Microemulsion Dynamics from Neutron Spin Echo Spectroscopy

Group D

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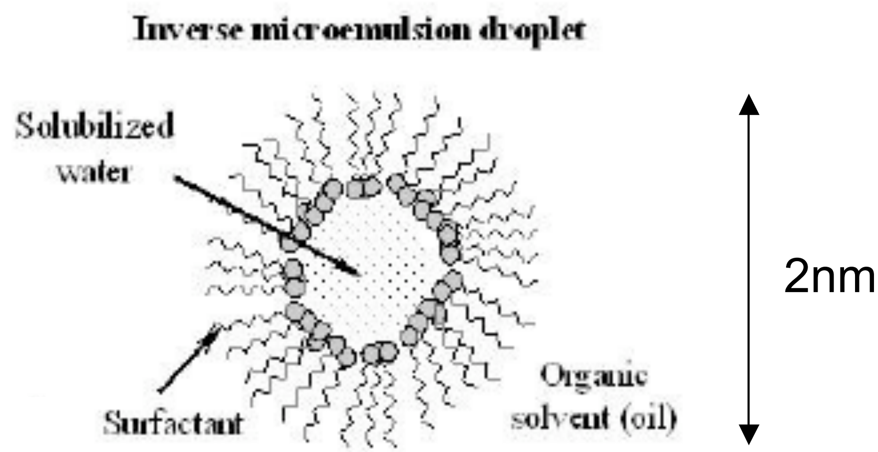
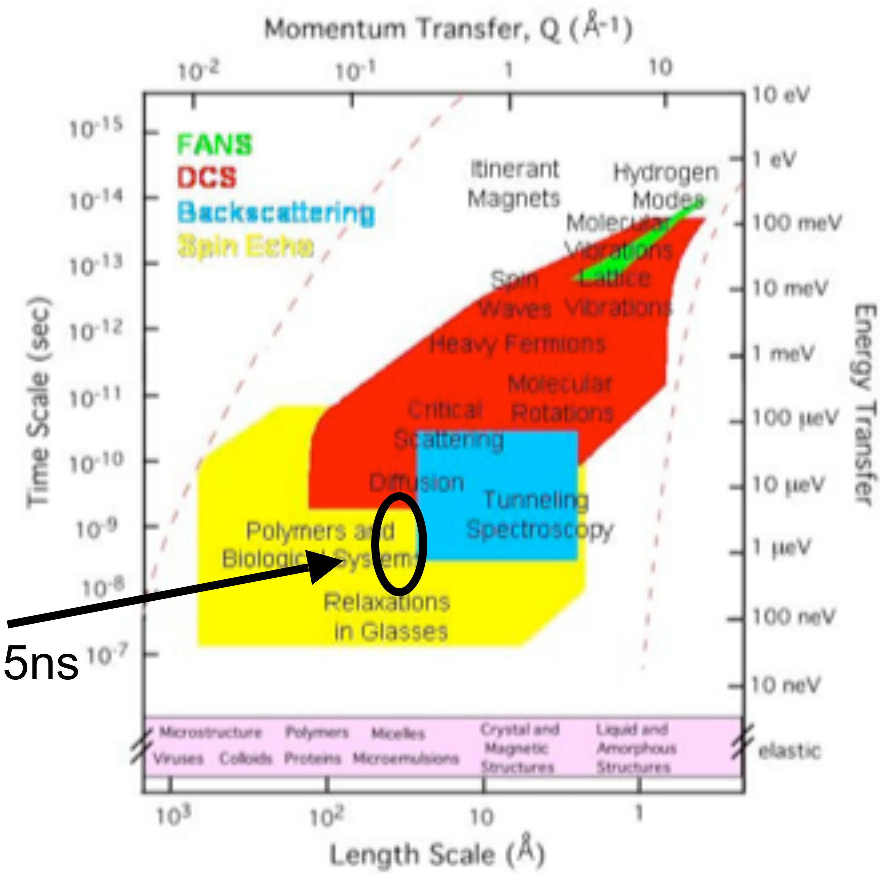
Why study microemulsions?

