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Imaging the microscopic structure of shear thinning and thickening colloidal suspensions XIANG CHENG, Dept of Physics, Cornell University, JONATHAN MCCOY, Department of Physics and Astronomy, Colby College, JACOB ISRAELACHVILI, Dept. of Chemical Engineering, University of California, Santa Barbara, ITAI COHEN, Dept. of Physics, Cornell University — The viscosity of colloidal suspensions varies by orders of magnitude depending on how quickly they are sheared. Such non- Newtonian behavior arises from the arrangement of suspended particles and their mutual interactions. Although numerical simulations and various scattering experiments have revealed much about the local and average suspension structures, particle dynamics at mesoscopic length scales, where non-Newtonian behaviors are believed to originate, are still poorly understood. Here, by combining fast confocal microscopy with simultaneous rheological measurements, we systematically investigate changes in suspension structure over a range of length scales, as the suspension transitions through regimes with different rheological signatures. Our measurements bridge previous simulation and scattering results, and unambiguously show that shear thinning is coupled to particle layering, that shear thickening is decoupled from suspension order-to-disorder transitions, and that there exists a novel phase where particles self-assemble into strings oriented normal to the plane of shear.

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