Heinz Maier-Leibnitz Zentrum

JÜLICH FORSCHUNGSZENTRUM

Single sided wall confinement of microemulsions with and without additive

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Applications of Surfactants

Hair care

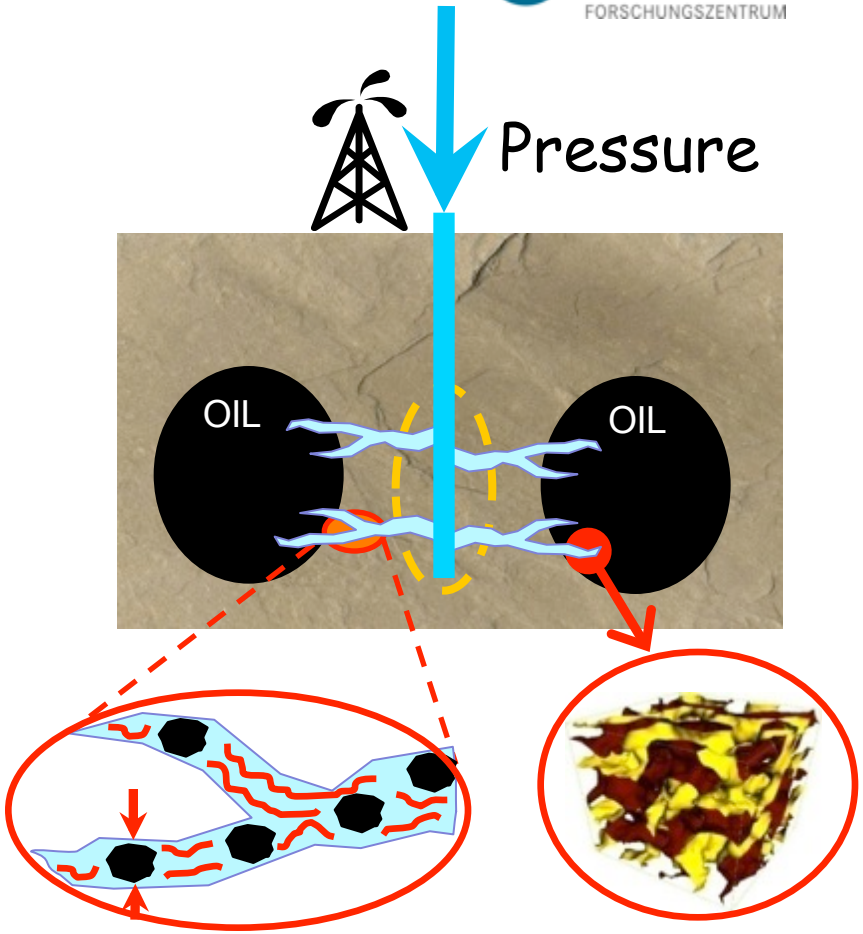
Cosmetics

Personal care

Detergents

Enhanced oil recovery

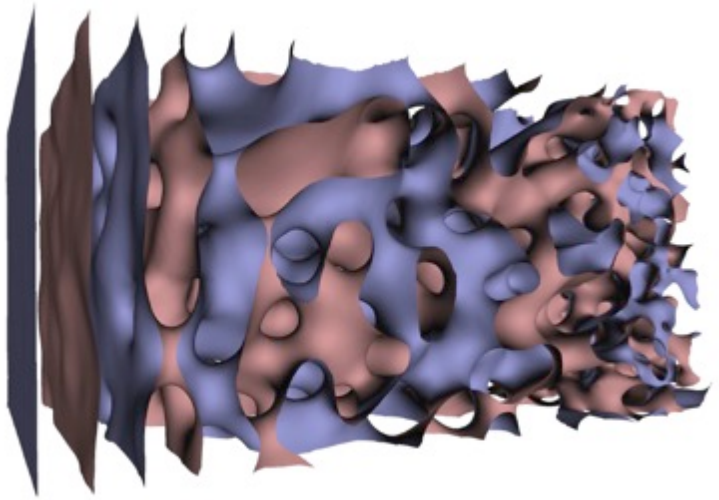
Oil Production

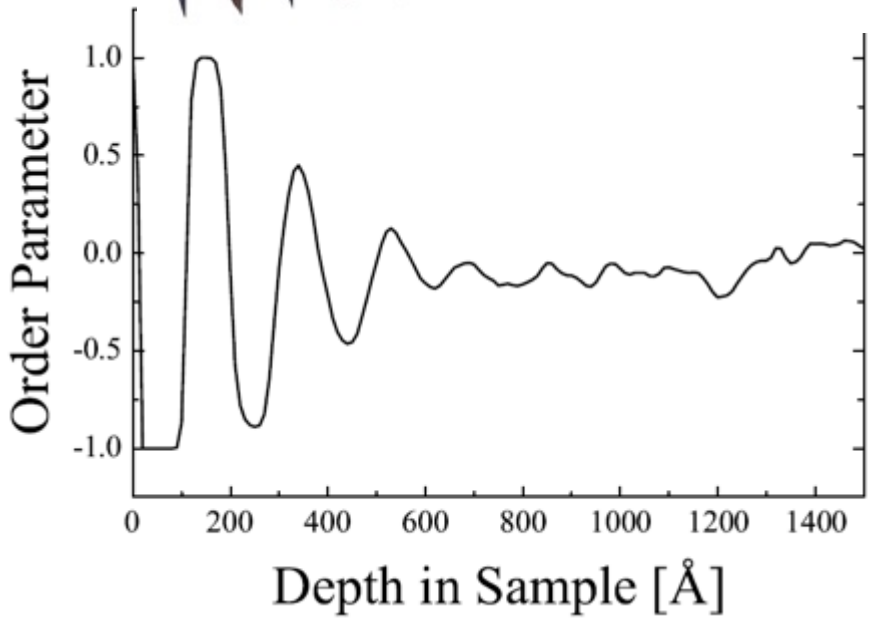


Aqueous Surfactant Systems are used for:

- Drilling Fluid
- Secondary/Tertiary Oil Production
- Fracturing Fluid

Simulations (M. Belushkin)



