Numerical Simulations of 3D Richtmyer-Meshkov Instability with a Cube-Shaped SF6 Bubble Using a High-Order Targeted-ENO Finite-Volume Method

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Compressible multicomponent and multiphase flows are found in a wide variety of important practical flow problems such as astrophysics, combustion, explosions and detonations, nuclear reacators and medical treatment procedures. These flows typically features both turbulence and sharp shock or material interfaces that require numerical methods that are high-order in smooth regions and non-oscillatory around sharp gradients.

For the case of an initially cube shaped bubble, the shock incident angle remains constant along the inhomogeneous interface, allowing control over the baroclinic torque vorticity generation mechanism. Following this, Luo et al. [1] conducted experiments with a light/heavy air/SF6 interface for square, streamwise, and transverse rectangle, forward and backward triangle, and diamond polygons.

In this paper, we have applied a high-order finite-volume code to numerically solve the multicomponent compressible Euler equations using a combination of Gauss Legendre quadrature [2], the recently published targeted ENO scheme for spatial reconstruction of primitive variables [3], the HLLC approximate Riemann solver , and a third-order TVD Runge-Kutta for explicit time advancement, as was recently published by Haimovich and Frankel [4].

The interaction of a planar shock wave with a three-dimensional cube-shaped sulphur hexafluoride, SF6, bubble is numerically studied. We study and quantify the contribution of baroclinic, dilatation and stretching vorticity components on the flow dynamics. We also observe the phenomena of axis switching [5] of the bubble along time.

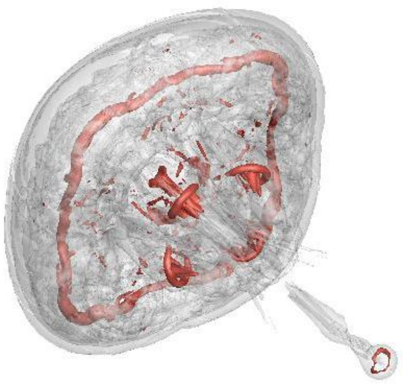

Figure1. Iso-contour plot of vorticity magnitude captured at t=1.5 msec.

References:
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