Colloquium

Institute for Plasma Research

Title : Time-analyticity of Lagrangian particle trajectories in ideal fluid flow governed by the Euler equations: historical and modern perspectives

Speaker : Prof. Uriel Frisch
University of Nice, France

Date : 31st October 2014 (Friday)

Time : 4.00 PM

Venue : Board Room,New Building IPR
(via video conferencing)

Abstract:

Two prized papers, one by Augustin Cauchy in 1815, presented to the French Academy and the other by Hermann Hankel in 1861, presented to Goettingen University, contain major discoveries on vorticity dynamics whose impact is now quickly increasing.

In this lecture, I shall show how Augustin Cauchy's result can now be used to prove in an elementary way the analyticity in time of fluid particle trajectories for flow with only limited initial smoothness. I shall also show how a time-Taylor expansion method exploiting analyticity can be used to develop a Cauchy-Lagrangian method for numerical integration of the Euler equations in Lagrangian coordinates. This can be viewed as a numerical implementation of Arnold's result that the Euler equation is a geodesic flow on the infinite-dimensional manifold SDiff of volume preserving diffeomorphisms. As such the Cauchy-Lagrangian method handles the Euler equation as an ODE (in a functional space) and is far less affected by rounding errors than

numerical methods using Eulerian coordinates. Because such integrations can now be carried out in very high precision, they should enable us to get good evidence for or against finite-time blow up of the solutions to the 3D incompressible Euler equations.

The presentations are based in part on the two following papers:

1. Frisch, U. and Villone, B. 2014.
Cauchy's almost forgotten Lagrangian formulation of the Euler equation for 3D incompressible flow, EPJ H vol. 39, pp. 325--351. arXiv:1402.4957 [math.HO]

2. Zheligovsky, V. and Frisch, U. 2014.
Time-analyticity of Lagrangian particle trajectories in ideal fluid flow, J. Fluid Mech., vol. 749, pp. 404--430. ArXiv:1312.6320 [math.AP]