SPECIAL PHYSICAL MATHEMATICS SEMINAR

TOPIC: AC ELECTRO-OSMOTIC FLOW ON POLARIZED ELECTRODES

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ABSTRACT:

There is growing interest in the micro-fluidic community in electrokinetic phenomena of colloidal or biological suspensions subjected to time-dependent applied electric field. For example, AC electric fields have been applied at micro-electrodes to pump liquid electrolytes and to concentrate or separate collidal particles and cells. I will present my analysis of AC electrokinetic flow on polarized electrodes, with the hope that it will lead to better device design. Two mechanisms are shown to drive flow on the electrode pair, either of which can dominate depending on the conditions. At voltages below the ionization voltage, capacitive charging of ions from the bulk electrolyte by the external field dominates. Above this ionization voltage, Faradaic charging prevails. These two mechanisms induce opposite fluid flows and vortex circulations, have different field screening features at low frequencies and scale differently with respect to the applied voltage. I will address some important physical phenomena and devices we have produced by exploiting these different features, with emphasis on the following two topics.

Electrokinetic flows and vortices due to capacitive charging can collect particles from the bulk and the electrode surface and focus them into two distinct linear aggregates along their stagnation lines, where the normal flow is away from the electrode. With a voltage increase and a subsequent transition to Faradaic charging, the flow reverses direction and the lines are erased. By analyzing the single-layer Cauchy integral, I predicted the position of the stagnation lines to be at 1/$\sqrt{2}$ of the width of a wide electrode, which is favorably compared to experimental imaging. We are currently developing a long-range bacteria trap based on this mechanism.

As Faradaic charging scales exponentially with respect to the voltage instead of the quadratic scaling of capacitive charging, it offers a stronger pumping mechanism than the capacitive pumps proposed by earlier researchers. I will present a new Faradaic micro-pump design from our group that also exploits field amplification by geometric singularities and the distinct flow direction of the Faradaic mechanism.

DATE: FRIDAY, MARCH 5, 2004

TIME: 2:30 PM

LOCATION: Building 2, Room 338

Refreshments at 3:30 PM in Building 2, Room 349.

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