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Study of higher harmonics based on (3+1)-dimensional relativistic viscous hydrodynamics

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Currently a possible origin of "Mach-Cone-like structure" is regarded as triangular flow and higher harmonics which are produced through event-by-event fluctuated initial states, which is a push to implement effects of event-by-event fluctuations in the initial conditions of relativistic hydrodynamic models.
When the hydrodynamic simulation is performed with initial conditions with the event-by-event fluctuation, shock-wave capturing schemes should be used to describe the hydrodynamic expansion correctly.
Here we develop a fast numerical scheme for causal relativistic hydrodynamics with dissipation for analyses of relativistic high energy collisions, which is based on Ref. [1]. This shock-wave capturing scheme for solving relativistic viscous hydrodynamic equation suffers less artificial dissipative effect and is more suitable for physical viscosity analyses, compared to SHASTA, Kurganov-Tadmor (KT) and rHLLE schemes which are mainly used in current analyses based on hydrodynamic models.
Using the relativistic viscous hydrodynamic model first we evaluate the viscosity effect in collective flow such as elliptic flow, triangular flow and higher harmonics. In particular, we investigate the time evolution of them and discuss the relation between the initial geometry and final states.

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