TIFR Centre for Interdisciplinary Sciences
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Seminar

The turbulent 'mixing' layer as a problem in vortex gas statistical mechanics

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Turbulence has been considered as the last unsolved problem in classical physics, in part because of its strongly nonlinear nature. Most theoretical attempts as well as the biggest computer simulations performed to understand turbulence have been limited to the simplified homogeneous isotropic setting. While such an approach has provided some insights, homogeneous isotropic turbulence lacks many of the essential features found in real world shear flows, in particular the emergence of ordered motion in form of coherent vortical structures, and hence may not be the most appropriate simple problem.

This talk (based on Suryanarayanan, Narasimha & Hari Dass, Phys. Rev. E 89, 013009, 2014) will be focused on what may be considered a more appropriate simple problem – a turbulent mixing (or free shear) layer between two initially-separated streams with different velocities. Extensive simulations of a vortex-gas model of the same suggest that inspite of being two dimensional and inviscid, the model has quantitative characteristics of the large scale evolution of real world plane mixing layers. Being a Hamiltonian N-body problem, the vortex gas is amenable to statistical-mechanical treatment following Onsager (Il Nuovo Cimento 6, 279, 1949). Present simulations, which show emergence & interaction of coherent structures and negative temperature states, also reveal a universality of the exponent as well as the coefficient during the nonequilibrium evolution relevant to the fluid-dynamic self-preservation regime. Implications to fluid dynamics, equilibrium and non-equilibrium statistical mechanics including kinetic theory based approaches will be discussed.

Wednesday, Jan 13th 2016

11:30 AM (Tea/Coffee at 11:15 AM)

Seminar Hall, TCIS