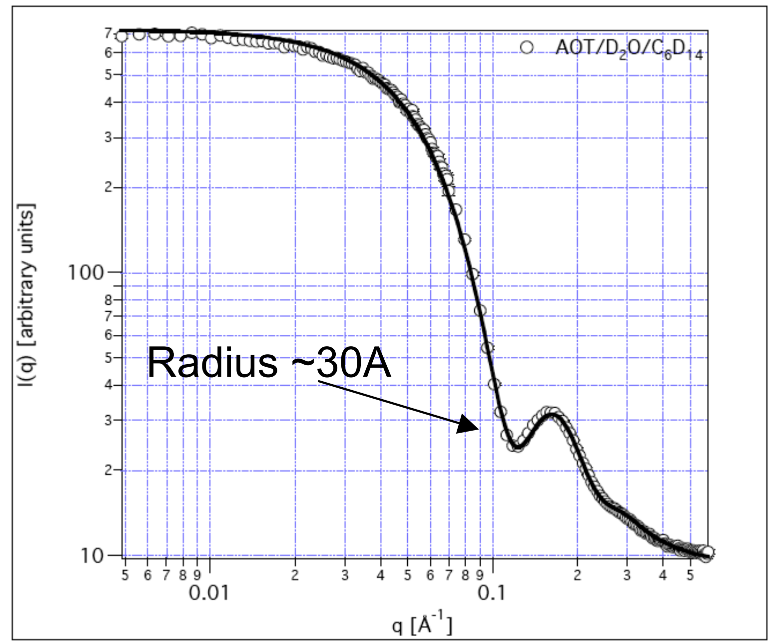
- 1987 J. Huang et al PRL 59
- Role of interface tension vs bending energy
- Fluctuations driven by bending elasticity



How do we measure the dynamics?



0.05-15ns



SANS Structure Factor

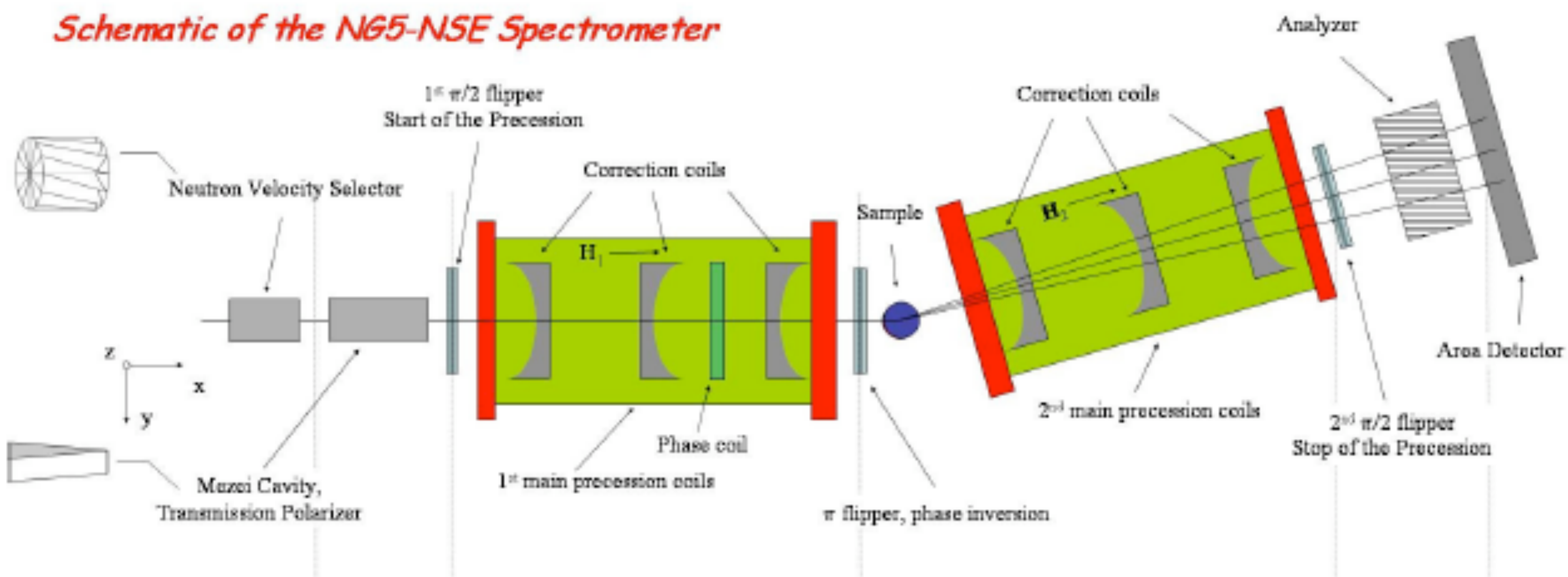
Coherent scattering-collective dynamics of surfactant shell

