Physics Colloquium

Michigan Technological University

Thursday, January 26, 2012 at 4:00 pm
Rekhi Hall, Room B006

Stretch, Fold, and Spin: Dynamical Structures and Nonlinear Mechanisms of Mixing

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(Faculty Candidate for SFHI Water)

Abstract: Fluid mixing is a key process we must understand in order to make predictions about a variety of water-related phenomena: the growth of phytoplankton, oceanic transport of salt and heat, and the dynamics of clouds, for example. I will talk about two recent lines of experiment, both intimately connected to mixing. One focuses on characterizing mixing and connecting it to coherent structures in the underlying flow; we address mixing by separating measured flow deformation into stretching and folding (affine and non-affine parts). In future work I will use the technique to study the mixing and growth dynamics of oceanic plankton, with implications for marine ecology, food chains, and carbon uptake. Rather than work with actual plankton, initial experiments will use an analogous, flow-coupled chemical reaction because it progresses on timescales convenient in the lab. The second line of work focuses on a major mechanism for marine mixing, Coriolis-restored inertial waves typical in rotating fluids. In recent experiments we identified particular inertial waves relevant to Earth's core, going on to explain their excitation and mode selection. In future work I will experimentally measure nonlinear interactions of colliding inertial wave beams, with implications for salt and heat transport in Earth's oceans.

Biography: Douglas H. Kelley is a Postdoctoral Research Associate in the Department of Mechanical Engineering & Materials Science at Yale University, working with Prof. Nick Ouellette. Doug earned a PhD in physics under the direction of Prof. Dan Lathrop at University of Maryland in 2009, an MS in physics from Auburn University in 2004, and a BS in electrical engineering from Virginia Tech in 2000. From 2000 to 2002 he engineered fiber optic communication systems for Corning. In his research Doug seeks low-dimensional representations of high-dimensional systems--especially fluids. His recent experiments have focused on connecting mixing and transport of scalars to dynamically relevant coherent structures. He has also studied mixing and transport of magnetic fields in Earth's geodynamo, using laboratory models with liquid sodium as the working fluid. His other scholarly interests include rotating turbulence, transport of chemically and/or biologically active materials, and collective motion of animals.

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