A Simple, Accurate Lagrangian Hydrocode

Tyler B. Lung[†] **and Philip L. Roe**[†]

[†] Department of Aerospace Engineering, University of Michigan (`tblung@umich.edu`, `philroe@umich.edu`)

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ABSTRACT

Lagrangian hydrocodes play an important role in the computation of transient, compressible, multi-material flows. Here a simple cell-centered Lagrangian method for the Euler equations is presented that respects multidimensional physics while achieving second order accuracy. Algorithms that acknowledge the multidimensional physics associated with vorticity transport and acoustic wave propagation are needed in order to increase accuracy and prevent spurious mesh distortions. As such, one-dimensional Riemann solvers and spatial gradient limiters, which are common to traditional Godunov-type schemes, have been abandoned. Instead, we employ multidimensional vertex fluxes that automatically define the mesh motion and temporal, physics-based flux limiting. The first- and second-order accurate Lagrangian methods presented here are an extension of the vorticity preserving Lax-Wendroff-type methods detailed in [1]. In addition to the base schemes, a nonlinear, limited method has also been developed by taking inspiration from the Flux-corrected transport (FCT) framework. Here a simple temporal-based flux limiter reduces the antidiffusive flux in order to reduce overshoots. The Lagrangian schemes developed here suffer from minimal mesh imprinting and are able to preserve radial symmetry, even when solving the Noh problem on a Cartesian mesh as shown in Figure 1. Additional numerical results will be presented to illustrate current successes and ongoing challenges.
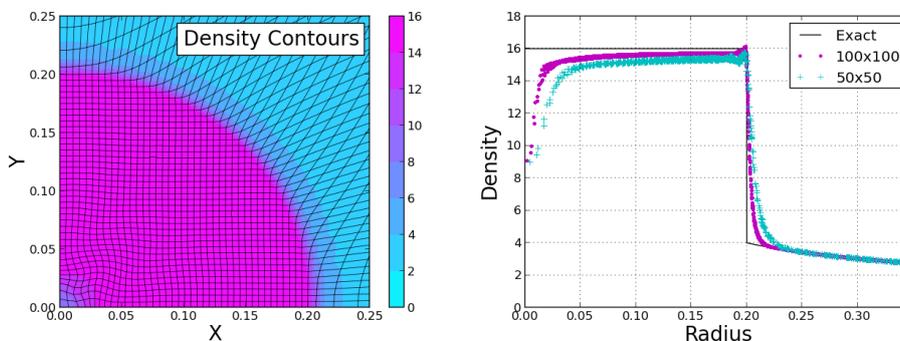
Figure 1: Limited second order density solutions for the Noh problem ($\gamma = 5/3$, $t = 0.6$): Left - Density contours with mesh, 50×50 cells, Right - Radial plots for 50×50 mesh and 100×100 mesh

References

[1] T.B. Lung and P.L. Roe (2014), Toward a reduction of mesh imprinting, *Int. J. Numer. Meth. Fluids*, 76, pages 450470, doi: 10.1002/fld.3941