From the laboratory to astrophysics: the Rayleigh-Taylor instability

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Recent breakthroughs in inertial confinement fusion have demonstrated fusion ignition, but significant physics and engineering challenges remain to truly achieve energy breakeven. Hydrodynamic mix at material interfaces is known to be detrimental for laser-driven and pulsed-power-driven inertial confinement fusion implosions. Hence, mitigation of mix remains an open challenge. The Rayleigh-Taylor instability (RTI), which occurs when the interface between two fluids with different densities is accelerated, has been known to play a critical role in producing hydrodynamic mix at material interfaces. The RTI is an ubiquitous instability and RTI-like features and growth have been noted in astrophysical observations. The presence of magnetic fields, plasma transport, and kinetic effects can significantly alter the evolution of the RTI, which may explain discrepancies between numerical simulations and observations. These will be discussed in this talk. Other high-energy-density research relevant to pulsed-power implosions such as the growth of the electrothermal instability that can seed the late-time RTI will be discussed briefly. There is a need for high-fidelity computational models to study high-energy-density plasmas. A hierarchy of models, ranging from magnetohydrodynamic (MHD) to fully kinetic, are developed and applied across a wide range of parameter regimes in the PLASMAWISE laboratory at the University of Washington.

Brief bio:

Bhuvana Srinivasan is an Associate Professor in the William E. Boeing Department of Aeronautics and Astronautics at the University of Washington. Prior to this appointment, she was an Associate Professor in the Kevin T. Crofton Department of Aerospace and Ocean Engineering at Virginia Tech where she has developed a program in computational plasma physics. Prior to joining Virginia Tech, she was a postdoc and a scientist at the Los Alamos National Laboratory. She is the director of the PLASMAWISE Laboratory (previously the Plasma Dynamics Computational Laboratory at Virginia Tech). The primary research areas in her group include plasma-material interactions in thrusters and fusion devices, instabilities in high-energy-density fusion and astrophysical plasmas, ionospheric plasma instabilities, and numerical algorithm development for fluid and kinetic models. She is a recipient of the NSF CAREER award, the 2017 Outstanding Assistant Professor award and the 2019 Faculty Fellow awarded by the Dean of the College of Engineering at Virginia Tech. She was appointed to the Endowed Crofton Faculty Fellowship in Engineering from 2021-2023. She is a member of the Fusion Energy Sciences Advisory Committee to the U.S. Department of Energy and serves on the Executive Committee for the American Physical Society Division of Plasma Physics. She is also active in Diversity, Equity, and Inclusion (DEI) efforts as the past Chair of the DEI committee in the aerospace and ocean engineering department at Virginia Tech and through her involvement with the Center for the Enhancement of Engineering Diversity at Virginia Tech.