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Electrokinetics and Electrohydrodynamics in Microfluidics

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Electric fields offer an exquisite means of control over small-scale fluid and particle motion. In some instances *electrokinetics* - the applied field acts on the intrinsic (equilibrium) electric charge arising from covalently bound ionogenic groups bound to an interface. In other cases *electrohydrodynamics* the charge arises from the action of a field on an otherwise electrically neutral system. Despite this similarity, descriptions of electrokinetic and electrohydrodynamic motion developed more or less independently. The theoretical underpinnings of electrokinetics were laid down by Helmholtz and Smoluchowski in the late 19th and early 20th centuries; the theory of electrohydrodynamics was set forth by G.I. Taylor and J. R. Melcher in the 1960's. Nevertheless, both descriptions stem from the same fundamental model: the Navier-Stokes equations augmented with an electrical body force, Gauss's law, and conservation equations for the several ionic species. The development of a unified picture will be described along with its implementation. Special attention will be will be given to microfluidic applications involving the movement of particles and fluids by electrophoresis and electroosmosis and the assembly of colloidal crystals.

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