Boulder Fluid Dynamics Seminar Series

Tuesday, September 2, 2014
3:30pm-4:30pm (refreshments at 3:15pm)
Bechtel Collaboratory in the Discovery Learning Center (DLC)
University of Colorado at Boulder

Large Amplitude Solitary Waves and Dispersive Shock Waves in Conduits of Viscous Liquids

Mark Hoefer, *University of Colorado Boulder*

A dispersive shock wave (DSW) represents the combination of solitary and linear dispersive wave phenomena into one coherent structure. DSWs are therefore fundamental nonlinear structures that can occur in any conservative hydrodynamic setting, e.g., superfluids, "optical fluids" as well as classical fluids such as shallow water. Experimental studies of DSWs in all media have been restricted by inherent physical limitations such as multi-dimensional instabilities, difficulties in capturing dynamical information, and, eventually, dissipation. These limit DSW amplitudes, evolution time, and spatial extent. In this talk, a new medium is proposed in which to study DSWs that overcomes all of these difficulties, allowing for the detailed, visual investigation of dispersive hydrodynamic phenomena. The vertical evolution of the interface between a buoyant, viscous liquid conduit surrounded by a miscible, much more viscous fluid exhibits nonlinear self-steepening (wave breaking), dispersion, and negligible dissipation. First, it will be shown experimentally and theoretically that the two-soliton interaction geometry can be classified into three distinct types, extending Peter Lax's famous result for the weakly nonlinear Korteweg-de Vries equation into the strongly nonlinear regime. Then, DSW experiments and novel DSW-soliton interaction behaviors will be presented and compared with modulation theory. The talk will cover multiple scales, from the microscopic (Navier-Stokes), mesoscopic (interfacial conduit equation), and macroscopic (Whitham modulation equations), to the truth (experiments).

The Effect of an Obstacle Unsteady Wake on Reaction Enhancement Between Two Initially Distant Scalars

Farrokh Shoaei and John Crimaldi, *University of Colorado Boulder*

The effect of a turbulent wake behind a round obstacle on mixing and reaction between two initially distant scalars has been investigated using a two-channel planar laser-induced fluorescence technique (2C-PLIF). The scalars are stirred and mixed in the mildly turbulent (Re=2000) wake of a round cylinder. The scalars are released continuously upstream of the cylinder, with a separation that initially impedes the reaction. The direct effect of the wake on mixing enhancement is determined by comparing segregation parameter for cases with and without the cylinder obstruction. Results indicate that mixing and reaction rates in the low-Damkohler limit between the two scalars plumes increase with the presence of the cylinder in the domain. The study also shows that the dominant contribution of total reaction derives from the scalar covariance associated with instantaneous flow processes, and depends strongly on streamwise location. In addition, the effect of viscosity and non-Newtonian rheology of the scalars on mixing and reaction has been investigated using a biopolymer called Xanthan Gum. The results have broad implications for biological and ecological mixing processes involving now-Newtonian fluids.