ReALE – Reconnection-based Arbitrary Lagrangian Eulerian Method

M. Shashkov*, J. Breil†, S. Galera††, R. Loubere+ and P.-H Maire++

* Group XCP-4, X-Computational Physics Division
Los Alamos National Laboratory
† UMR CELIA, Université Bordeaux I
†† INRIA, Team Bacchus
+ CNRS, Mathematical Institute of Toulouse
++ CEA_CESTA BP 2

ABSTRACT

We present a new reconnection-based multi-material Arbitrary Lagrangian Eulerian (ALE) method [1,2]. The main elements in an standard ALE simulation are an explicit Lagrangian phase in which the solution and grid are updated, a rezoning phase in which a new grid is defined, and a remapping phase in which the Lagrangian solution is transferred (conservatively interpolated) onto the new grid.

In standard ALE methods the new mesh from the rezone phase is obtained by moving grid nodes without changing connectivity of the mesh. Such rezone strategy has its limitation due to the fixed topology of the mesh. In our new method we allow connectivity of the mesh to change in rezone phase, which leads to general polygonal mesh and allows to follow Lagrangian features of the mesh much better than for standard ALE methods.

Rezone strategy with reconnection is based on using Voronoi tessellation. Mesh smoothing is achieved by using notion of centroidal Voronoi diagrams. Because of reconnection we have to use discretizations of Lagrangian hydro, which are capable to deal with general polygonal mesh. In this work we use both cell-centered and staggered discretizations on general polygonal meshes. For remapping stage we use algorithms based on intersections of Lagrangian and rezoned mesh.

We demonstrate performance of our new method on series of numerical examples and show it superiority and robustness in comparison with standard ALE methods without reconnection.

In Figure 1, we present the result of application of the ReALE method for Kelvin-Helmholtz instability.
Figure 1. Kelvin–Helmholtz Instability.

REFERENCES


Acknowledgements

Los Alamos National Laboratory is operated by the Los Alamos National Security, LLC, for the National Nuclear Security Administration of the U.S. Department of Energy under Contract DE-AC52-06NA25396.