A high-order moving mesh kinetic scheme based on WENO reconstruction for compressible flows on unstructured grids

Guoxi Ni,Xihua Xu, Song Jiang
Beijing Institute of Applied Physics and Computational Mathematics,China
P.O. Box 8009, Beijing 100088, China.
E-mail: gxni@iapcm.ac.cn, xihuaxu@gmail.com, jiang@iapcm.ac.cn

ABSTRACT Based on the WENO reconstruction, we present a high-order (at least three order) moving mesh kinetic scheme for compressible flow computations on unstructured meshes. To construct our scheme, we employ the frame of the remapping-free ALE-type kinetic method [G.X. Ni, S. Jiang and K. Xu, Remapping-free ALE-type kinetic method for flow computations, J. Comput. Phys. 228 (2009), 3154-3171.] to discrete Euler equation. As a result of the WENO reconstruction and mesh movement, a new steady set of stencils is set up. We make use of the kinetic flux evolution to construct the numerical fluxes in order to achieve their time-accuracy[K. Xu, A gas-kinetic BGK scheme for the Navier-Stokes equations and its connection with artificial dissipation and Godunov method, J. Comput. Phys. 171 (2001)]. To move meshes adaptively so that the accuracy and robustness of the scheme can be improved, we use the adaptive moving mesh approach from . A number of numerical examples, such as different one-dimensional Riemann problems for the Euler equations, the Mach 3 shock density-wave interaction and the two-dimensional double-Mach shock reflection problems, are presented. Also, an isentropic vortex problem is numerically tested under the trivial mesh velocity to show the convergence order (3rd-order) of our scheme. All the numerical results demonstrate the accuracy and robustness of the scheme.

Keywords: WENO scheme, finite volume scheme, adaptive moving mesh method, ALE method, gas kinetic scheme, compressible gas dynamics

References

(1)R. Abgrall, On essentially non-oscillatory schemes on unstructured meshes: Analysis and implementation, J. Comput. Phys. 114 (1994), pp. 45-58.

(2) C.W. Hirt, B.D. Nichols, An arbitrary Lagrangian Eulerian computing method for all flow speed, J. Comput. Phys. 135 (1997), pp. 203-216.

(3) G.X. Ni, S. Jiang, K. Xu, Remapping-free ALE-type kinetic method for flow computations, J. Comput. Phys. 228 (2009), pp. 3154-3171.

(4) J.X. Qiu, C.W. Shu, Runge-Kutta discontinuous Galerkin method using WENO limiter, SIAM J. Sci. Comput. 26(3) (2005), pp. 907-933.

(5) K. Xu, A gas-kinetic BGK scheme for the Navier-Stokes equations and its connection with artificial dissipation and Godunov method, J. Comput. Phys. 171 (2001), pp. 289-335.