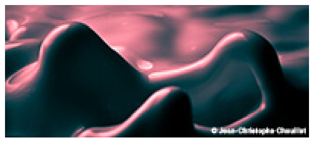
Physics of Dense Suspensions

Coordinators: Bulbul Chakraborty, Emanuela Del Gado, and Jeff Morris

Scientific Advisors: Wilson Poon

Dense, or high-solid-loading, suspensions of particulates in liquids are found in a range of applications across many industrial sectors and in geophysical flows. The size range of the particles may vary from the colloidal (say, 10 nm to 10 μm, where Brownian motion dominates) to the granular (say, 10 μm to 10 mm). At low solid loading, suspensions are typically fluid-like, but at high loadings, their behavior is complex and diverse. In particular, a number of flow transitions can occur as the applied stress or shear rate increases —from solid to flowing, from a low- to high-viscosity state, or from flowing to jammed. There is great practical interest in unraveling the origins of these and other non-linear flow phenomena in suspensions spanning the whole range of particle sizes. Such advances will form the basis of a predictive science of suspensions in diverse contexts, from cement mixing to advanced additive manufacturing. At the same time, elucidating the physical basis for such behavior will be challenging, and is of great fundamental interest to a large community of soft matter and statistical physicists interested in non-equilibrium phenomena.

In this program, the focus will be on the physics underlying the highly nonlinear responses of concentrated suspensions, with a focus on pulling together researchers from across disciplines – e.g., fluid mechanics and rheology, statistical physics, colloid and interfacial chemistry, tribology, and applied mathematics – to drive new directions of inquiry into the behavior of densely-packed particles under flow. Sudden changes in flow state have been regarded as nonequilibrium phase transitions by statistical physicists and the program will focus on the fundamental understanding of how such strongly non-linear response may emerge from the simple components in colloidal and granular systems, in analogy with classical critical phenomena and granular jamming. Among the key questions to be probed are: What physics underlies the large fluctuations in local properties (e.g., stresses and deformation rates) detected prior to the onset of nonlinearities? What features of the particle surfaces or particle effective interactions control the flow inhomogeneities? Within this context we will discuss new theories, advanced computational approaches, and novel experimental techniques that can be transformational. We especially welcome participation from scientists in relevant allied areas such as surface science and tribology, which recent advances have shown to be important in controlling the non-linear flow response of high-solid-loading suspensions (e.g., via inter-particle friction).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DATES

Jan 16, 2018 - Apr 6, 2018

QUICK LINKS

Online Talks (http://online.kitp.ucsb.edu/onli

Photos (https://www.kitp.ucsb.edu/act

Associated KITP Conference: Non-linear mechanics and rheology of dense suspensions: nanoscale structure to macroscopic behavior (https://www.kitp.ucsb.edu/act c18)