Structure and Dynamics of Interfaces: Drops and Films

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Aim: the measurements of the *structure* and *dynamics* of certain liquid – fluid interfaces using an ensemble of techniques in *collaboration*:

1. Surface light scattering spectroscopy (SLSS)
2. Brewster angle microscopy (BAM)
3. Drop-shape analysis
4. SLSS and BAM done on an Interfacial Footprint
Geometry of Fluctuating Interfaces
Polymeric Aqueous Two-Phase Systems (ATPS)

Concentration of polyethylene glycol (PEG) 35k % (w/w)

Concentration of dextran (DEX) 500k % (w/w)

Initial composition

Tie line

Binodal curve

PEG-rich phase (Top)

DEX-rich phase (Bottom)

Interface

Two phases

PEG-rich phase

DEX-rich phase

Interfacial Tension Measurements with Aqueous Two-Phase Systems (ATPS)

ATPS: 5.0% (w/v) PEG – 6.4% (w/v) DEX

Modeling Cell Partition

PEG phase + DEX phase

Add Cells Mix

Equilibrate

PEG-Rich
DEX-Rich

Aqueous PEG phase

Aqueous DEX phase

Based on Theory of “Flotation” Beyond Gravity Effects

Ehsan Atefi
Fluctuations in [P] generates Ripplons

\[ [J] = (J^{(+)} - J^{(-)})_{\Sigma} \]
The Very Low Interfacial Tension Suggests A Complex Interface For Example:
Footprint of the incident beam
Capillary waves for measuring mechanical properties of Monolayers


\[
<|\zeta_q|^2> = \frac{K_B T}{(\gamma + g\Delta \rho + B_c q^2)q^2 A_0}
\]

\[
\frac{\rho \omega_0^2}{\gamma q^2 |q|} = Y_1 \text{(visco–elastic parameters)} \approx 1
\]

The spectrum function $G(\text{Parm}, q; \text{freq})$ is derived using $\zeta_0 << 1$

- But including all known surface and volume effects.
The Image of the 500 1/cm Phase Grating Water/Vapor Interface

~1 mm Gaussian diameter spot

\[ N = k\sigma \sim 50 \]

9.5 cm from lens.
Power Measured at the detector plane: 0-order spot and the +1, -1 order spots
Orders 1 \( q = 503.52 \, 1/\text{cm} \)

Order 2 \( q = 925.6 \, 1/\text{cm} \)

Order 2

Order 3

Extended Correlation Function

Delay Time (\( \mu \text{s} \))
Correlation Function for Capillary Waves of 0.2 nm rms Amplitude
KSV Langmuir Monolayer System with Brewster Angle Microscopy (BAM)
1,2-bis(10,12-Tricosadiynoyl)-sn-Glycero-3-Phosphoethanolamine

Pattern Formation in Langmuir films of **Chiral** Lipids
Prem Basnet, E. K. Mann, S. Chaieb
1,2-bis(10,12-Tricosadiynoyl)-sn-Glycero-3-Phosphoethanolamine
Determination of a Line-Tension

J. Wintersmith
One Conclusion: SLSS + BAM!

Nabin Thapa

Case School of Engineering and Kent State University (physics department)
An “Acceptable” Correlogram
And a “Precise” FFT Spectrum
The Variation of the Second Moment of the Spectrum

4-octyl-4-cyanobiphenyl (8CB)
Now To Combine BAM and SLSS

Local anisotropic surface tension and viscoelasticity

Nabin Thapa
NASA Application: CVB-2 (Constrained Vapor Bubble) Wickless Heatpipe Experiment
Grating Constant Determined Against Three Fluids of Known Surface Tension

\[ q = 1022.1 \ \text{1/cm} \]
Correlation Function and its FFT
50% Mixture Pentane and 2-Methyl Pentane

2-methyl pentane

Pentane
We Expected a Langmuir Fit!

\[
\frac{(\rho^- + \rho^+) \omega_c^2}{\gamma |q^3|} = Y_1 \approx 1
\]
The Density of the Mixtures Were Measured

This data justifies the Linear combining rule used in estimating $Y_1$. 

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