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Tentative topic of the invited talk

Induced charged electrokinetics: Motion of an uncharged particle

Abstract of the invited talk

Electrophoresis is a cornerstone technique in (bio)chemical analysis, widely used for the manipulation and separation of charged species under an externally applied electric field. Traditionally, the electrophoretic mobility of a particle is attributed to its intrinsic surface charge, which drives motion through electrostatic interactions and electroosmotic flow. However, recent developments in induced-charge electrokinetics (ICEK) have revealed that even uncharged yet polarizable particles can exhibit motion through the nonlinear coupling between the electric field and the induced charge distribution at the particle-electrolyte interface. For symmetric particles in uniform fields, the induced flow is typically symmetric, leading to no net motion. Nevertheless, breaking this symmetry can generate directed movement. Several established mechanisms for symmetry breaking include the presence of Janus coatings, native surface charge, partial dielectric coatings, or geometric distortions such as non-spherical shapes. In this context, we present a distinct and theoretically established mechanism whereby uncharged particles can acquire significant electrophoretic mobility in the absence of such explicit asymmetry. Our analysis demonstrates that particles with very high dielectric permittivity, when suspended in charge-asymmetric electrolytes, experience uneven induced-charge distributions that generate significant electroosmotic flows, ultimately yielding a measurable electrophoretic response even under weak electric fields. Although experimental validation remains to be conducted, the theoretical framework suggests that this effect should be observable under typical microfluidic conditions involving low ionic strength and moderate field strengths. The findings open exciting prospects for future exploration, particularly in the development of new electrokinetic manipulation strategies for neutral particles, selective separation based on material polarizability, and advanced control of colloidal transport in complex fluids. Furthermore, this mechanism could inspire innovative applications in lab-on-a-chip systems, targeted drug delivery, and soft matter assembly, thereby extending the scope of electrokinetic science beyond conventional charged-particle dynamics.