Numerical Simulation of Compressible Turbulent Mixing due Rayleigh-Taylor Instability.

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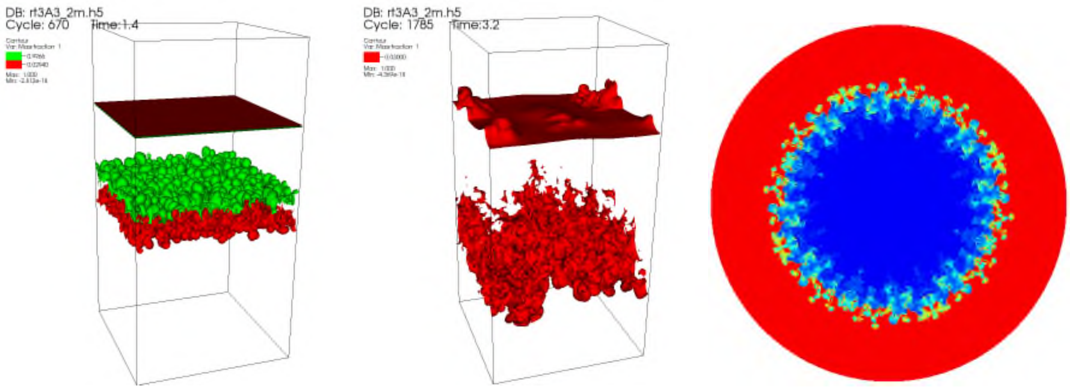
Turbulent mixing due to Rayleigh-Taylor (RT) instability and related processes is of importance in a range of applications including Inertial Confinement Fusion (ICF), astrophysical and environmental flows. During the past few decades 3D simulation [Implicit Large Eddy Simulation (ILES) and Direct Numerical Simulation (DNS)] has made a major contribution to understanding these processes, see for example [1,2]. This talk will describe some of the key features of high-Reynolds number RT mixing in simple situations and will show a range of results from 3D simulations (see images below).



(a) (b) (c)

Figure 1: (a),(b) break-up of a dense layer due to RT instability, (c) turbulent mixing in a spherical implosion. [1]

The choice of numerical technique is a topic of considerable controversy, in particular (i) the use DNS versus ILES, (ii) the use of ILES versus LES with an explicit sub-grid-scale model and (iii) the role of Reynolds-Averaged Navier-Stokes (RANS) or other engineering models. A summary of the simplified 3D compressible Lagrange-Remap hydrocode TURMOIL, which has been used for ILES and DNS, will be given. Results for simple benchmark problems will be used to illustrate the choice of approach used here.

DNS is limited to relatively simple situations but is necessary if the effect of finite Reynolds number is important. It is proposed that ILES is more suitable than LES with a sub-grid-scale model for the cases considered here which have density discontinuities and shocks. ILES is essential for more complex cases and should give a valid approximation to high-Reynolds number turbulent mixing. RANS models are needed for the most complex applications with additional physics. It is strongly argued here that ILES and DNS for simplified problems have an essential role for RANS model calibration and validation.

References

1. Youngs, D.L. 2009 Application of monotone integrated large eddy simulation to Rayleigh-Taylor mixing: *Phil.Trans. R. Soc. A*, **367**, 2971-2983.
2. Youngs, D.L. 2013 The density ratio dependence of self-similar Rayleigh-Taylor mixing: *Phil. Trans. R. Soc. A*, **371**, 20120173.