



Bending Modulus of Microemulsions Using Neutron Spin Echo Spectrometer

Group A

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Outline

- Colloidal systems (Microemulsions)
- Neutron Spin Echo Spectrometer
- Data Analysis
- Results and Discussion

Colloidal systems

Cylindrical micelles Lamellae Vesicles

Properties of the surfactant film:

- Interfacial tension
- Lateral elasticity
- Spontaneous curvature
- **Bending elasticity**
- Saddle splay elasticity

H_2O D_2O (deuterated)
 Surfactant C_6H_{14} AOT (hydrogenated) C_6D_{14} (deuterated)

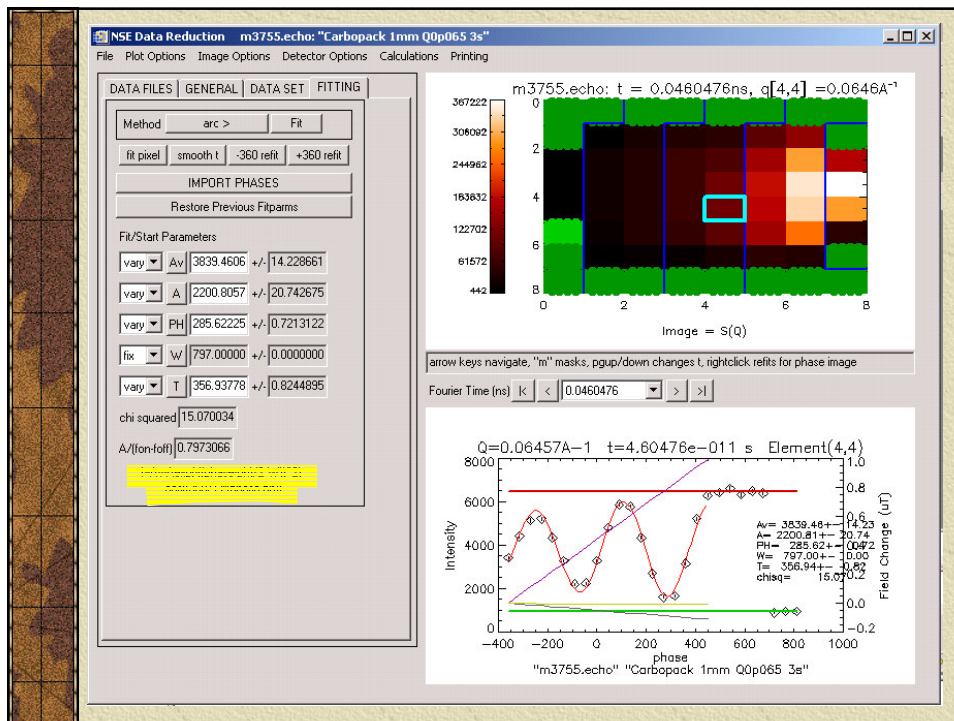
AOT/ D_2O /d-Hexane -5.1/2.5/92.4 v/v% $\phi = 0.077 = 7.7\%$

Neutron Spin Echo

- $\delta E = 10^{-5} - 10^{-2}$ meV (very small!!!) -- Fourier time of 10 ps to 100 ns
- $Q = 0.05 - 1.25 \text{ \AA}^{-1}$ (Resolution : +/- 0.02 \AA^{-1})
- Cold neutrons: $\lambda = 5 - 12 \text{ \AA}$, $E = 0.5 - 3.3$ meV

