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Research Field: Soft Material Physics
Expected Semester of Graduation: Spring 2018

Translational and Rotational Mobilities of Isotropic Inclusions in Liquid Crystal Films

Abstract:

The discovery of ultra-thin, freely suspended liquid crystal films opened the field of 2-dimensional hydrodynamics to experimental study. The subject of my research is how inclusions on such a film are affected by proximity to a boundary. I am interested in the effect on the translational- and rotational- mobility of an isotropic inclusion as a function of distance from the boundary. This understanding can then be extended to non-isotropic inclusions and eventually to biological membranes.

Prospectus:

2-Dimensional (2-D) hydrodynamics is a relatively new field of study, and liquid crystal films provide an excellent way to study such systems. The study of 2-D hydrodynamics truly blossomed after the work of Saffman and Delbrück, who described a relation between the diffusion of a small particle embedded in a thin membrane and the viscosities of the membrane and the surrounding medium [1]. Hughes, Pailthorpe, and White, and later Petrov and Schwille, extended this theory to describe the diffusion of particles with radii near a characteristic length scale called the Saffman length [2-3]. This theoretical model has been confirmed experimentally for isolated islands by researchers in the Liquid Crystal Group at the University of Colorado (CU) at Boulder [4]. A similar model for the rotational diffusion has also been developed by the same group. For both of these models a simpler approximation has been developed by Petrov, Petrosyan, and Schwille [5]. Another important area of interest is how the diffusion of inclusions is affected by the boundary of the system, and this is the focus of my research. Understanding these effects can potentially be adapted to similar situations in biological membranes and other similar systems.

The goal of my research is to confirm a theoretical model developed by Tatiana Kuriabova, Thomas Powers, and others from the CU Liquid Crystal Group, which itself stems from a model of point particle interactions developed by Levine and MacKintosh [6-7]. It is expected that the mobility (derived from diffusion) will follow a logarithmic decay as separation distance from the boundary drops, similar to the observed 3-Dimensional dependency [8].

Bibliography:

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[5] E. P. Petrov, R. Petrosyan and P. Schwille, Soft Matter, 2012, **8**, 7552
[6] A. J. Levine and F. C. MacKintosh, Phys. Rev. E **66**, 061606 (2002).
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Timeline:

By Oct. 6:

- Finish troubleshooting rotational diffusion analysis process
- Try new film holder

By Oct. 20:

- Gather data far from boundary to check if things are fixed
- If all is well, gather data on rotational diffusion near boundary

By Nov. 3:

- Analyze data so far
- Begin troubleshooting parallel translational diffusion near boundary

By Nov. 17:

- Finish troubleshooting parallel case, start collecting data

By Dec. 1:

- If needed, collect more data to fill in gaps/ double check outliers
- Possibly look at non-isotropic inclusions

By Dec. 13:

- Finish parallel and rotation cases
- Begin writing process if not already started

Important future dates:

October/2017 **Start writing thesis**
January/2018 **Complete main research activities**
February/2018 **Provide initial draft to advisor for feedback**
March/2018 **Provide polished thesis to committee including advisor's feedback**
March/2018 **Defend thesis**