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Development of 3+1D glasma simulation in Milne coordinates and its application to the glasma evolution

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The real-time lattice simulation of the classical Yang-Mills (CYM) field is widely used to describe the non-equilibrium evolution of the highly-occupied and weakly coupled gluon matter, called glasma, in the early stage of the relativistic heavy-ion collision. When we study the glasma with the CYM simulation, we often assume no rapidity dependence, namely the boost invariance. This assumption means the relativistic limit and is effective, especially in studying experimental results in the central rapidity region. However, in recent years, much attention has been paid to the rapidity dependence of the glasma beyond the boost invariance [1-3].

In this study, we propose a new numerical simulation method for the 3+1D CYM simulation based on the MV model. We give the initial condition of the CYM field and two 3D classical color sources on a lattice when the two nuclei are still apart. We then solve the discretized classical equation of motion and obtain their evolution. The strategy given above is basically the same as that in [3] but is performed in Milne coordinates, whereas the previous 3+1D CYM simulation employs Minkowski coordinates. Since Milne coordinates automatically account for the expanding geometry in the collision, the lattice simulations in the Milne coordinates are expected to save the longitudinal volume of the lattice used in the simulation.

We apply the 3+1D CYM simulation to the central and non-central collisions. We show the energy density, pressure, and angular momentum and compare them with previous papers' results and experimental values.

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Theory / experiment

Theory

Group or collaboration name

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