Ferrari, A.; **Dumbser, M.**; **Toro, E. F.**; **Armanini, A.**
A new stable version of the SPH method in Lagrangian coordinates. (English) Zbl 1364.76175
Commun. Comput. Phys. 4, No. 2, 378-404 (2008).

Summary: The purpose of this paper is to solve some of the trouble spots of the classical SPH method by proposing an alternative approach. First, we focus on the problem of the stability for two different SPH schemes, one is based on the approach of *J. P. Vila* [Math. Models Methods Appl. Sci. 9, No. 2, 161–209 (1999; Zbl 0938.76090)] and another is proposed in this article which mimics the classical 1D Lax-Wendroff scheme. In both approaches the classical SPH artificial viscosity term is removed preserving nevertheless the linear stability of the methods, demonstrated via the von Neumann stability analysis. Moreover, the issue of the consistency for the equations of gas dynamics is analyzed. An alternative approach is proposed that consists of using Godunov-type SPH schemes in Lagrangian coordinates. This not only provides an improvement in accuracy of the numerical solutions, but also assures that the consistency condition on the gradient of the kernel function is satisfied using an equidistant distribution of particles in Lagrangian mass coordinates. Three different Riemann solvers are implemented for the first-order Godunov type SPH schemes in Lagrangian coordinates, namely the Godunov flux based on the exact Riemann solver, the Rusanov flux and a new modified Roe flux, following the work of *C. D. Munz* [SIAM J. Numer. Anal. 31, No. 1, 17–42 (1994; Zbl 0796.76057)]. Some well-known numerical 1D shock tube test cases [*E. F. Toro*, Riemann solvers and numerical methods for fluid dynamics. A practical introduction. Berlin: Springer (1997; Zbl 0888.76001)] are solved, comparing the numerical solutions of the Godunov-type SPH schemes in Lagrangian coordinates with the first-order Godunov finite volume method in Eulerian coordinates and the standard SPH scheme with Monaghan's viscosity term.

MSC:

76M28 Particle methods and lattice-gas methods
76M25 Other numerical methods (fluid mechanics) (MSC2010)
76N99 Compressible fluids and gas dynamics

Keywords:

SPH; meshfree particle methods; Riemann solvers; gas dynamics in Lagrangian coordinates; Godunov type schemes

Software:

HE-E1GODF

Full Text: Link