Fluid Instabilities and Interfacial Mixing

Friday, October 14th, 2022
12:30 PM

Bowen Hall, Room 222

MAE Seminar Series

Snezhana I. Abarzhi
University of Western Australia

Rayleigh-Taylor (RT) instabilities and RT interfacial mixing control a broad range of processes in nature and technology. Examples include the evolution of supernova remnants, the formation of Solar flares, the pollutant dispersion in the atmosphere, the atomization of liquid jets, the materials transformation under the impact, the multi-phase micro-fluidics, and the inertial confinement fusion. Rayleigh-Taylor unstable flows are driven by accelerations and shocks, have sharply and rapidly changing fields, and are anisotropic, non-uniform, and statistically unsteady. At macroscopic and microscopic scales, their properties depart from canonical scenarios; yet, they exhibit self-organization and order. We discover a special self-similar class in Rayleigh-Taylor mixing with variable accelerations, by exploring its symmetries, scaling laws, correlations, and fluctuations. We find that RT mixing can vary from super-ballistics to sub-diffusion depending on the acceleration and retain memory of the initial conditions for any acceleration. We explain long-standing puzzles in Rayleigh-Taylor experiments at high Reynolds numbers, and discuss perspectives, unexplored before, for understanding and controlling fluid instabilities and interfacial mixing in nature and technology.

Snezhana I. Abarzhi is a Professor and Chair of Applied Mathematics at the University of Western Australia. Before that, she worked at Carnegie Mellon University, the University of Chicago, Stanford University, SUNY Stony Brook in the USA, and Osaka University in Japan, and the University of Bayreuth in Germany. She got her Ph.D. at the Landau Institute for Theoretical Physics of the Russian Academy of Sciences. Professor Abarzhi is also a theoretical physicist and applied mathematician specializing in the dynamics of fluids and plasmas and their applications in nature and technology. Her key results are the mechanism of interface stabilization, the special self-similar class in interfacial mixing, and the fundamentals of Rayleigh-Taylor instabilities. Her key contributions to the community are the program 'Turbulent Mixing and Beyond' and the editorial work. Her achievements are recognized nationally and internationally (by, e.g., the National Science Foundation and National Academy of Sciences in the USA, Japan Society for Promotion of Science in Japan, Alexander von Humboldt Foundation in Germany). She is a Fellow of the American Physical Society, elected for 'for deep and abiding work on the Rayleigh-Taylor and related instabilities, and for sustained leadership in that community. She serves the APS Committee on Scientific Publications.

PRINCETON
Mechanical & Aerospace Engineering