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Fluid Dynamics Prize Lecture: The Micromechanics of Colloidal Dispersions

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What do corn starch, swimming spermatozoa, DNA and self-assembling nanoparticles have in common? They are all (or can be modeled as) "particles" dispersed in a continuum suspending fluid where hydrodynamic interactions compete with thermal (Brownian) and interparticle forces to set structure and determine properties. These systems are "soft" as compared to molecular systems largely because their number density is much less and their time scales much longer than atomic or molecular systems. In this talk I will describe the common framework for modeling these diverse systems and the essential features that any hydrodynamic modeling must incorporate in order to capture the correct behavior. Actually computing the hydrodynamics in an accurate and efficient manner is the real challenge, and I will illustrate past successes and current efforts with examples drawn from the diffusion and rheology of colloids to the "swimming" of catalytic nanomotors.