AC Electroosmosis and Dielectrophoresis for Trapping Spherical Particles Between Rectangular and Triangular Electrodes

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Abstract

We describe methods and results of simulations done for predicting behavior of particles in an aqueous solution under an applied AC electric field on electrodes of rectangular and triangular shapes. Here the two major effects which come into play are Dielectrophoresis and AC electroosmosis. Two simulations have been presented, one for rectangular and one for triangular shaped electrodes. Both these simulations have been done in COMSOL Multiphysics®. Both geometries have a mirror plane, so we have reduced the domain in both simulations to a half electrode region. For the triangular electrodes, the vertex V points towards the mirror plane P (Refer Figure 1). We have used the results of the rectangular electrode system which has been widely studied before, to verify the findings with previously established simulations, as a stepping stone to the more sophisticated triangular electrode systems. It's assumed that the particles are spherically shaped which permits us to use expressions for Dielectrophoresis which have been previously established [2]. COMSOL Multiphysics' Electric Currents physics and Laminar Flow physics are used to simulate AC Electroosmosis and Dielectrophoresis. The powerful model features of COMSOL Multiphysics®is harnessed in our simulation which allows us to first separately calculate results for both the phenomenon and then superimpose both of them. With the final result at hand, the visualization tools provided in COMSOL Multiphysics® like color maps and arrow diagrams are used to observe the effect of both phenomena acting simultaneously on a particle. Specifically, for rectangular electrodes, the simulation is a 2D one in which successfully shows the change of position of trapping points as the radius of the particle is varied. This result is verified by comparing with another paper [1]. For triangular electrodes, total force vectors on the particles are plotted and observed (Refer to Figure 2). The geometry of the triangular electrode setup is shown in Figure 1, and the vertex V is also shown. Use of color maps has been done to plot the magnitude of these forces (Refer to Figure 4). We report our observation that that these forces are mostly concentrated at the vertex of the triangular electrodes. We also point out that the forces are smeared along edges on both sides of the vertex V (Refer to Figure 4). Another important finding which we report is the presence of a trapping point near the vertex of the triangular electrode which points towards the other electrode (Refer to Figure 2 and 3). Finally, we report possible further work which can be

done in order to understand the effect of combined AC electroosmosis and Dielectrophoresis in a system with triangular electrodes, for example, the nature of trapping points in terms of their stability and extension of these results to non spherical particles by including higher order moments in the dielectrophoresis expression [3].

Reference

1.Loucaides, N. G. et al. "Trapping and manipulation of nanoparticles by using jointly dielectrophoresis and AC electroosmosis", Journal of Physics: Conference Series, Vol. 100, No. 5, p. 052015 (2008)

2.Ronald Pethig, "Review article—dielectrophoresis: status of the theory, technology, and applications." Biomicrofluidics, 4,022811 (2010)

3.Green, Nicolas G. et al. "Numerical determination of the effective moments of non-spherical particles", Journal of Physics D: Applied Physics, 40.1,78 (2007)

