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Validation and improvement of the ZPC parton cascade inside a box

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The quark-gluon plasma is formed in high energy heavy ion collisions such as those at RHIC and LHC, where parton interactions greatly affect many final state observables. Both elastic and inelastic parton cascade models have been constructed, such as ZPC, MPC and BAMPS. Recent studies from a multi-phase transport (AMPT) model, which includes the ZPC elastic parton cascade, have shown that even a few parton scatterings in a small system is enough to generate significant momentum anisotropies. It is therefore important to ensure that the parton cascade solution is accurate.

In this work [1], we evaluate and then improve the accuracy of the ZPC parton cascade for elastic scatterings inside a box. It is well known that cascade solutions of the Boltzmann equation such as ZPC suffer from the causality violation at high densities and/or parton scattering cross sections (i.e., large opacities), and that the parton subdivision technique can be used to solve this problem. However, parton subdivision alters the event-by-event correlations and fluctuations and is also much more computationally expensive. Therefore our goal is to find an algorithm that is accurate enough without parton subdivision. We first test a dozen different collision schemes for the collision times and ordering time of ZPC and find that the default collision scheme does not accurately describe the equilibrium momentum distribution at large opacities. We then find a particular collision scheme that can describe very accurately the equilibrium momentum distribution as well as the time evolution towards equilibrium even at high opacities. In addition, we use a novel parton subdivision method to obtain the "exact" time evolution of the moment distribution towards equilibrium. This subdivision method is valid for such box tests and is much more efficient than the traditional subdivision method; e.g. we typically use a subdivision factor of 10^6 in this study. This work is the first step towards the validation and improvement of the ZPC parton cascade for scatterings in 3-dimensional expansion cases.

[1] X.L. Zhao, G.L. Ma, Y.G. Ma, Z.W. Lin, arXiv:2001.10140.

Collaboration (if applicable)

Track

New Theoretical Developments

Contribution type

Contributed Talk

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