Chez Pierre

Presents ...

Thursday, February 16, 2012

1:30pm

MIT Room 4-331

SPECIAL CHEZ PIERRE SEMINAR

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"Imaging the microscopic structure of shear thinning and thickening colloidal suspensions"

While a simple Newtonian fluid such as water flows with a constant viscosity, many structured fluids exhibit fascinating non-Newtonian flow behaviors including shear thinning and shear thickening. One typical example is a colloidal suspension, where its viscosity can vary by orders of magnitude depending on how quickly it is sheared. Although these non-Newtonian behaviors are believed to arise from the arrangement of suspended particles and their mutual interactions, microscopic particle dynamics in such suspensions are difficult to measure directly. Here, by combining fast confocal microscopy with simultaneous force measurements, we systematically investigate a suspension's structure as it transitions through regimes of different flow signatures. Our measurements of the microscopic single-particle dynamics unambiguously show that shear thinning results from the decreased relative contribution of entropic forces and that shear thickening arises from particle clustering induced by inter-particle hydrodynamic lubrication forces. Furthermore, we explore out-of-equilibrium structures of sheared colloidal suspensions and report a novel string phase, where particles link into log-rolling strings normal to the plane of shear. Our techniques illustrate an approach that complements current methods for determining the microscopic origins of non-Newtonian flow behavior in complex fluids.