Figures used in the abstract

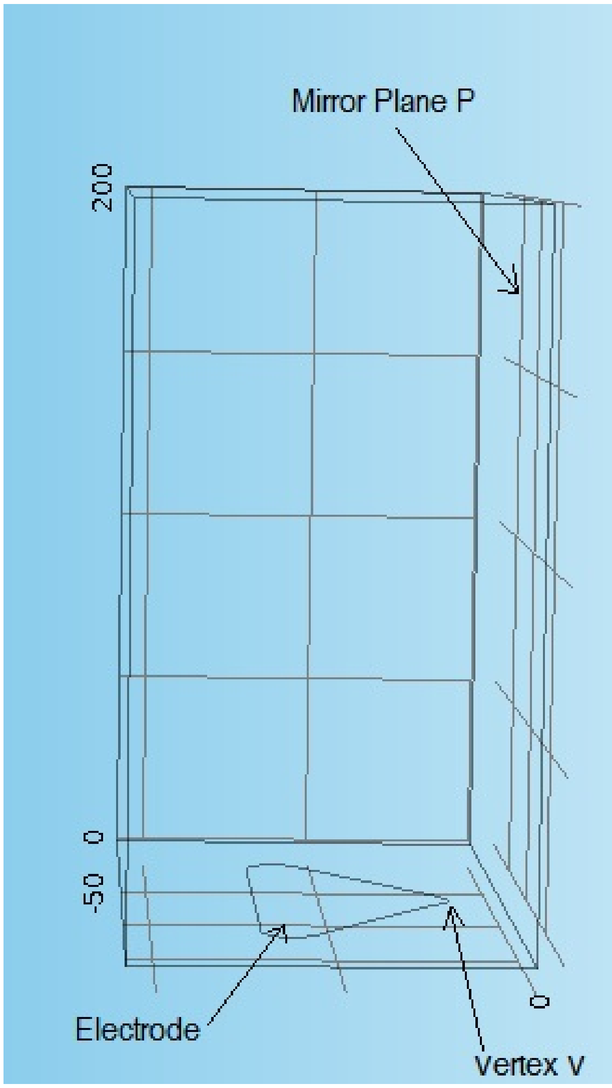

Figure 1: Geometry of the system

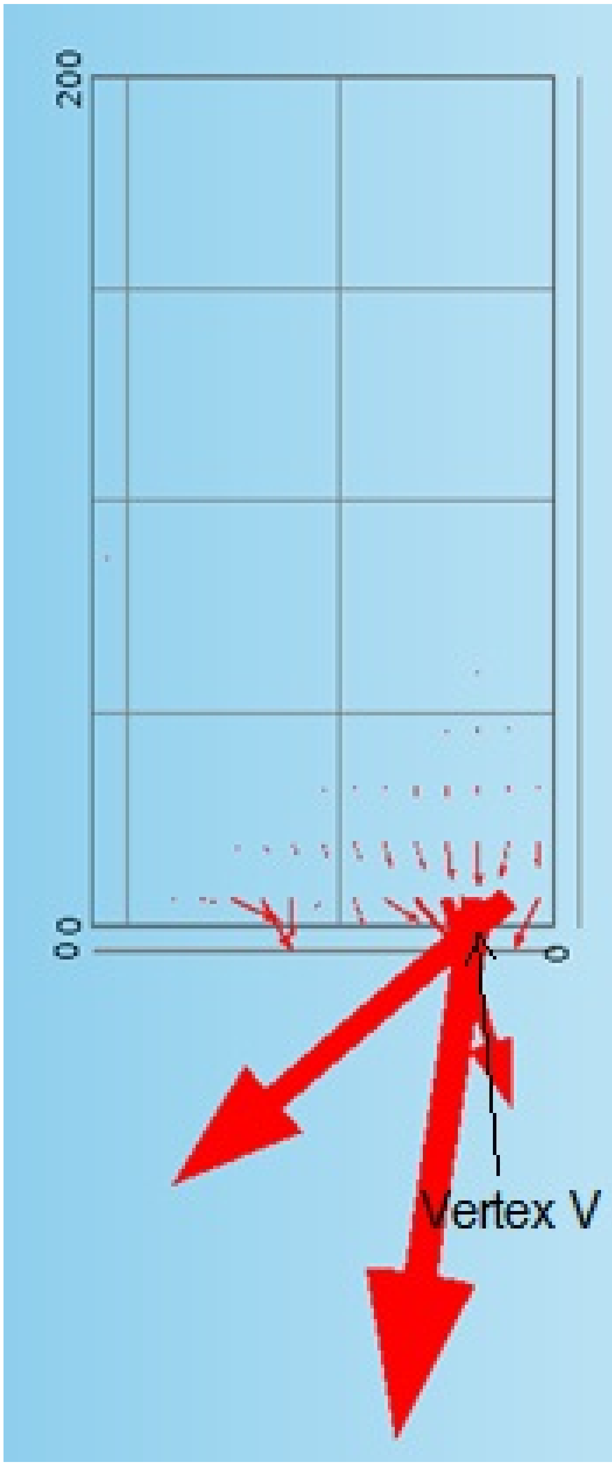

Figure 2: Force vectors for a particle on the plane which contains vertex V and is perpendicular to the base and the mirror plane

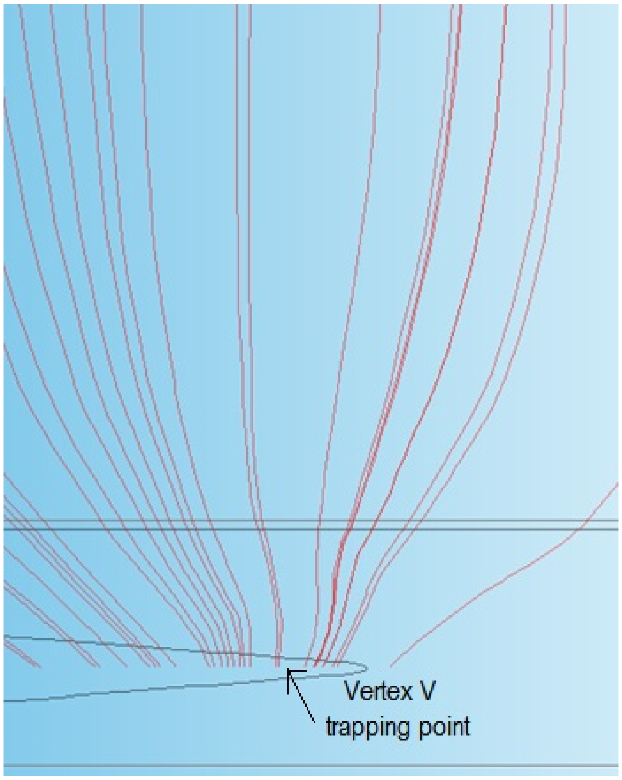

Figure 3: Force contours around the vertex V on the plane which contains vertex V and is perpendicular to the base and the mirror plane

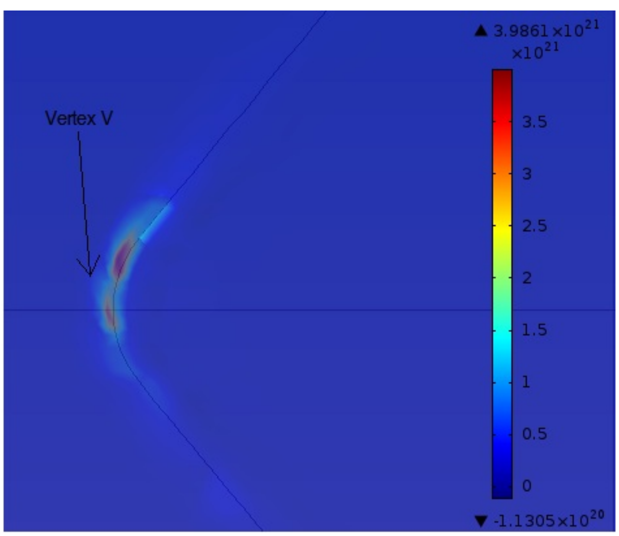

Figure 4: Color diagram of the force magnitude displaying concentration of forces near and around the vertex