Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Measuring Mechanical Properties by Staring: Using Stress Assessment from Local Structural Anisotropy (SALSA) to Probe Viscosity and Visualize Stress Networks in Colloidal Suspensions ITAI COHEN, MATTHEW BIERBAUM, JAMES SETHNA, NEIL LIN, Cornell University — Measurement of stress induced thermal fluctuations in materials can be used to determine macroscopic mechanical properties including viscosity in fluids, as well as bulk and shear moduli in solids. When extended to the single particle scale, such measurements also reveal underlying spatially inhomogeneous response mechanisms in systems such as glasses, gels, and polycrystals. Unfortunately, it is not possible to experimentally measure these temporal and spatial stress fluctuations in a colloidal suspension using conventional rheometers. Here however, we show that using fast confocal microscopy it is possible conduct a Stress Assessment from Local Structural Anisotropy (SALSA) to measure such spatio-temporal stress fluctuations. We directly image the microstructure of a nearly hard-sphere suspension using a high-speed confocal microscope and determine particle positions. We compute the structure anisotropy of the suspension and building on the Brady formalism, calculate particle-level stresses. In conjunction with the fluctuation-dissipation theorem, we then determine the bulk viscosity of a colloidal liquid. Furthermore, we show our local measurements allow direct visualization of the complex stress networks in a 3D supercooled liquid under compression. Our method provides an experimental approach that applies to a broad range of processes arising in sheared glasses, compressed gels, and even indented crystals.

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Date submitted: 31 Jul 2014 Electronic form version 1.4