Contrast Match SLDs

solvents(D20, d-hexane)~6.1E-6

Surfactant (AOT) ~0.7E-6

NSE Spectrometer

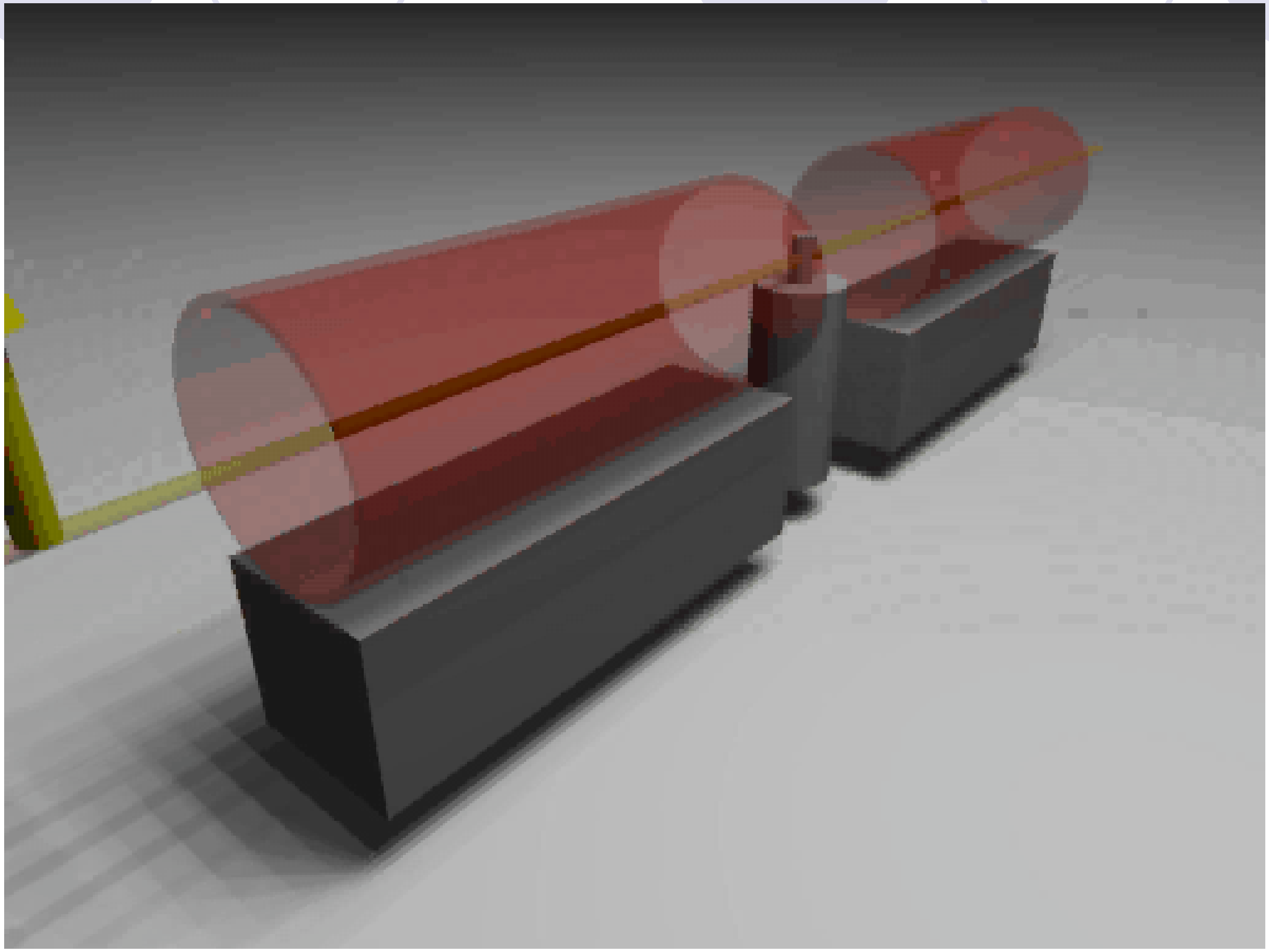


- Scatters from the nuclear interaction
