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On fundamentals of Rayleigh-Taylor instabilities and mixing[1]

SNEZHANA I. ABARZHI, University of Chicago & University of Illinois at Chicago. IL, USA — Rayleigh-Taylor instability (RTI) develops when fluids of different densities are accelerated against the density gradient; extensive inter-facial mixing of the fluids ensues with time. Rayleigh-Taylor (RT) mixing controls a variety of plasma processes in high and low energy density regimes, including supernova explosion, stellar convection, and light-material interaction. RT mixing is a central concern in achieving ignition in fusion plasmas due to the seeding of RTI by the drive and target imperfections. Traditionally, it was presumed that RTI leads to uncontrolled growth of small-scale imperfections, single-scale nonlinear dynamics, and extensive mixing that is similar to canonical turbulence. A need in alternative scenarios is suggested now by the success that was recently achieved on the sides of experiments in high energy density plasmas, large-scale numerical simulations, and rigorous analysis of RTI and RT mixing. We find that RT evolution is essentially multi-scale, and that the properties of RT mixing depart substantially from those of canonical turbulence. The accelerated self-similar RT mixing indeed exhibits more order thus opening new opportunities for its regularization and control in high energy density plasmas.

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