Microemulsion Dynamics from Neutron Spin Echo Spectroscopy

Group D
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Why study microemulsions?

- 1987 J. Huang et al PRL 59
- Role of interface tension vs bending energy
- Fluctuations driven by bending elasticity
How do we measure the dynamics?

Coherent scattering-collective dynamics of surfactant shell

0.05-15ns

Radius ~30Å

SANS Structure Factor

Contrast Match SLDs
solvents(D20, d-hexane)~6.1E-6
Surfactant (AOT) ~0.7E-6
Scatters from the nuclear interaction

Measured property-Final polarization

\[ \Delta \phi \approx \omega t_F \quad t_F \propto \lambda^3 I \]

I is field integral
Elastic Scatter
\[ \langle P_Z \rangle = \frac{2A}{N_{up} - N_{down}} \]

Also normalize to Carbon powder (Resolution)
Results on microemulsion

- $I(Q,t)$ at $Q = 0.065, 0.1, 0.125$
- 13 fourier times at $\lambda = 6 \text{Å}$

$$\frac{I(Q,t)}{I(Q,0)} = \exp\left(-D_{\text{eff}}(Q)Q^2t\right)$$
Deff (Q) = D_{tr} (Q) + D_{def} (Q)

D_{def} (Q) = \frac{5\lambda_2 f_2 (QR_0) \langle |a_2|^2 \rangle}{Q^2 \{4\pi [j_0 (QR_0)]^2 + 5f_2 (QR_0) \langle |a_2|^2 \rangle \}}

Extract Fit parameters R_0, a^2, D_{tr}, \lambda_2

k = \frac{1}{48} \left[ \frac{k_B T}{\pi \rho^2} + \lambda_2 \eta R_0^3 \frac{23\eta'}{3\eta} \right]

k = 0.25kT
Conclusions

- Were able to measure dynamics and elastic modulus for surfactant shell.
- Subsequent experiments have used spin-echo to study elastic modulus of membranes. (Bossev 2005 SS Invited Talk)
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