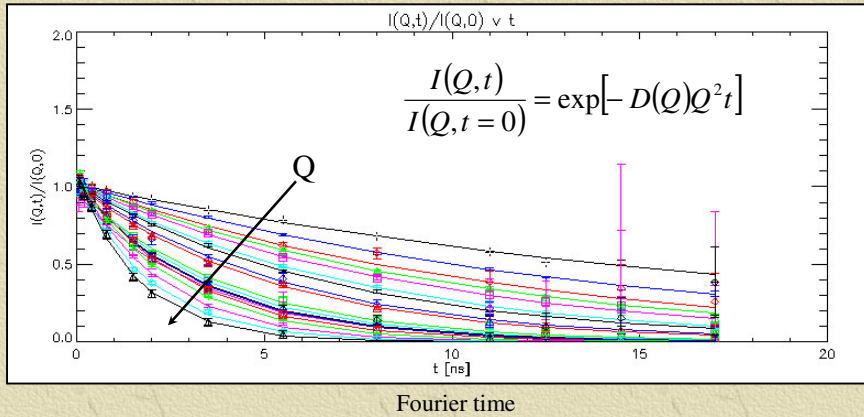
NSE-Data Reduction and Analysis

- ✦ Carbo-pack—Fully Elastic scattering (For Resolution Measurement)
- ✦ Background—Solvent
- ✦ Sample—Quasi-elastic Scattering
- ✦ Micro emulsion information—Average size and polydispersity from SANS

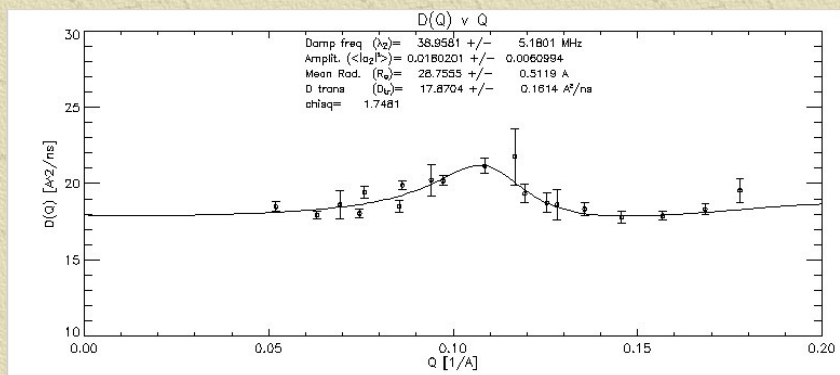


Intermediate Scattering function

$$(I_{\text{sample}} - I_{\text{background}}) / I_{\text{Resolution}}$$



Diffusion Coeff. of Droplet Deformation



$$D_{\text{eff}}(Q) = D_{\text{tr}} + \frac{5\lambda_2 f_2(QR_0) \langle |a_2|^2 \rangle}{Q^2 \left[4\pi [j_0(QR_0)]^2 + 5f_2(QR_0) \langle |a_2|^2 \rangle \right]}$$

Bending Modulus of Elasticity

$$k = \frac{1}{48} \left[\frac{k_B T}{\pi p^2} + \lambda_2 \eta R_0^3 \frac{23\eta' + 32\eta}{3\eta} \right]$$

Our Result: $k / k_B T = 0.24$ @ 298K

TABLE I. Sample composition and summary of the fitted (R_m , K , \bar{K}/K) and calculated (Z , γ , $\langle |u_z|^2 \rangle$) parameters as explained in the text. The total volume fraction of AOT + D₂O + butanol in the deuterated-decane solvent was constant ($\approx 6\%$).

	D ₂ O/AOT (molar ratio)	Butanol/AOT (molar ratio)	R_m (Å)	K (kT)	\bar{K}/K	γ (dyn/cm)	$\langle u_z ^2 \rangle$	Z
A0	24.4	0	39.1	3.8	-1.89	0.07	0.011	19.7

Farago *et al.* (1990)

λ_2 – frequency of deformation

$\langle |a|^2 \rangle$ – amplitude of deformation

p^2 – size polydispersity, measurable by SANS or DLS

Acknowledgments

✦ Dobrin P. Bossev, Antonio Faraone, Steve Kline and Larry Kneller for their dedication and support during the experiments.

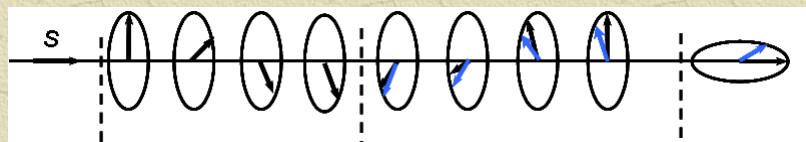
✦ The entire NCNR staff for organizing the 2005 summer school.



Questions



Echo-point



1nsec_8A_19990609.dat
1 cm apertures before solmain1 and after solmain2
solphase1 = 1.1296 A

