Mon4.1 Nishihara et al.

Linear and nonlinear evolution of Richtmyer-Meshkov instability

Katsunobu Nishihara[1], Chihiro Matsuoka[2], Gustavo J. Wouchuk[3] , Snezhana I. Abarzhi[4] & Vasilii V. Zhakhovskii[1]

1. Institute of Laser Engineering,
Osaka University, Japan
nishihara@ile.osaka-u.ac.jp

2. Deaprtment of Physics,
Ehime University, Japan
matsuoka@phys.sci.ehime-u.ac.jp

3. E. T. S. I. Industrials-UCLM-(13071) Campus,
Universitario s/n Ciudad Real, Spain
gwouchuk@ind-cr.uclm.es

4. Center for Turbulence Research,
Stanford University, USA
snezha@summer8.Stanford.edu

The Richtmyer-Meshkov instability (RMI) develops at a corrugated interface separating two fluids for following two cases, a shock wave traverses the interface (for example, Dimonte (1996)), and the interface is accelerated in impulsive form during short time (Jacobs (1996)). We here present analytical solutions for linear and nonlinear evolution for both cases, which agree very well with those experiments (Dimonte (1996) and Jacobes (1996)). In a shock-driven environment, the linear theory (Wouchuk (1997)) indicates that the instability is driven by the nonuniform velocity shear left by transmitted and reflected rippled shocks at the interface. The instability is also governed by compressibility effects which are more important as stronger are the shocks involved (Wouchuk (2001)). In later case, on the other hand, no shock wave has been used to accelerate the interface and therefore compressibility of the fluids can be ignored. Based on a weakly nonlinear theory (Matsuoka (2003)), we can describe the instability evolution for any Atwood number at the interface and the asymmetry of the bubble and spike structures. In this work, the nonlinear evolution of the interface has been investigated as a self-interaction of a nonuniform vortex sheet with a density jump. The theory developed shows the importance of the finite density jump and the finite initial corrugation amplitude of the interface. The vorticity on the interface for a finite density jump is not conserved in the nonlinear regime. Our results suggest that the spiral structure of the spike is due to local increase and decrease of the vorticity on the interface. Nonlinear analysis shows that the large initial amplitude of the corrugation results in rapid increase of the vorticity, which may also explain the fast roll up motion of the spiral for large amplitudes. We have also developed a theory (Abarzhi (2003)) that yields a non-trivial dependence of the bubble velocity and curvature on the density ratio and reveals an important qualitative distinction between the dynamics of Rayleigh-Taylor and RM bubbles.

References

Abarzhi, S. I., Nishihara, K and Glimm, J., 2003, Phys. Lett. A, **317**, 470.

Dimonte, G., Frerking, C. E., Schneider, M. and Remington, B., 1996, Phys. Plasmas **3**, 614.

Jacobs, J. W. and Shelly, J. M., 1996, Phys. Fluid **8**, 405.

Matsuoka, C., Nishihara, K. and Fukuda, Y., 2003, Phys. Rev E **67**, 036301.

Wouchuk, J. G. and Nishihara, K., 2003, Phys. Plasmas **4**, 1028.

Wouchuk, J. G. 2001, Phys. Rev. E **63**, 056303.