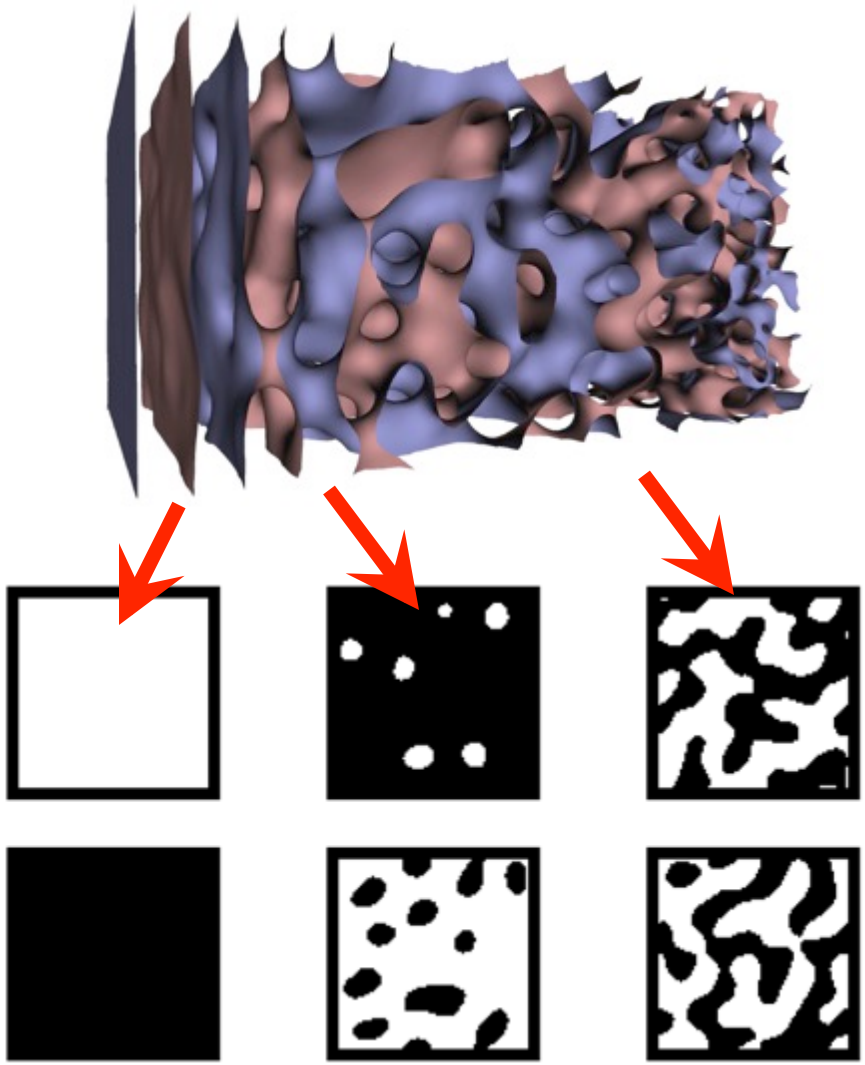


Single order parameter:

+1: Oil
-1: Water
0: Surfactant

Lamellar order decays !!!

Simulations (M. Belushkin)



Single order parameter:

+1: Oil
-1: Water
0: Surfactant

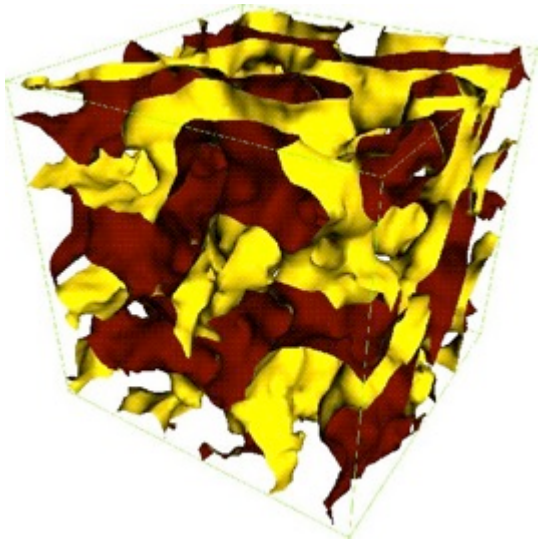
3 structures !!!

How to access experimentally ???

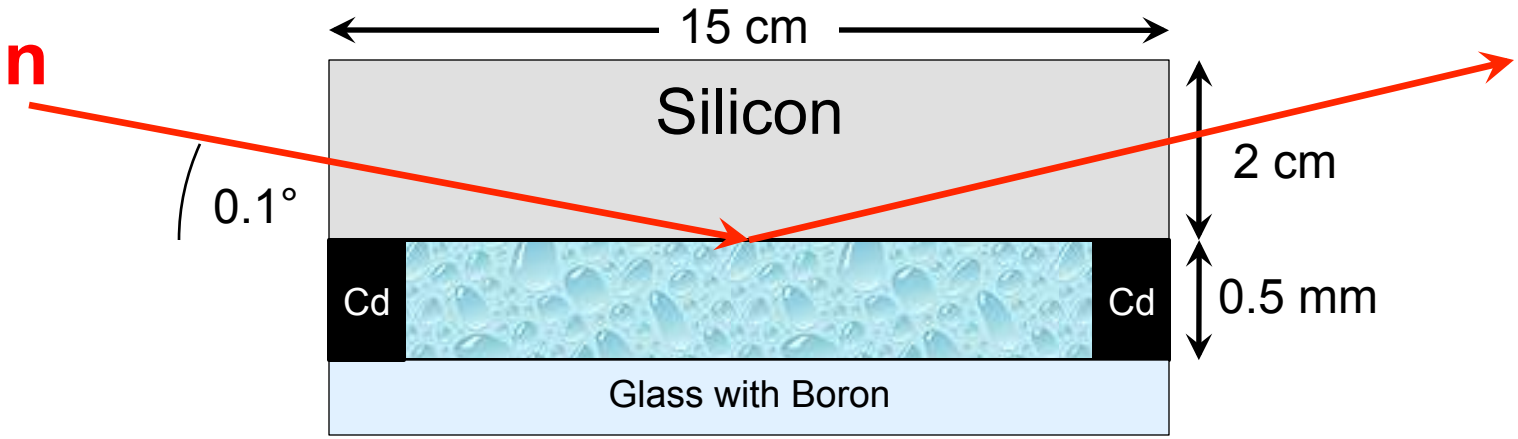
The System

Water:	D_2O, H_2O	(41.5%vol)
Oil:	Decane	(41.5%vol)
Surfactant:	$C_{10}E_4$	(17.0%vol)

