Artificial viscosity based on the subcell-edged approximate Riemann solver

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Abstract

The Lagrangian method, which track the material interface naturally, is widely used in the multi-material and moving boundary problem. In the Lagrangian algorithm on the staggered grids, the artificial viscosity is introduced to capture shock waves. The performance of artificial viscosity is essential for numerical results especially on the distorted grids with large aspect ratio.

The artificial viscosity method, as addition of a fictitious term into the invisid Euler equations of fluid dynamics in order to automatically capture shock waves in a fluid, is perhaps the oldest numerical device in the relatively new field of computational physics and mechanics. In the past years, many different functional forms of artificial viscosity have been proposed.

In the past years, many advanced artificial viscosity has been given, such as the edge artificial viscosity[1] and tensor artificial viscosity[2]. In this type artificial viscosities, the limiter is used to distinguish the shock waves and the isentropic compression. These artificial viscosities acquire good results, while the grid dependence problem occurs.

R. Loubere et. al developed another artificial viscosity based on a cell-centered approximate Riemann solver[3]. This artificial viscosity ,which can preserve the conservation of momentum and satisfy the entropy inequality, acquire good results for shock problems. But in the cases of isotropic compression, this artificial viscosity will also have influence. Another problem of this artificial viscosity is that it can't satisfy the wave-front invariance in spherical implosion problem.

A new artificial viscosity based on the subcell-edged approximate Riemann solver is presented in this paper. The new artificial viscosity can preserve the conservation of momentum and satisfy the entropy inequality. By the limiters for the difference of velocity on the subcell edges, the new artificial viscosity is able to distinguish the shock wave and isentropic compression and satisfy the wave front invariance in the spherical symmetric problem.

The performance of new artificial viscosity is demonstrated by means of various numerical simulation results with large aspect ratio. The presented artificial viscosity has been used in radiation hydrodynamics code, and acquire good results in the integration simulation of indirect-drive laser fusion problem.

Keywords: Lagrangian hydrodynamics, artificial viscosity, approximate Riemann solver, large aspect ratio grid\sep inertial confinement fusion.

References

[1] Caramana, E. J., Shashkov, M. J., and Whalen, P. P.(1998), Formulations of artificial viscosity for multi-dimensional shock wave computations, *J. Comput. Phys*., **144**, 70.

[2] Campbell, J. C., and Shashkov, M. J.(2001), A tensor artificial viscosity using a mimetic finite difference algorithm, *J. Comput. Phys.*,**172**, 739.

[3] Loubere, R., Maire, P. H., and Vachal, P.(2010), A second-order compatibles staggered lagrangian hydrodynamics scheme using a cell-centered multidimensional approximate Riemann solver, *Procedia Computer Science*, 1, 1925-**1**, 933.