UNDERGRAD SUMMER PROJECT

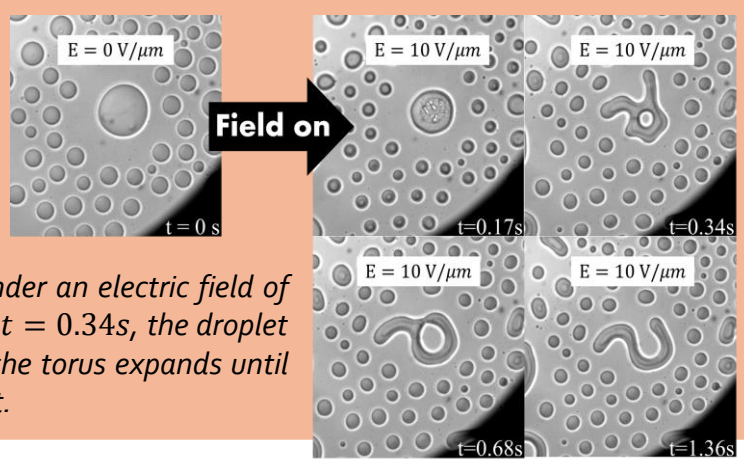
Electrohydrodynamics Analysis of Oil Droplets in Applied Electric Fields: Theoretical Insights and Computational Simulations

Are you passionate about using state-of-the-art computational tools to study the dynamics of physical systems? We're seeking an enthusiastic undergraduate student for a summer research opportunity focused on simulating droplets within oil-in-oil emulsions.

Oil-in-oil emulsions are systems in which small droplets of one type of oil (e.g., castor oil) are suspended in another type of oil (e.g., motor oil). Such emulsions are used in a variety of scientific and industrial applications. Experiments show that droplets exhibit a fascinating range of physical phenomena when exposed to an applied electric field. A particularly striking example is the phenomenon of electrorotation, in which droplets spontaneously begin to spin when a field is applied.

Project

In this project, the student will develop computer simulations of droplets in applied electric fields with the goal of building a fundamental understanding of electrorotation and related phenomena, as well as possibly identifying new phenomena as well. The simulations will be based on a mathematical framework known as leaky dielectric theory that was first introduced in 1966 by the famous fluid dynamicist G. I. Taylor. This framework is a cornerstone of the field of electrohydrodynamic and has experienced a recent burst of interest (e.g., Dong & Sau 2023) as improved computer technology has enabled exploration of the theory using computer simulations. The simulations for this project will be developed in close collaboration with ongoing laboratory experiments in the experimental soft materials laboratory.



The time evolution of a mineral oil droplet in castor oil under an electric field of $10V/\mu m$: At $t = 0.17s$, the breakup process initiates. By $t = 0.34s$, the droplet transforms into a torus shape. Subsequently, the hole in the torus expands until $t = 0.63s$. Finally, the torus breaks into a wormlike droplet.

Supervision

The student will be jointly supervised by, Dr. Joseph Fitzgerald (theory and simulation), Dr. Anand Yethiraj (theory and experimental - soft materials lab, and Majid Bahraminasr (theory and experimental - soft materials lab) in the Department of Physics and Physical Oceanography.

Qualification

- Familiarity with electromagnetism at the undergraduate level (e.g. the book by David Griffiths) .
- Some experience in computer coding. This project will use C but specific C experience is not required to start the position as these skills can be learned on the job.

Apply here

You can access the application form HERE.
If you need assistance, please email: mbahraminasr@mun.ca

DEADLINE May 1st.