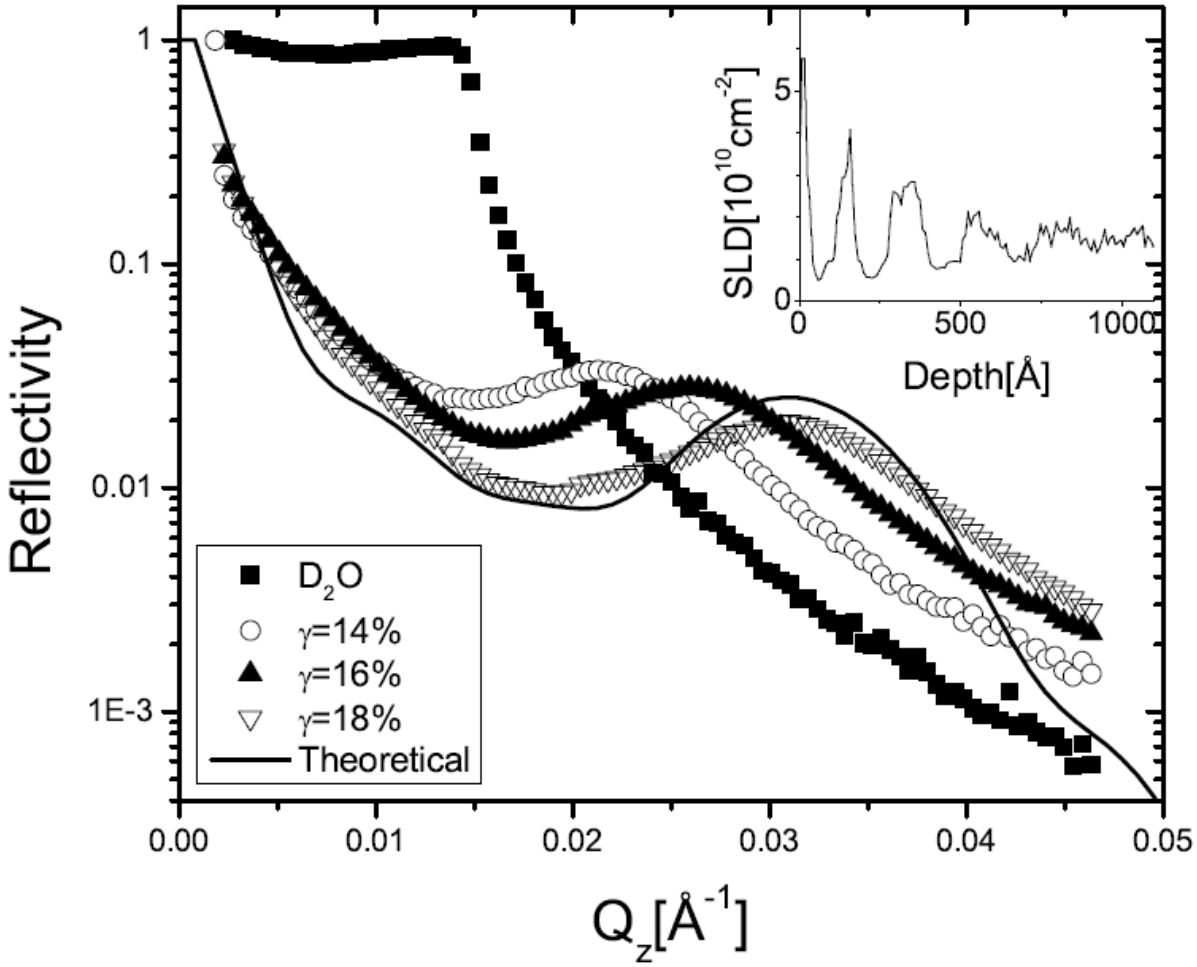
Temperature ca. 25°C

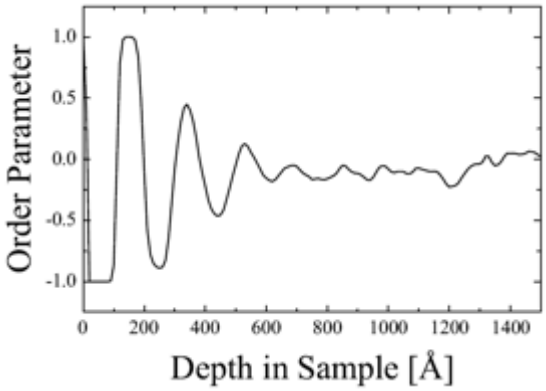


The Cell

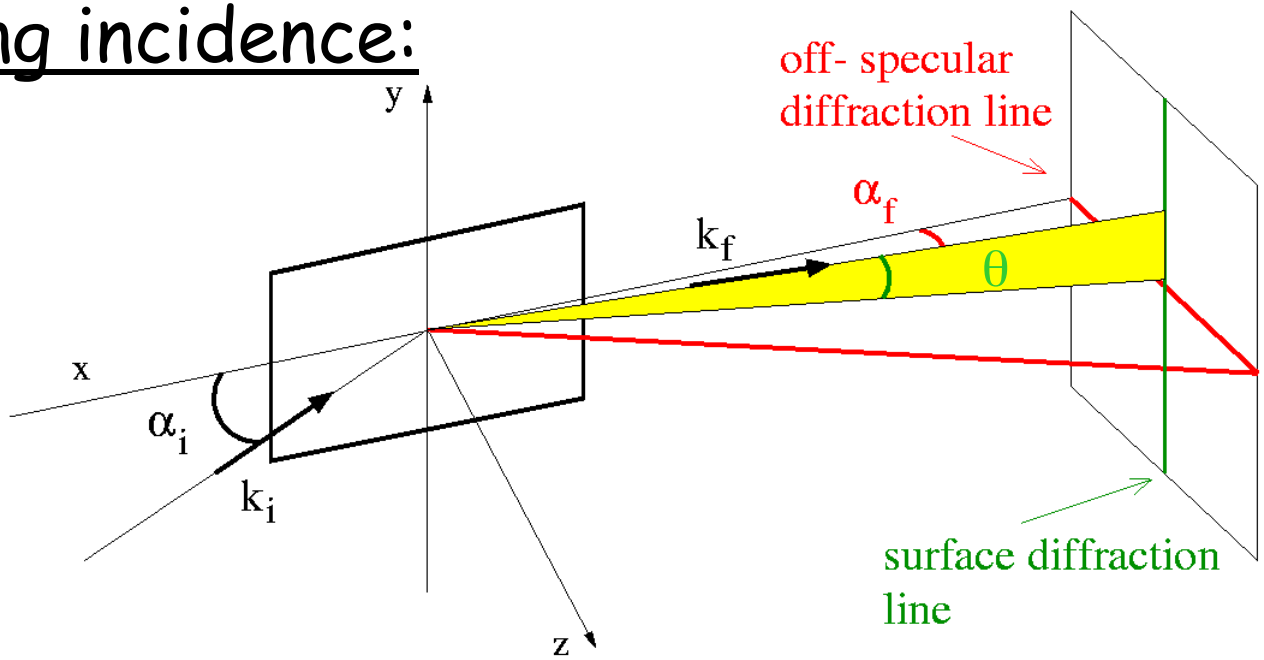


Reflectometry





Grazing incidence:



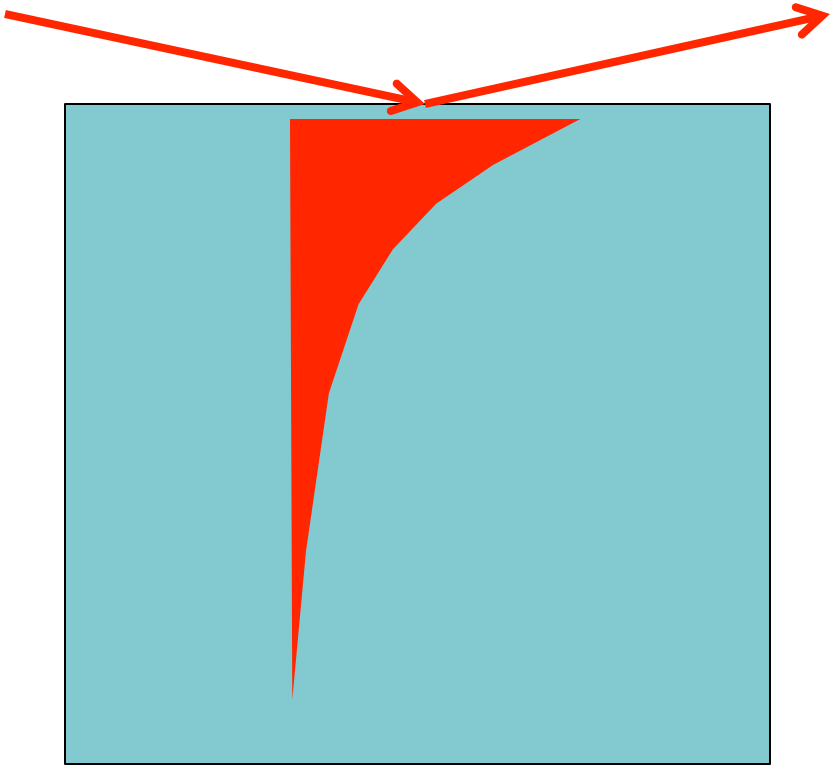
$$\begin{pmatrix} q_x \\ q_y \\ q_z \end{pmatrix} = \frac{2\pi}{\lambda} \cdot \begin{pmatrix} \frac{1}{2}(\alpha_i^2 - \alpha_f^2) - \frac{1}{2}\theta_y^2 \\ \theta_y \\ \alpha_i + \alpha_f \end{pmatrix}$$

Reflect.: $1\ \mu m < \zeta_{//} < 20\ \mu m$

GISANS: $2\ nm < \zeta_{//} < 600\ nm$

(large θ_y, α critical angle)
α might be large...

Evanescent Wave: the depth information



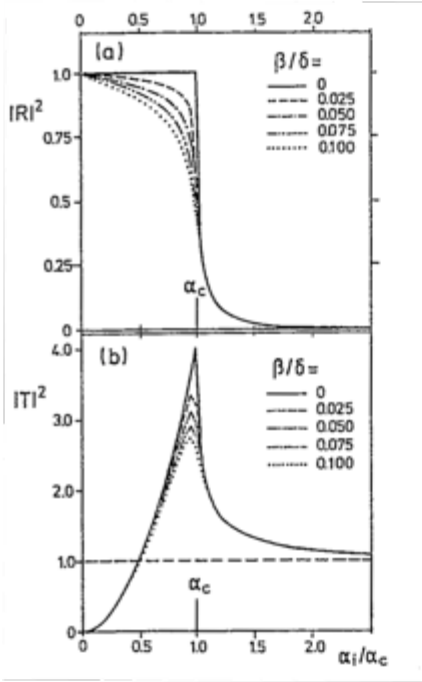


Fig. 2.2. (a) X-ray reflectivity $|R_i|^2$ and (b) transmissivity $|T_i|^2$ versus α_i for various β/δ

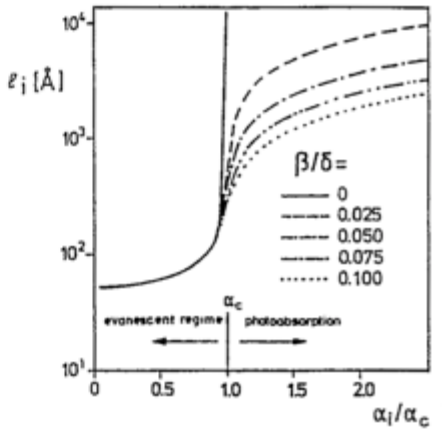
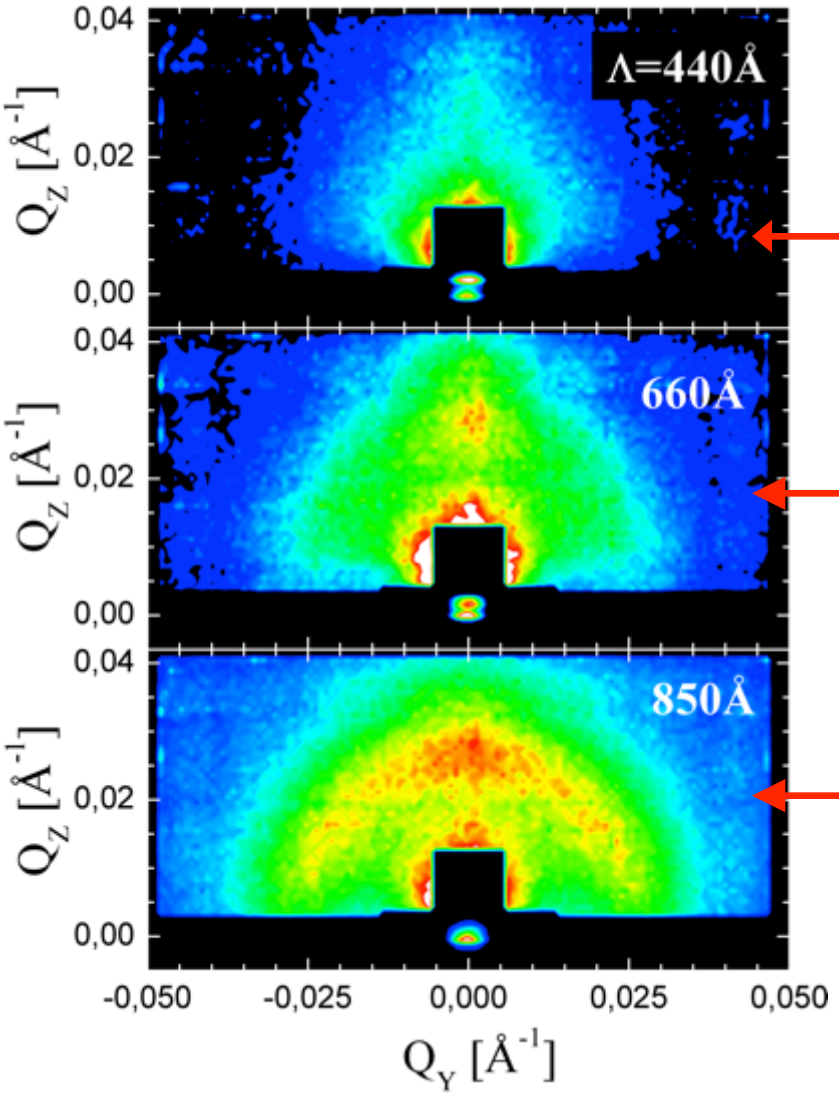


