CENTER FOR FLUID MECHANICS
AND
THE FLUIDS, THERMAL AND CHEMICAL PROCESSES GROUP
OF
THE DIVISION OF ENGINEERING
SEMINAR SERIES

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Novel Marangoni Flows

In this talk I will describe three recent studies of novel Marangoni flows, i.e., flows that are driven by tangential stresses due to temperature, compositional, or electrical fields. These stresses can drive bulk flows that are vigorous and in many cases, counter-intuitive.

The first two studies involve gradients of concentration of surfactants arising from variation in the rate of chemical reaction producing them. We study the effect of in-situ production of surfactants on viscous fingering instabilities. We find that Maragoni stresses result in wider fingers, a larger fractal dimension of the pattern, and an increase in displacement efficiency. We then describe a surprising phenomenon of spontaneous, self-sustained chemically driven oscillations at the tip of a drop suspended from a needle. We connect this phenomenon with the well-known tip-streaming in drops subjected to extensional flows. Plausible physical mechanisms are proposed for both of these phenomenon.

Finally we describe theory and experiment on internal circulations in drops that are driven by a combination of translation and tangential electrical stresses. Modulation of the electric field responsible for the latter then results in chaotic advection and good mixing within the drop. Theory and experiment for the mixing patterns are found to be in good agreement. Transport of heat (or mass) to such chaotically stirred drops has a surprisingly non-monotonic dependence on the frequency of modulation. Visualization of the temperature (concentration) fields by means of movies explains why.

TUESDAY – FEBRUARY 28, 2006
Barus & Holley, Room 190
3:00pm