Multidimensional staggered grid residual distribution scheme for Lagrangian hydrodynamics

R. Abgrall[†] **and S. Tokareva**[†]

[†] Institute of Mathematics, University of Zurich (remi.abgrall@math.uzh.ch, svetlana.tokareva@math.uzh.ch)

Keywords: Lagrangian hydrodynamics; residual distribution scheme; finite elements.

ABSTRACT

In this talk we discuss the extensions of the second-order Staggered Grid Residual Distribution (SGH RD) scheme [1] for the Lagrangian hydrodynamics to multiple space dimensions and high order of accuracy. The residual distribution scheme presented in [1] is based on the same staggered finite element discretizations as the scheme of [2]. However, the advantage of the residual formulation consists in the natural mass matrix diagonalization thus allowing to avoid the solution of the linear system with the global sparse mass matrix while retaining the design order of accuracy. This is achieved by resorting to Bernstein polynomials as finite element shape functions and coupling the space discretization with the deferred correction type timestepping method [3]. Moreover, it can be shown that for the Lagrangian formulation written in non-conservative form, our residual distribution scheme ensures the exact conservation of the total energy [1, 4]. We shall also discuss several stabilization techniques for the high order residual distribution schemes applied to Lagrangian hydrodynamics.

Thanks to the generic formulation of the staggered grid residual distribution scheme, it can be directly applied to both single- and multimaterial and multiphase models.

Finally, we shall demonstrate the computational results obtained with the proposed residual distribution scheme for several challenging two-dimensional test problems on both triangular and quadrilateral grids.

References

[1] R. Abgrall, S. Tokareva, Staggered grid residual distribution scheme for Lagrangian hydrodynamics, *SIAM J. Sci. Comput.*, 39, pp. A2317–A2344, 2017.

[2] V. Dobrev, T. Kolev, and R. Rieben, High order curvilinear finite element methods for Lagrangian hydrodynamics, *SIAM J. Sci. Comput.*, 34, pp. B606–B641, 2012.

[3] R. Abgrall, P. Bacigaluppi, S. Tokareva. High-order residual distribution scheme for the time-dependent Euler equations of fluid dynamics. *Computers and Mathematics with Applications, submitted*, 2017.

[4] R. Abgrall, P. Bacigaluppi, S. Tokareva. A high-order nonconservative approach for hyperbolic equations in fluid dynamics. *Computers & Fluids, accepted*, 2017.