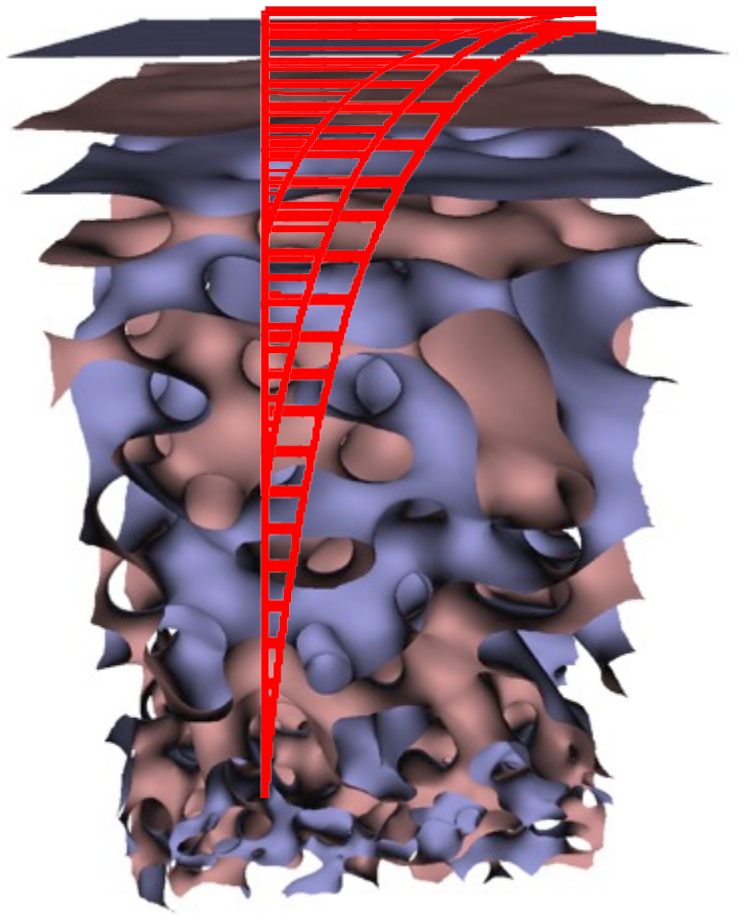
Fig. 2.3. Penetration depth ℓ_i of evanescent x-rays versus α_i/α_c for various β/δ

$$L_{i,0} \propto \Delta\rho^{-1/2}$$

Approximate Interpretation

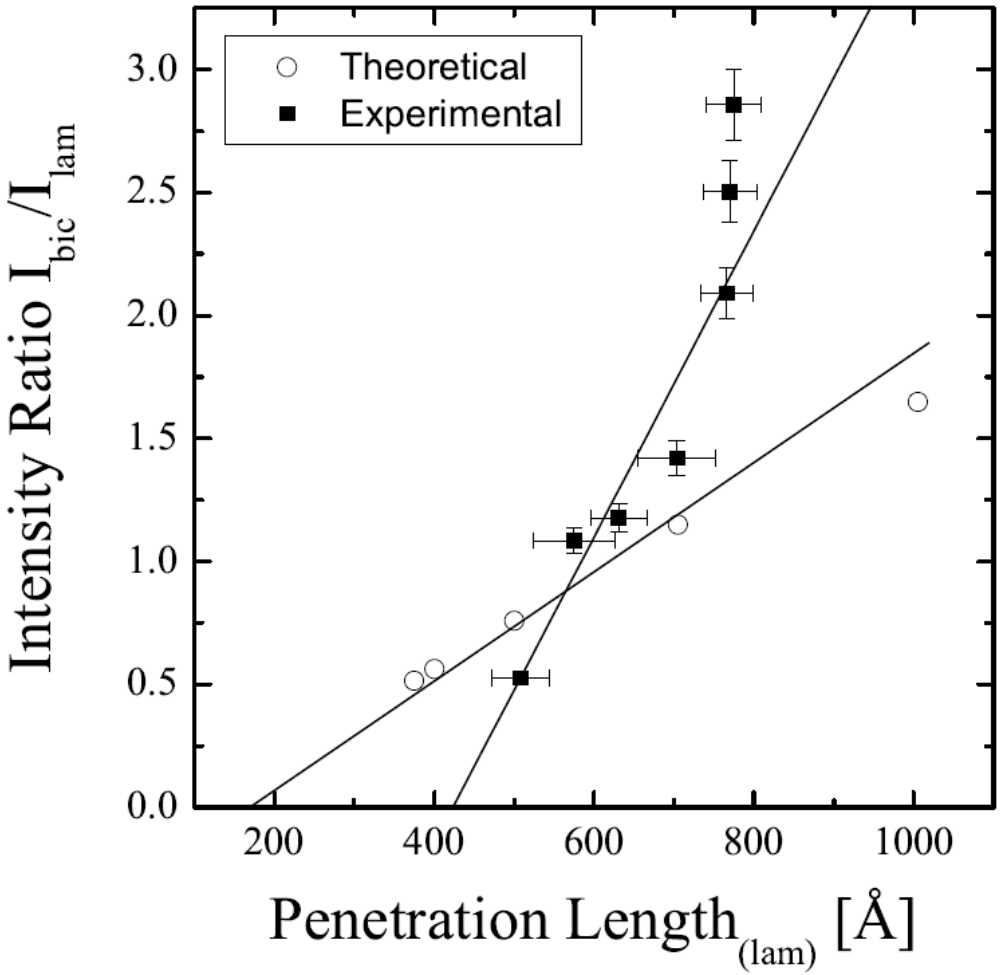


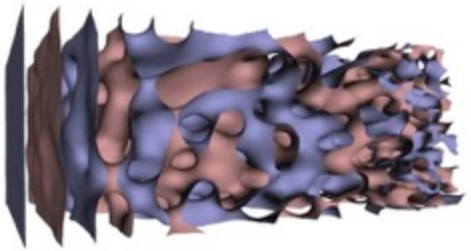
Structure from Computer Simulations:

