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High resolution numerical scheme for hydrodynamic analysis of heavy ion collisions and formation of an incoming shock wave induced by reheating

We analyze hydrodynamic evolution of fireballs created by relativistic heavy ion collisions by applying a high resolution scheme of numerical hydrodynamics with a focus on the possibility of shock formation in the course of time evolution.

The possibility of shock formation has not been taken into account seriously in numerical analysis of relativistic heavy ion collisions. State of art high resolution codes which are capable of capturing shocks have not been adopted with few exceptions.
The possibility of shock formation or discontinuity is an important feature of hydrodynamics, and this should be treated carefully.
We have developed a computational code on the basis of Chakravarthy-Osher scheme, which is one of flux-vector splitting schemes and is known to reproduce shock waves well in numerical simulations for a variety of situations. When equation of states with a first order phase transition is employed, our simulation reveals the manifestations of shock wavesand shock-like structures having a sharp edge, which are blurred by numerical viscosity in previous analyses, during the time evolution of fireballs. In particular, we find a high temperature region surrounded by sharp edges owing to the reheating of matter at early stage, and the formation of incoming shock-wave induced by this high temperature region. We will clarify the mechanism that produces these novel structures and discuss their importance for the observables in heavy ion collisions.

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