UCCS Mathematics Colloquium

Thursday, November 17th, 2011

UC 307

12:30pm – 1:30pm

(Refreshments at 12:15pm)

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Transport and Mixing in Time-Dependent Flows

Abstract: Traditionally fluids are mixed by violent stirring, which induces turbulent flow that enhances gradients and thereby speeds diffusion. However, in many cases, the effective viscosity is too large for turbulent mixing, e.g., when the fluid volume is small (micro-fluidics). In this case, one must using laminar stirring. Our understanding of mixing in this case is based on ideas of Hassan Aref for the chaotic dynamics of Lagrangian tracers.

A important tool in the study of mixing is that of transport: the quantification of flux between regions in phase space. Traditional methods are based on constructing partial barriers containing lobes; these are naturally formed formed from heteroclinic intersections between invariant manifolds. This theory is well-developed for the case of low dimensional Hamiltonian flows; we will review the more recent theory of transport mechanisms for incompressible 3D flows and volume-preserving maps.

Aperiodically time-dependent dynamical systems may have no hyperbolic invariant sets, and so new ideas must be developed. In geophysics and the laboratory, flows are typically aperiodic and they are always transient. We will give a short review of transport theories based on short time information using Lyapunov exponents, distinguished trajectories, approximate invariant sets, and transitory dynamics.