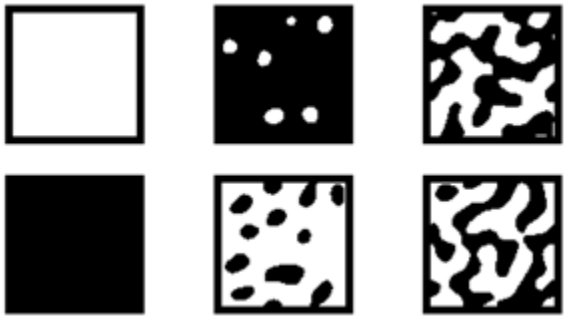


M. Belushkin

Results from GISANS



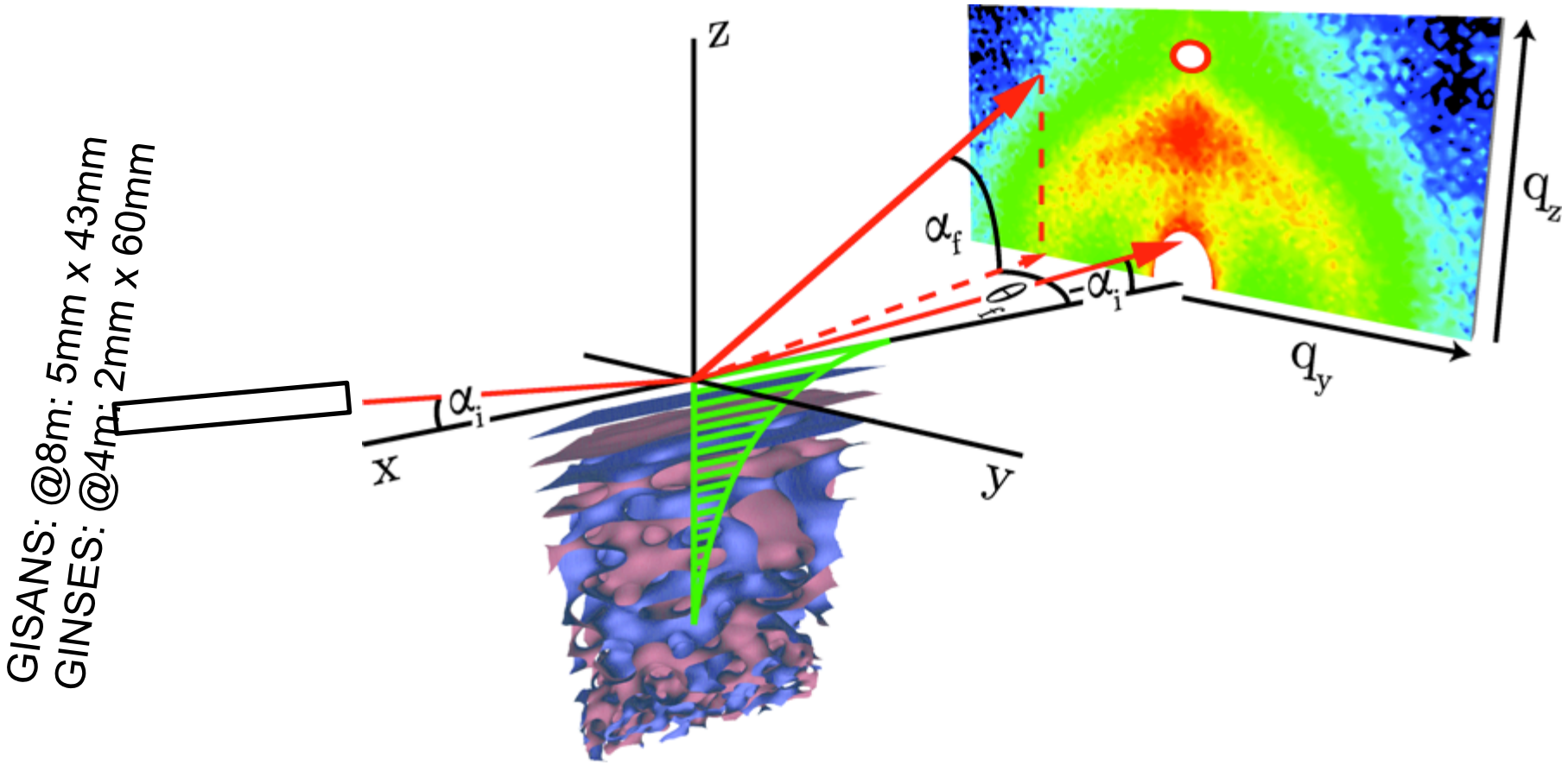




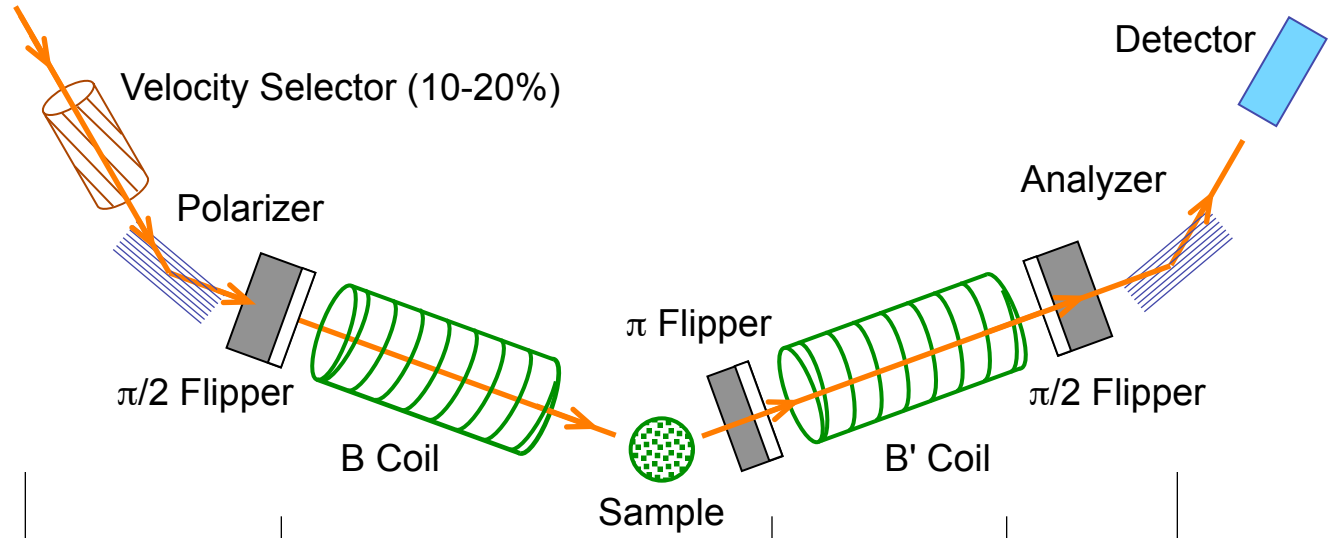
Lamellar: Peak

Isotropic: perforated lam.
+ bicontinuous

