

Fluid instabilities and interfacial mixing in high energy density plasmas

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Rayleigh-Taylor (RT) and Richtmyer-Meshkov (RM) instabilities and RT/RM interfacial mixing are common to occur in high energy density plasmas (HEDP) at astrophysical and at atomic scale. Examples include RTI quenching ignition in inertial confinement fusion, blast wave induced RT mixing in core-collapse supernova creating conditions for synthesis of heavy mass elements, and RTI governing material transformation in nano-electronics. By analyzing symmetries of RT dynamics in high energy density plasmas relevant conditions and by focusing on certain patterns of variable acceleration, we discover a special class of self-similar solutions and identify their scaling, correlations and spectra. We find that dynamics of RT mixing can vary from super-ballistics to sub-diffusion depending on the acceleration and can retain memory of deterministic conditions for any acceleration. These rich dynamic properties considerably impact the understanding and control of RT relevant phenomena in high energy density plasmas. Particularly, they reveal the new mechanism for energy accumulation and transport at small scales in supernova, via energy localization and trapping.

The work is supported by the University of Western Australia (AUS) via project grant 10101047, and the National Science Foundation (USA) via award 1404449.