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Nonlinear Surface Transport in the Thin Double-Layer Limit

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— At high applied electric fields, ionic transport within the double layer plays a significant role in the overall response of electrokinetic systems. It is well-known that surface transport processes, including surface electromigration, surface diffusion and surface advection, may impact the strength of electrokinetic phenomena by affecting both the zeta-potential and the magnitude of the tangential electric field. Therefore, it is important to include these effects when formulating the effective boundary conditions for the equations that govern electrokinetic flow outside of the double layer. In this talk, we discuss the application of a general formulation of "surface conservation laws" for diffuse boundary layers to derive effective boundary conditions that capture the physics of electrokinetic surface transport. Previous analyses (*e.g.* Deryagin & Dukhin 1969) are only valid for weak applied fields and are based on a linearization of the concentration and potential about a reference solution, but our results are fully nonlinear and hold at large applied fields as long as the double layer is sufficiently thin. We compare our nonlinear surface transport theory with existing linear analogues and apply it to the canonical problem of induced-charge electro-osmosis around a metal sphere or cylinder in a strong DC field.

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