APPROXIMATE OSHER-SOLOMON SCHEMES FOR HYPERBOLIC SYSTEMS

MANUEL J. CASTRO DÍAZ, JOSÉ MARÍA GALLARDO MOLINA, AND ANTONIO MARQUINA

Abstract. This paper is concerned with a new kind of Riemann solvers for hyperbolic systems, which can be applied both in the conservative and nonconservative cases. In particular, the proposed schemes constitute a simple version of the classical Osher-Solomon Riemann solver (see [4]) , and extend in some sense the schemes proposed in [2, 3]. The viscosity matrix of the numerical flux is constructed as a linear combination of functional evaluations of the Jacobian of the flux at several quadrature points. Some families of functions have been proposed to this end: Chebyshev polynomials and rational-type functions (see [1]). The schemes have been tested with different initial value Riemann problems for ideal gas dynamics, magnetohydrodynamics and multilayer shallow water equations. The numerical tests indicate that the proposed schemes are robust, stable and accurate with a satisfactory time step restriction, and provide an efficient alternative for approximating time-dependent solutions in which the spectral decomposition is computationally expensive.

Keywords:Hyperbolic systems, nonconservative products , Osher-Solomon, Euler equations, ideal magnetohydrodynamics, Multilayer shallow-water system

Mathematics Subject Classifications (2010): 65M08

References

[1] M.J. Castro, J.M. Gallardo, A. Marquina, A class of incomplete Riemann solvers based on uniform rational approximations to the absolute value function, J. Sci. Comput. 60 (2014) 363–389.
[2] M. Dumbser, E.F. Toro, On universal Osher-type schemes for general nonlinear hyperbolic conservation laws, Commun. Comput. Phys. 10 (2011) 635–671.
[3] M. Dumbser, E.F. Toro, A simple extension of the Osher Riemann solver to non-conservative hyperbolic systems, J. Sci. Comput. 48 (2011) 70–88.
[4] S. Osher, F. Solomon, Upwind difference schemes for hyperbolic conservation laws, Math. Comput. 38 (1982) 339–374.

Universidad de Málaga. Dpto. Análisis Matemático
E-mail address: castro@anamat.cie.uma.es

Universidad de Málaga. Dpto. Análisis Matemático
E-mail address: jmgallardo@uma.es

Universidad de Valencia. Dpto. Matem´tica Aplicada
E-mail address: marquina@uv.es