Rensselaer

The HOWARD P. ISERMANN
DEPARTMENT OF CHEMICAL AND
BIOLOGICAL ENGINEERING

CBE Seminar Series – Spring 2020

Dr. Jeffrey F. Morris

Professor of Chemical Engineering & Director of the Levich Institute
CUNY City College of New York

Seminar: Wednesday, February 26, 2020
9:30 a.m. (RI 203)

"Discontinuous Shear Thickening in Dense Suspensions"

Abstract:

Suspensions of solid particles in liquids represent an important model for understanding of both engineering materials and statistical physics of mixtures, particularly of nonequilibrium systems.
Dense suspensions, with industrial examples including coatings or precursors to solid ceramics and cements, can be quite difficult to process because their flow properties are very sensitive to particle surface interactions. We focus on the extreme rate dependence known as "discontinuous shear thickening" (DST) where the viscosity undergoes a finite and typically large discontinuous jump in viscosity at some shear rate. Simultaneous with DST, there is a large increase in the normal stress response, including the nonequilibrium osmotic pressure, or 'particle pressure', leading to the historical name of `dilatancy' for shear thickening. Our computational simulations inclusive of the three ingredients of i) lubrication hydrodynamics, ii) repulsive interparticle forces (e.g. due to surface charge) and iii) contact with friction have been shown to reproduce the primary features of DST found experimentally; this is called lubricated-to-frictional (LF) rheology. Here, we describe the main features of the shear thickening transition in the LF scenario, including the observation of extreme fluctuations. Using our simulation results, we explore the microscopic basis for the LF transition in the force network developed under flow.

Biography:

Jeff Morris received his bachelor's degree at Georgia Tech (1989), and his MS (1991) and Ph.D. (1995) at Caltech. He has worked industrially for Shell Research Amsterdam (1994-1995) and Halliburton Energy Services (2002-2004).

Morris develops constitutive and bulk fluid mechanical descriptions appropriate for complex fluids, based in fundamental understanding of the microstructure. Defining questions are: How are mixture flows intrinsically different from their single-phase counterparts, and why? What is the appropriate predictive framework for these materials accounting for their multiphase nature? The focus has been on suspensions, from submicron colloids to sand slurries. Unifying features of these materials are the influence of hydrodynamic interactions and the flow-induced microstructure on rheology and bulk flow. Morris has analyzed two distinct forms of particle migration, one induced by the bulk rheological influence of the particles and known as shear-induced migration, and one driven by inertia. Morris has recently focused on frictional interactions between particles in viscous liquids, toward understanding of shear thickening. Morris was elected Fellow of the American Physical Society (APS) in 2013 and of the Society of Rheology in 2019. He was awarded the 2015 J. Rheology Publication Award, the 2017 AICHE/Shell Thomas Baron Award for Fluid-Particle Systems, and 2019 Stanley Corrsin Award of the APS. Jeff Morris is currently an Associate Editor of the Journal of Fluid Mechanics, and authored the text A Physical Introduction to Suspension Dynamics, with Elisabeth Guazzelli.

Refreshments will be available in the Ricketts Coonley Lounge (120) at 9:00 a.m.
For more information, please contact Lisa Martin (swishl@rpi.edu)