Nonlinear screening effects in colloidal electrophoresis

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In this work, we address relations between the static and kinetic parameters of charged colloidal particles at various screening conditions. Using primitive model simulations and Poisson-Boltzmann type analysis, we show that in a variety of situations the renormalized colloidal charge and effective potential can be used to estimate the zeta potential, which then can be used as an input to the standard mean-field electrokinetic model for predicting electrophoretic mobility of the colloidal particle. We demonstrate that this methodology allows one to overcome the difficulties caused by nonlinear screening effects in a variety of difficult conditions. In particular, we use it to describe (i) counterion dominated screening regime that appears, for example, at low salt, high colloidal charge or high colloidal volume fractions, and (ii) screening with a multivalent salt leading to the zeta-potential and mobility reversal, where the standard mean-field methods are unsuccessful.