state of quarks and antiquarks while in NJL the gluonic degrees of freedom are integrated out and not considered explicitly but contained in an effective coupling constant for the interaction of quarks/antiquarks. As initial condition we use the energy density profile (Fig. 1) from an actual heavy-ion collision calculated within the Parton-Hadron-String-Dynamics (PHSD) transport approach [2].

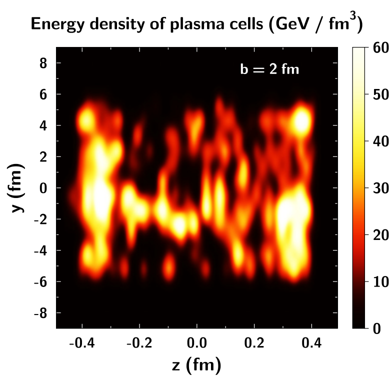

Figure 1: Initial energy density for cells in the local rest frame in the $y - z$ plane of the heavy ion collision.

Relativicstic Molecular Dynamics

In Fig. 1 we show the slice of plasma during the beginning of a Au+Au collision at $\sqrt{s} = 200$ GeV in terms of the energy density in the local cells. In Fig. 2 we show an example of initial conditions using the PHSD energy density converted to NJL partons with the help of the NJL equation of state. Fluctuations in the energy density are clearly visible in the initial parton density. The microscopic study of the expansion and the hadronization through a cross over transition is possible within our transport model.

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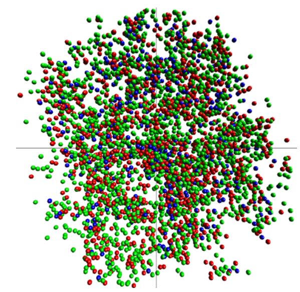

Figure 2: Initial geometry profile of quarks and antiquarks in the $x - y$ plane of the heavy ion collision.

Hadronization

The hadronization volume can be extracted from the r.h.s of Fig. 3 where we show the position in space and time of the inelastic collisions $q\bar{q} \rightarrow MM$ that lead to hadron production in the NJL. Since the full microscopic information is available we can also extract a variety of observables from such simulations as the transverse flow, the p_T-spectra and also study of the influence of the initial condition fluctuations on the final observables.

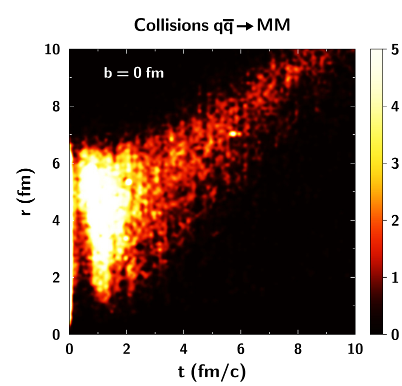

Figure 3: Distribution of inelastic collisions $q\bar{q} \rightarrow MM$ in space $\vec{r}$ (distance from the center of the plasma) and time t from the molecular dynamics calculations.

References

[1] R. Marty, J. Aichelin, *Molecular dynamics description of an expanding $q/\bar{q}$ plasma with the Nambu-Jona-Lasinio model and applications to heavy ion collisions at RHIC and LHC energies*, arXiv:1210.3476 [hep-ph]

[2] V. P. Konchakovski, E. L. Bratkovskaya, W. Cassing, V. D. Toneev, S. A. Voloshin, and V. Voronyuk, *Azimuthal anisotropies for Au+Au collisions in the parton-hadron transient energy range*, Phys. Rev. C **85** (2012) 044922, arXiv:1201.3320 [nucl-th]