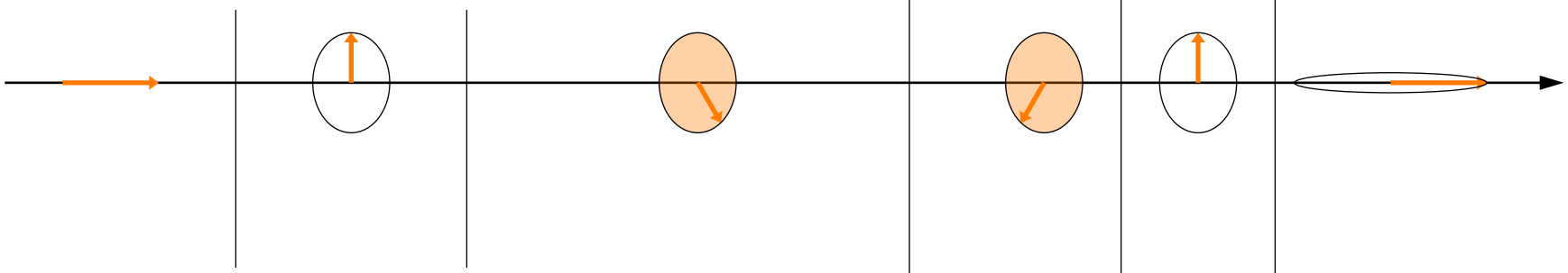
Grazing Incidence Neutron Spin Echo



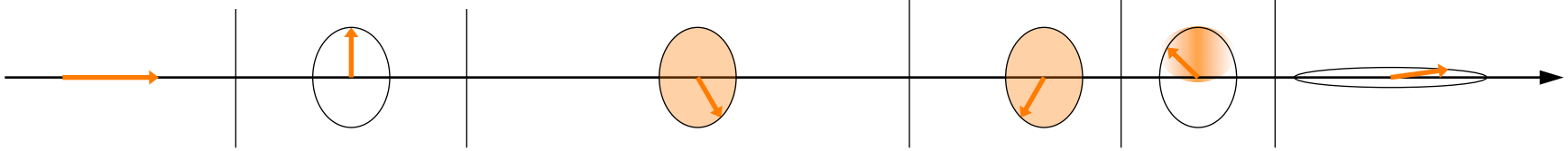
Neutron Spin Echo



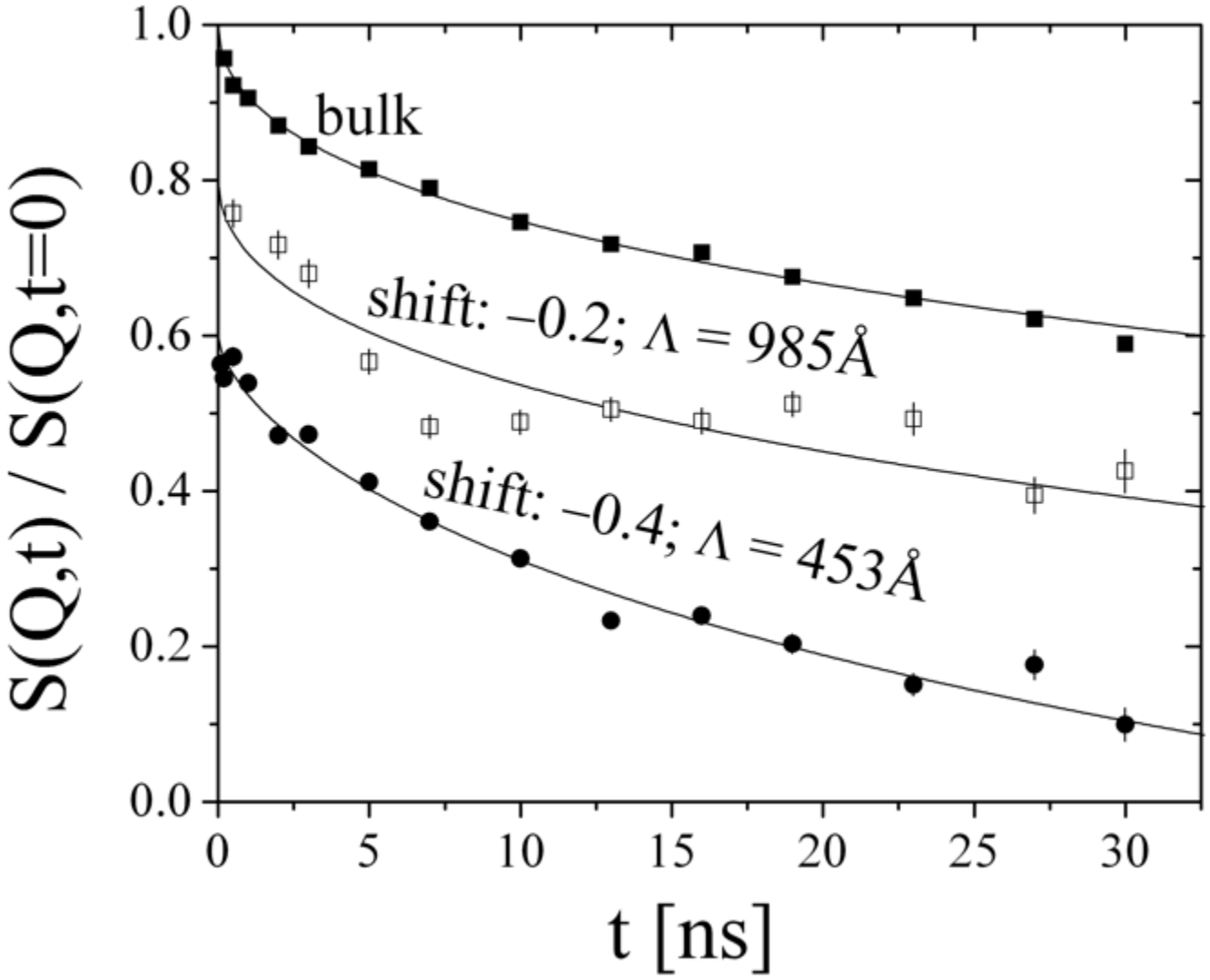
Spin development, elastic:



