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On special class of self-similar dynamics and fundamentals of Rayleigh-Taylor mixing with variable acceleration

We observed Rayleigh-Taylor instability (RTI) when watching water flowing from an overturned cup. RTI develops at the interface between two fluids accelerated against their density gradients and leads to intense interfacial Rayleigh-Taylor (RT) mixing of the fluids. RTI and RT mixing have critical importance in a broad range of processes in plasmas, fluids and materials, at astrophysical and at atomic scale. Examples include: RTI quenches ignition in inertial confinement fusion; RT mixing in core-collapse supernova creates conditions for heavy mass elements synthesis; RTI governs material transformation under impact in nano-fabrication. In most instances, RT flows are driven by variable acceleration, whereas the bulk of existing studies have considered only constant acceleration. We apply group theory to analyze symmetries of RT dynamics with variable acceleration and find solutions for scale-dependent RTI and self-similar RT mixing. We discover a special class of self-similar solutions for RT mixing with variable acceleration and identify their scaling, correlations and spectra. Dynamics of RT mixing can vary from super-ballistic to sub-diffusive depending on the acceleration and retain memory of deterministic conditions for any acceleration. Particularly, for strong accelerations RT mixing keeps order and laminarize, whereas for weak accelerations RT mixing is slower than diffusion. These rich dynamic properties considerably impact our understanding and control of RT relevant phenomena in plasmas, fluids, materials. For instance, in blast-wave driven RT mixing in supernova, we reveal new mechanism of energy accumulation and transport at small scales to provide conditions for synthesis of heavy mass elements.

Biography

Snezhana I Abarzhi is a Professor of Applied Mathematics at the University of Western Australia, AUS. Before the UWA, she developed her research program at Carnegie Mellon University, University of Chicago, Stanford University, SUNY Stony Brook in the USA, at Osaka University in Japan and University of Bayreuth in Germany. She has completed her PhD at Landau Institute, Russia. She has published 80 papers, founded program Turbulent Mixing and Beyond, organized 15 research books, and served as an Editor in Physica Scripta and as Guest Editor in the PTRS and PNAS. Her research is recognized with international awards.

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