Center for Fluid Mechanics Seminar

Professor Markus Zahn
Department of Electrical Engineering and Computer Science
Laboratory for Electromagnetic and Electronic Systems
Massachusetts Institute of Technology

Ferrohydrodynamic And Electrohydrodynamic Flow Phenomena

Continuum electromechanics of ferrohydrodynamic interactions in magnetic liquids (ferrofluids) and electrohydrodynamic interactions between charged and polarizable dielectric liquids will be described with video presentations of simple experiments. With a brief presentation of magnetic fluid science and technology representative magnetic fluid phenomena include: ferrofluid rise due to magnetization force; ferrohydrodynamic spike and labyrinth instabilities; stabilization of the Saffman-Taylor pusher fluid fingering instability where a less viscous fluid pushes a more viscous fluid; and ferrofluid spiral patterns, flows, and abrupt transitions from a continuous to discrete phase in rotating magnetic fields. Analogous electrohydrodynamic presentations include: Coulombic force on a surface within a more conducting liquid (von Quicke's rotor); spontaneous high voltage generation from self-excited electrostatic induction machines (Lord Kelvin's dynamo using falling water droplets); interfacial fluid convection cells driven by interfacial surface charge; fluid rise due to electrical polarization forces; electrostatic control of fluid jet profiles; electric field stabilization of the Rayleigh-Taylor instability of a more dense fluid over a less fluid; and dielectric fluid labyrinth instability. Magnetic fluid analysis will also be presented for plane Poiseuille/Couette flow in alternating and rotating magnetic fields to demonstrate and explain "negative viscosity" phenomena. Confirming torque measurements using a Couette viscometer will be compared to the theory. Magnetic fluid bells, chains, and sheet flows will also be shown as a function of magnetic field strength and direction.

September 30, 2003
Barus & Holley, Room 190
4:00pm