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Accuracy of the adaptive GRP scheme and the simulation of 2-D Riemann problems for compressible Euler equations. (English) Zbl 1373.76130

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Summary: The adaptive generalized Riemann problem (GRP) scheme for 2-D compressible fluid flows has been proposed in [the first author et al., J. Comput. Phys. 229, No. 5, 1448–1466 (2010; Zbl 1329.76205)] and it displays the capability in overcoming difficulties such as the start-up error for a single shock, and the numerical instability of the almost stationary shock. In this paper, we will provide the accuracy study and particularly show the performance in simulating 2-D complex wave configurations formulated with the 2-D Riemann problems for compressible Euler equations. For this purpose, we will first review the GRP scheme briefly when combined with the adaptive moving mesh technique and consider the accuracy of the adaptive GRP scheme via the comparison with the explicit formulae of analytic solutions of planar rarefaction waves, planar shock waves, the collapse problem of a wedge-shaped dam and the spiral formation problem. Then we simulate the full set of wave configurations in the 2-D four-wave Riemann problems for compressible Euler equations [*T. Zhang* and *Y. Zheng*, SIAM J. Math. Anal. 21, No. 3, 593–630 (1990; Zbl 0726.35081)], including the interactions of strong shocks (shock reflections), vortex-vortex and shock-vortex etc. This study combines the theoretical results with the numerical simulations, and thus demonstrates what Ami Harten observed "for computational scientists there are two kinds of truth: the truth that you prove, and the truth you see when you compute" [*P. D. Lax*, J. Sci. Comput. 31, No. 1–2, 185–193 (2007; Zbl 1151.76555)].

MSC:

76M12	Finite volume methods applied to problems in fluid mechanics
35Q31	Euler equations
65M08	Finite volume methods for initial value and initial-boundary value problems involving PDEs
35L60	First-order nonlinear hyperbolic equations
65M25	Numerical aspects of the method of characteristics for initial value and initial-boundary value problems involving PDEs

Full Text: DOI