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A new relativistic viscous hydrodynamics code and its application to the Kelvin-Helmholtz instability in high-energy heavy-ion collisions

Relativistic hydrodynamic simulations play a key role in exploring the QGP bulk property and the QCD phase transition from analyses of high-energy heavy-ion collisions at RHIC and LHC. From the intensive study based on relativistic viscous hydrodynamic models with event-by-event initial fluctuations, we can extract detailed information of the bulk feature of the QGP such as transport coefficients and the QCD equations of states. In the quantitative analyses of the QGP property, high-precision numerical treatment on the hydrodynamic calculation is important.

Recently, we developed a new 3+1 dimensional relativistic viscous hydrodynamics code in Cartesian coordinates [1]. In the algorithm, we use a Riemann solver based on the two-shock approximation which is stable under existence of large shock waves. We extend the algorithm in Cartesian coordinates to that in Milne coordinates so that we can efficiently apply it to the analyses of relativistic heavy-ion collisions. We check the correctness of the numerical algorithm by comparing numerical calculations and analytical solutions in various problems for ideal and viscous fluids. The new numerical scheme is stable even with small numerical viscosity [2], which is very important to discuss the physical viscosities at RHIC and LHC.

We apply our relativistic viscous hydrodynamics code to the analysis of the Kelvin-Helmholtz instability in high-energy heavy-ion collisions. We find that the evolution of the hydrodynamic instability is sensitive to the values of the viscosities and the accuracy of the numerical calculation. We discuss possible existence of the Kelvin-Helmholtz instability originates from longitudinal fluctuations and effects of shear and bulk viscosities on the evolution of the instability [3].

[1] Y. Akamatsu, S. Inutsuka, C. Nonaka, and M. Takamoto, J. Comput. Phys. 256, 34 (2014).
[2] K. Okamoto, Y. Akamatsu, and C. Nonaka, arXiv:1607.03630.
[3] K. Okamoto and C. Nonaka, in preparation.

Preferred Track

Collective Dynamics

Collaboration

Not applicable

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