- Measured property-Final polarization

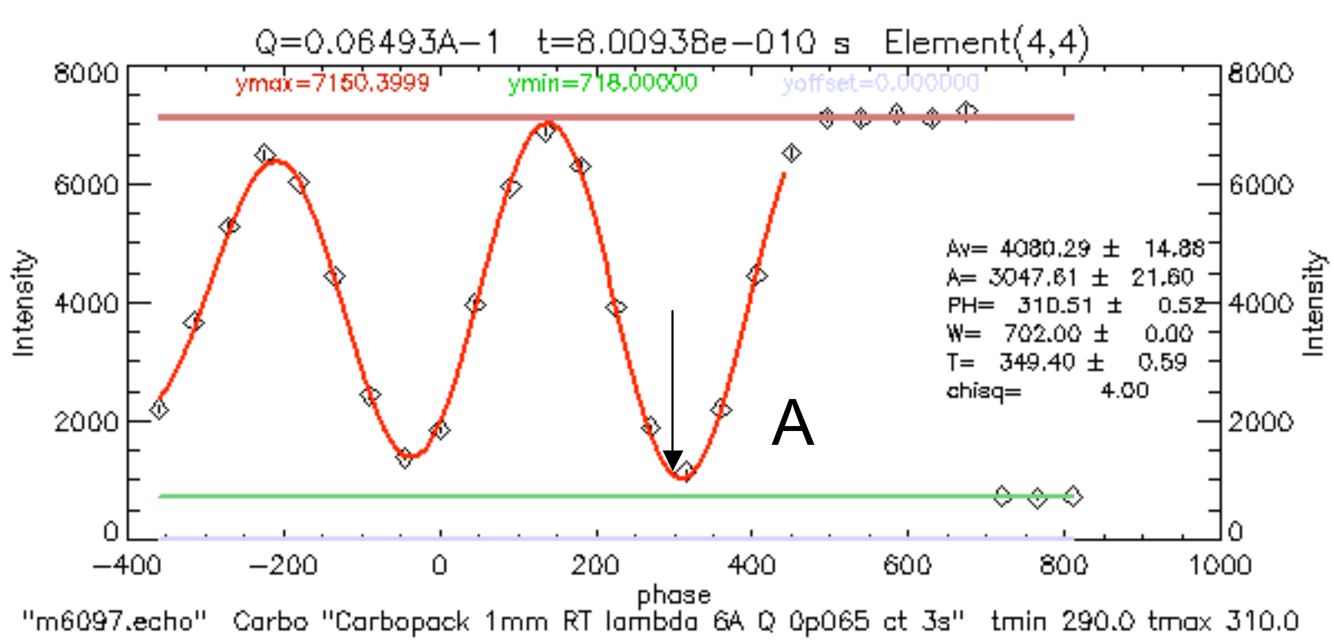
$$\Delta\phi \approx \omega t_F \qquad t_F \propto \lambda^3 I$$

