ICTS Fluid Dynamics Seminar

Title : Stability of Sedimenting Spheres Using an Idealized Two-Phase Continuum Model

Speaker : Dylan James Reynolds (ICTS-TIFR, Bengaluru)

Date : Friday, 20 June 2025

Time : 11:30 AM (IST)

Abstract : The study of Stokesian sedimenting particles has a long history and many applications. Of critical importance, in both industrial and natural phenomena, is understanding the stability of collections of particles interacting under hydrodynamic forces. The work of Crowley in the 1970s shows that regularly spaced 1D and 2D lattices of spherical particles suffer a viscous instability upon sedimentation, leading to the formation of clumps. However, and importantly, for a homogeneous 3D distribution of spheres this instability is not present, e.g. a 3D array of particles is stable. A rigorous analysis of this behavior is hard to come by in the fully nonlinear regime, and as such, our current understanding largely stems from numerical or experimental results.

In this talk I will outline a two-phase continuum theory of sedimenting spheres which is amenable to many analytical results, namely, steady state flow profiles and linear instabilities. While a more comprehensive two-phase model of suspensions has been discussed heavily in the literature, the model I'll introduce here contains only the fundamental properties of low Reynolds number hydrodynamics and conservation laws. Using this model, I will show that any large-scale spatial variation in the particle density ultimately leads to instability, with stability only occurring for a very fine-tuned region of the parameter space. Time permitting, I will show some numerical results that go beyond the linear regime and highlight the full range of the idealized model.

Venue : Emmy Noether Seminar Room
Zoom Link: https://icts-res-in.zoom.us/j/99344909613?pwd=AY5BMp93M0v6XmQLm45DKG6G9O1qgw.1
Meeting ID: 993 4490 9613
Passcode: 070109