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Electrophoresis in strong electric fields: The role of Maxwell stresses YARIV EHUD, Technion — Electrophoresis, the motion of a charged colloidal particle under the action of an externally-applied electric field, is common in miniaturized systems. This motion is usually described by a linear model, based upon the smallness of the applied field relative to the equilibrium field in the screening Debye layer surrounding the particle. This model, in turn, leads to the Smoluchowskis slip condition and eventually results in mobility relations. The mobility concept, however, is only valid provided the quadratic Maxwell stresses are neglected. In the literature, this neglect is implicitly supported by two arguments: (i) consistency with the linearization process leading to the slip condition; and (ii) the net electric neutrality of the combined particle-layer system. It will be shown that these arguments are incorrect. Accordingly, a consistent scheme is formulated for analyzing the motion of a particle in an applied field. The quadratic interactions with the field are represented by two tensorial coefficients, which describe the resulting particle translation and rotation. These nonlinear interactions are illustrated in two contexts: rotation of non-spherical particles, and drift of a spherical particle towards a planar wall. These effects are absent in the standard electrophoretic description.

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