Macromolecular Hydrodynamics
10.531J/2.341J Spring 2008

Lecturer: Robert C. Armstrong

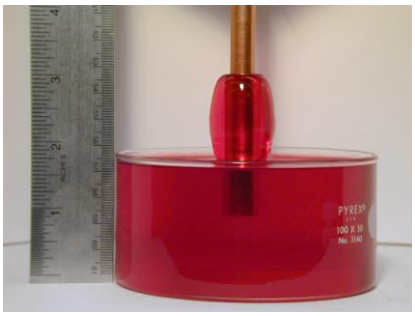
Units: 3-0-6 H-credit

No final exam, but instead an extensive class project & presentation.

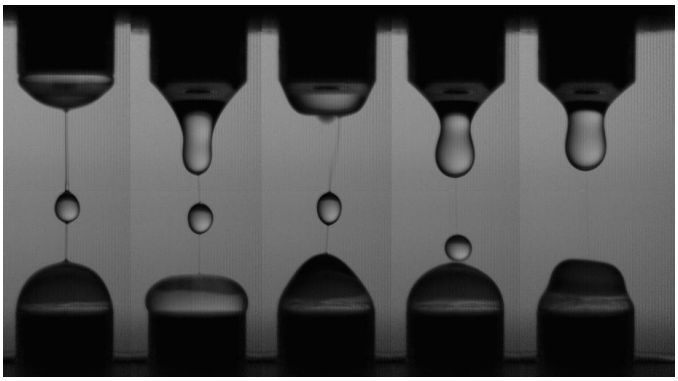
Meeting times: Tuesday/Thursday 2.30 – 4.00 pm; Room 66-168

Course description

- Flow phenomena in complex fluids.
- Modes of deformation, kinematics and material functions for non-Newtonian fluids.
- Techniques of viscometry, rheometry, and linear viscoelastic measurements for polymeric fluids and generalized Newtonian fluids.
- Continuum mechanics, frame invariance, and convected derivatives for finite strain viscoelasticity.
- Ordered fluid expansions.
- Differential and integral constitutive equations for viscoelastic fluids.
- Molecular scaling theories of polymeric fluids.
- Analytical solutions to isothermal and non-isothermal flow problems: the roles of non-Newtonian viscosity, linear viscoelasticity, normal stresses, creep and elastic recoil, stress relaxation.



Most graduate coursework in fluid mechanics focuses exclusively on Newtonian fluids (e.g. water, oils, and air). An increasingly large class of materials that engineers are presumed to be familiar with, and to be able to handle and analyze, is 'complex fluids,' which are *non-Newtonian* in nature; i.e. the stress-deformation rate relationship is strongly non-linear. The classical definitions of "solid" and "liquid", although formally correct, are inadequate for characterizing many everyday and industrial applications; common examples of complex fluids include greases & lubricants, waxes, polymer resins, liquid crystalline fluids, foodstuffs (mayonnaise, butter), surfactants, emulsions, suspensions and even amorphous glasses. The aim of this course is to provide a basic foundation in the fluid mechanics of structurally-complex materials. It is hoped to provide an understanding of the physics underlying the constitutive equations for these materials as well as an appreciation for the approximations needed in obtaining useful solutions to flow problems of engineering interest.



Course text:

Bird, R.B., Armstrong, R.C., and Hassager, O., *Dynamics of Polymeric Liquids. Volume 1: Fluid Mechanics*, 2nd Edition, Wiley Interscience, New York, 1987.