I is field Integral

Elastic Scatter



Data - Intensity for 1 detector

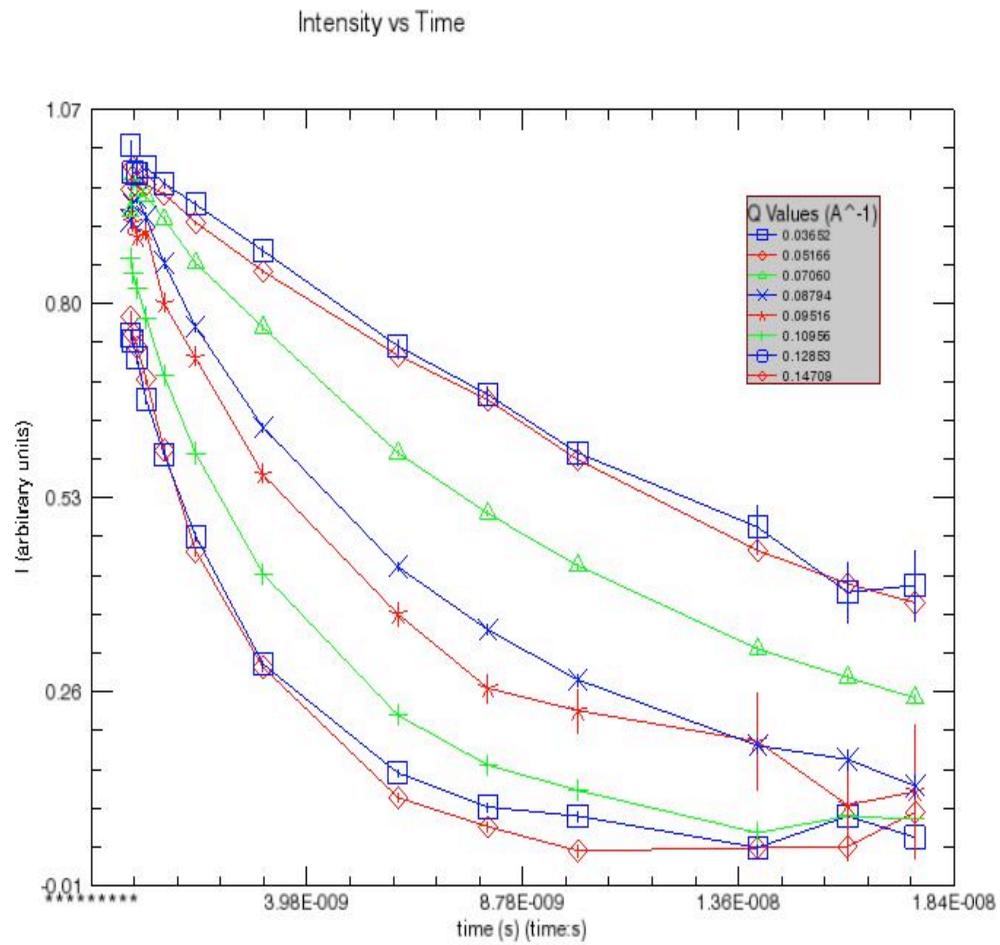


$$\langle P_Z \rangle = \frac{2A}{N_{up} - N_{down}}$$

Also normalize to Carbon powder (Resolution)

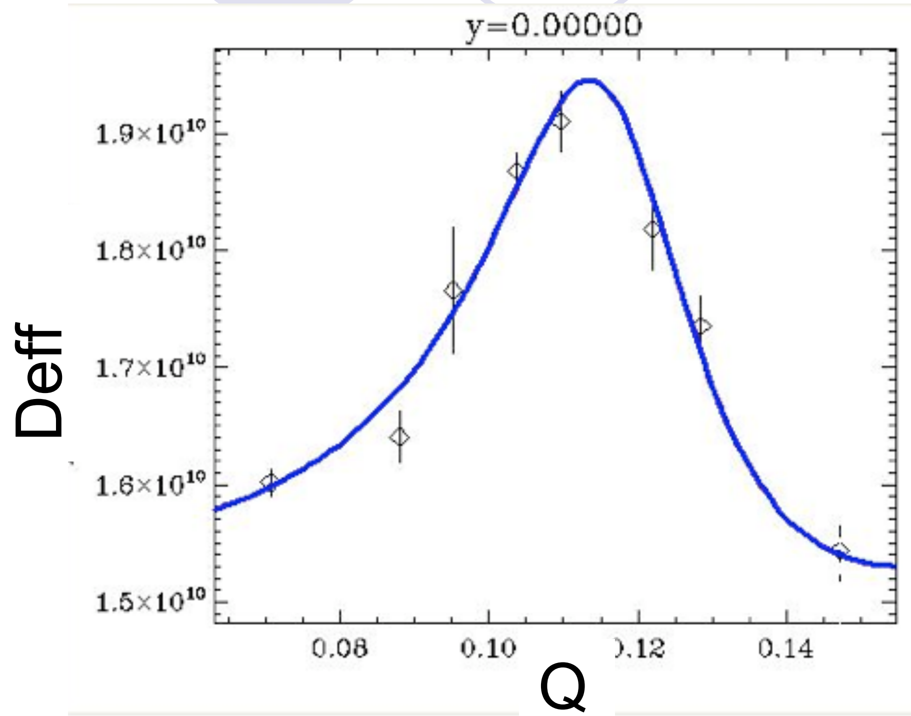
Results on microemulsion

- I(Q,t) at Q=.065,0.1,0.125
- 13 fourier times at λ=6A



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

Results-Elastic modulus



$$D_{eff}(Q) = D_{tr}(Q) + D_{def}(Q)$$

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

Extract Fit parameters R_0, a^2, D_{tr}, λ_2

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

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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- CHRNS

THANKS!