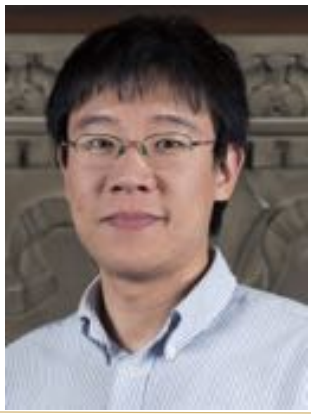
CHEMICAL ENGINEERING

SEMINAR SERIES



XIANG CHENG

Monday, November 13, 2017

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From Flocking Birds to Swarming Bacteria: A Study of the Dynamics of Active Fluids

ABSTRACT: Active fluids are a novel class of non-equilibrium complex fluids with examples across a wide range of biological and physical systems such as flocking animals, swarming microorganisms, vibrated granular rods, and suspensions of synthetic colloidal swimmers. Different from familiar non-equilibrium systems where free energy is injected from boundaries, an active fluid is a dispersion of large numbers of self-propelled units, which convert the ambient/internal free energy and maintain non-equilibrium steady states at microscopic scales. Due to this distinct feature, active fluids exhibit fascinating and unusual behaviors unseen in conventional complex fluids. Here, by combining high-speed confocal microscopy, holographic imaging, rheological measurements and biochemical engineering, we experimentally investigate the dynamics of active fluids. In particular, we use E. coli suspensions as our model system and illustrate three unique properties of active fluids, i.e., (i) abnormal rheology, (ii) enhanced diffusion of passive tracers and (iii) emergence of collective swarming. Based on theoretical tools of fluid mechanics and statistical mechanics, we develop a quantitative understanding of these interesting behaviors. Our study illustrates the general organizing principles of active fluids that can be exploited for designing ‚Äúsmart‚Äù fluids with controllable fluid properties. Our results also shed new light on fundamental transport processes in microbiological systems.

RECEPTION 3:30 • LECTURE 4:00 – 5:00
PHYSICS ASTRONOMY BLDG. PAA A110

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BIOGRAPHY: Xiang Cheng received his B.S. in physics from Peking University in China in 2002. He then moved to U.S. and obtained his Ph.D. in physics from the University of Chicago in 2009. He worked as a postdoctoral associate in the Department of Physics at Cornell University from 2009 to 2013. He is currently the Macosko Assistant Professor at the Department of Chemical Engineering and Materials Science at the University of Minnesota. Dr. Cheng has received several academic awards, including NSF Career Award, DARPA Young Faculty Award, 3M non-tenured faculty award, Packard Fellowship and McKnight Land-Grant Professorship. His research group studies experimental soft materials physics, with a special focus on the emergent flow behaviors of soft materials and their associated mesoscopic structures and dynamics. Particularly, his research interests include the rheology of colloidal suspensions and granular flows, dynamics of active fluids and fluid mechanics of liquid-drop impact processes.