Plasma Physics Seminar

BAPSF Auditorium Room 15-70 1000 Veteran Avenue
Via Zoom: https://ucla.zoom.us/j/92785449357?pwd=SVBTSko3bTdEUW03dzQwNks1Q2lKZz09
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3:00PM Refreshments will be served.

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 govern a broad range of processes in high energy density plasmas, in nature and technology. Examples include the RT/RM instabilities quenching ignition in inertial confinement fusion, the blast wave induced RT/RM mixing in supernova remnants, and RT/RM dynamics influencing materials' transformation in nano-fabrication. In high energy density settings, at astrophysical and at atomic scales, RT/RM flows are driven by variable accelerations and strong shocks, have sharply and rapidly changing fields, and are anisotropic, non-uniform, and statistically unsteady. Their dynamics depart from canonical scenarios; yet, they can exhibit self-organization and order. We employ the group theory approach to analyze RT/RM dynamics with variable accelerations typical in high energy density plasmas. We directly link the conservation laws governing RT/RM dynamics to the symmetry-based momentum model, precisely derive the model parameters and yield rigorous analytical solutions in the scale-dependent and scale-invariant regimes. We discover the special self-similar class in RT/RM mixing with variable acceleration, and explore its symmetries, scaling laws, spectral shapes, correlations and fluctuations. We reveal that the self-similar dynamics can vary from super-ballistics to sub-diffusion depending on the acceleration and retain memory of the initial conditions for any acceleration. The obtained results are consistent with the existing experiments and numerical simulations, and explain the long-standing puzzles observed in RT/RM experiments at high Reynolds numbers. We propose the experiments at the National Ignition Facility to implement the theory frontiers. We discuss perspectives, unexplored before, for better understanding, and ultimately – controlling, fluid instabilities and interfacial mixing in high energy density plasmas, from supernovae to fusion.