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"Superfast" and "Hyperfast" Electrophoresis in DC and AC Electric Fields EVGENY DEMEKHIN, ALEX KOROVYAKOVSKY, Russian Academy of Sciencies — Movement of a small conducting spherical granule in an electrolyte solution under force of DC and AC fields is considered. The problem is described by strongly coupled nonlinear PDE system. The fact that it has two small parameters, the ratio of the ion double layer to the diffusion layer and the ratio of the diffusion layer to the granule's diameter, makes the problem unique and extremely difficult to solve. This is the reason why only solutions for some particular cases have been known. In this work for the first time, combining asymptotic and numerical methods, a complete theory of electrophoresis in DC and AC fields is developed. By special decomposition method the system is transformed to new variables. Analytical solution in the inner region results in the nonlinear Smoluchowski slip velocity. In the intermediate region convection-diffusion equation is solved numerically. In tern, the intermediate solution is matched with the outer solution of Laplace equation to complete the statement. For a strong DC field ("superfast" electrophoresis) the theory predicts, in agreement with experiments, the granule's velocity to be proportional to the granule's size and squared external field; there is a large elongated vortex behind the granule and a small one near its equator. There is an excellent agreement with available experimental data. Granule's velocity for AC field becomes even larger than for DC, it has a maximum with respect to the field's frequency ("hyperfast" electrophoresis).

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