Mathematics > Analysis of PDEs

Global well-posedness and stability of electro-kinetic flows

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We consider a coupled system of Navier-Stokes and Nernst-Planck equations, describing the evolution of the velocity and the concentration fields of dissolved constituents in an electrolyte solution. Motivated by recent applications in the field of micro- and nanofluidics, we consider the model in such generality that electrokinetic flows are included. This prohibits employing the assumption of electroneutrality of the total solution, which is a common approach in the mathematical literature in order to determine the electrical potential. Therefore we complement the system of mass and momentum balances with a Poisson equation for the electrostatic potential, with the charge density stemming from the concentrations of the ionic species. For the resulting Navier-Stokes-Nernst-Planck-Poisson system we prove the existence of unique local strong solutions in bounded domains in $\R^n$ for any $n\geq2 $ as well as the existence of unique global strong solutions and exponential convergence to uniquely determined steady states in two dimensions.

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