

Line Tension and the Nature of the Boundary in a Pure Model System

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A Langmuir monolayer is a one-molecule-thick insoluble layer of organic material spread on to an aqueous subphase. Monolayers capture the interest of researchers because they represent the physical realization of a two-dimensional system. A more direct application can be found in the resemblance to important biological membranes. Furthering our knowledge on how the molecules of these monolayers move and interact with their surroundings can help us to better understand the details of transport within a cell membrane and how it affects cell function.

To explore this system, experiments have been done using the Brewster Angle Microscope and the Langmuir trough. A known amount of the liquid crystal 8CB (4-*n*-octyl-4'-cyanobiphenyl) is dissolved in a spreading solvent of hexane (C₆H₁₄) and deposited on the surface of the water in the Langmuir trough. The liquid crystal 8CB was selected for this experiment because liquid crystals are excellent reflectors of light, and 8CB in particular forms a smectic phase at room temperature and thus tends to align in planes or layers. This system provides a rich variety of fluid phases to test models for transport within the layer as well as the dynamic behavior of the films.

The average molecular area was adjusted to create two systems: a monolayer background with trilayer circular domains floating on its surface, and a gas phase background with monolayer domains. The domains were stretched via a four-roll mill, producing elongational flow around a stagnation point. The recorded video of this stretching and relaxation were analyzed to retrieve information such as line tension and other physical properties of this two dimensional system, through quantitative comparisons with a numerically tractable hydrodynamic model for the relaxation. A second focus of the gas-phase, monolayer experiment is to investigate the effects of the long-range repulsive forces caused by the alignment of molecular dipoles in the monolayer, both in the line tension and in domain configuration, with comparison with extensions of the previous model to include the long-range forces. It is predicted that this research will give some insight into the domain interactions of a similar system of lipids and proteins in biological membranes.