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Force Measurements Using Capillary Instabilities

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Planar surfaces are stabilized by the Laplace pressure, which dampens the entire capillary wave spectrum of a liquid surface. Pattern formation at surfaces and in thin films are therefore the consequence of a destabilizing pressure. The analysis of pattern formation processes can therefore be used to quantitatively measure the destabilizing force. My presentation will focus on three examples for such force measurements:

1. Electrohydrodynamic Instabilities. It is long known that electric fields destabilize liquid surfaces. An electric field applied across at thin polymer film causes the amplification of a single capillary mode, which is quantitatively predicted by a linear stability analysis. The good quantitative agreement of experimental results and theoretical predictions illustrates the usefulness of our approach.

2. Acoustic Casimir Effect. We show that the confinement of thermal modes (acoustic phonons) in thin films lead toe a Casimir-type force that leads to the breakup of thin polymer films.

3. Film Instabilities caused by temperature gradients. A high temperature gradient across a thin polymer film causes a amplified capillary instability. This non-convective effect is driven by the diffusion of heat across a polymer-air double layer and is a function of the acoustic impedance of the polymer-air interface.