Non-equilibrium pattern selection in particle sedimentation

Ashwin Vaidya
*Department of Mathematical Sciences, Montclair State University, Montclair, NJ 07043, USA.*

In this talk, we explain some well-known experimental observations in fluid solid interaction from a thermodynamic perspective. In particular we use the extrema of the rate of entropy production (MEP principle) to establish the stability of specific patterns observed in single and multi-particle sedimentation in an infinite fluid and the sedimentation of spheres in the presence of walls. For instance, a freely falling cylinder in a fluid will take on various orientations, in its mechanical steady state, depending upon the properties of the fluid and the geometry and material properties of the cylinder. While these phenomena have been explained numerically, there is no known rigorous theoretical argument to establish the stability of the observed configurations due to the underlying mathematical complexities. In the absence of many rigorous examples for the entropy production principle in fluid mechanics, our work advances this argument and lends it much credibility as a possible method to be used to explain the myriad of pattern formation problems in this field. In addition to looking at the rate of entropy production, we also put forth a very plausible heuristic argument based on the thermal gradients in the systems being studied, which could be the underlying causal principle for many known patterns in nature.