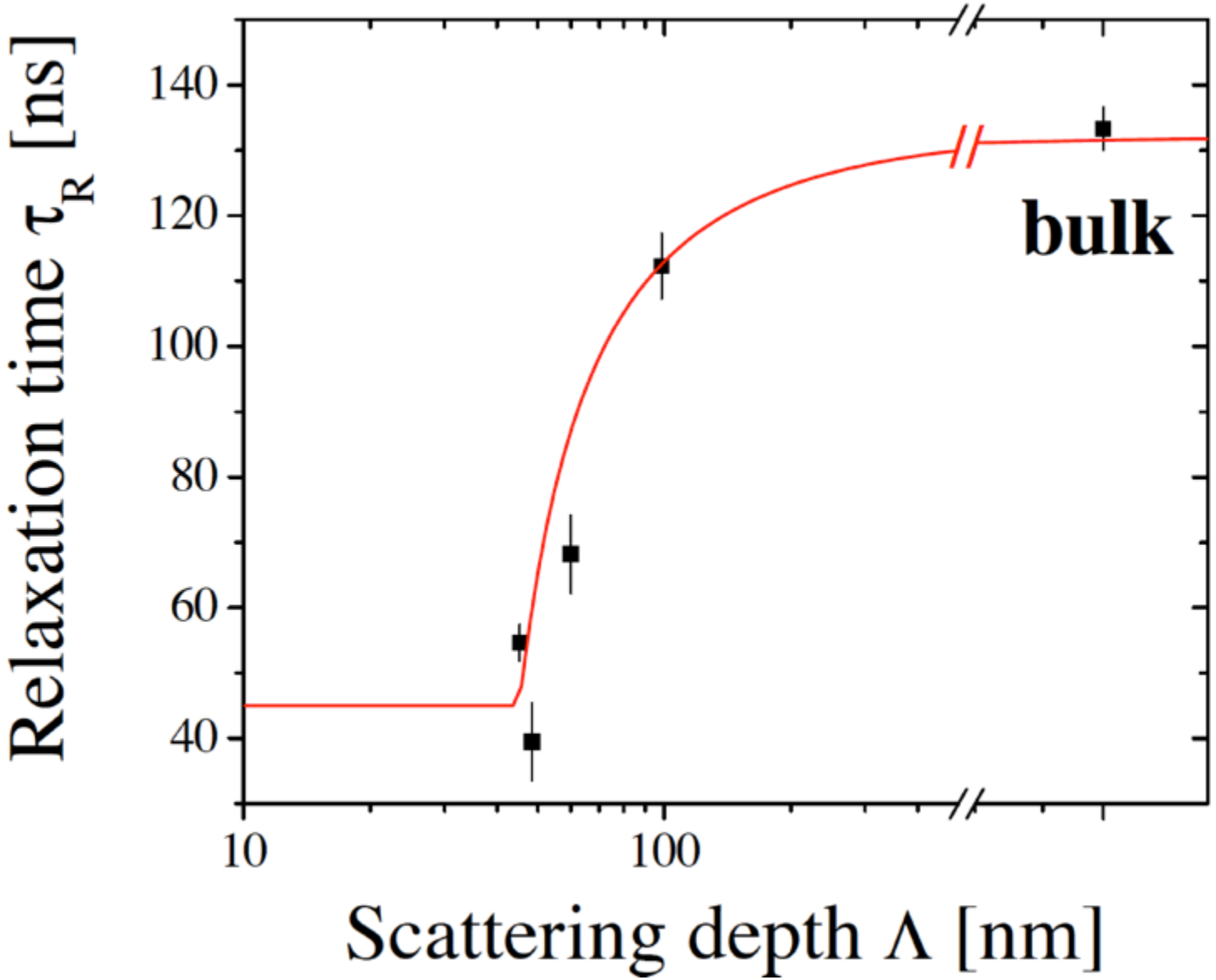
Spin development, inelastic:



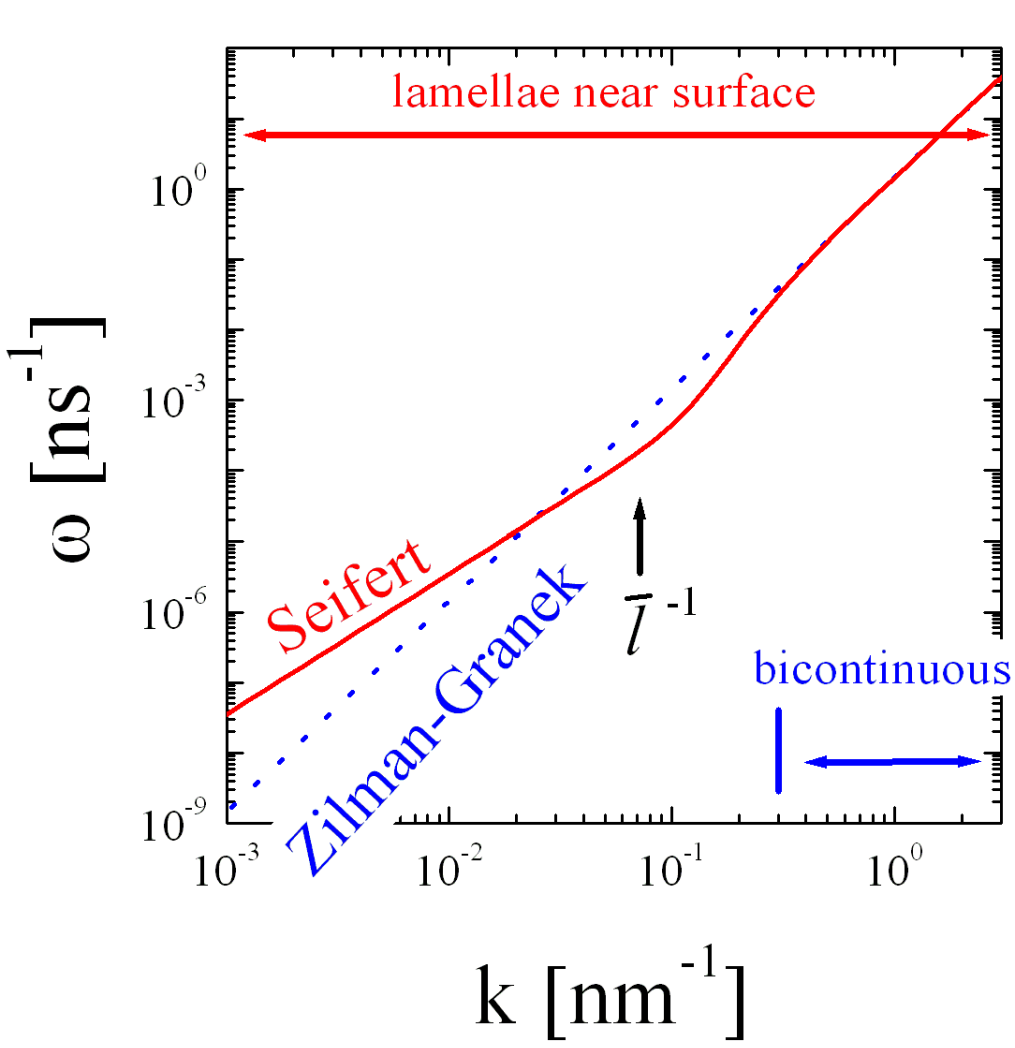
GINSE Relaxation Spectra

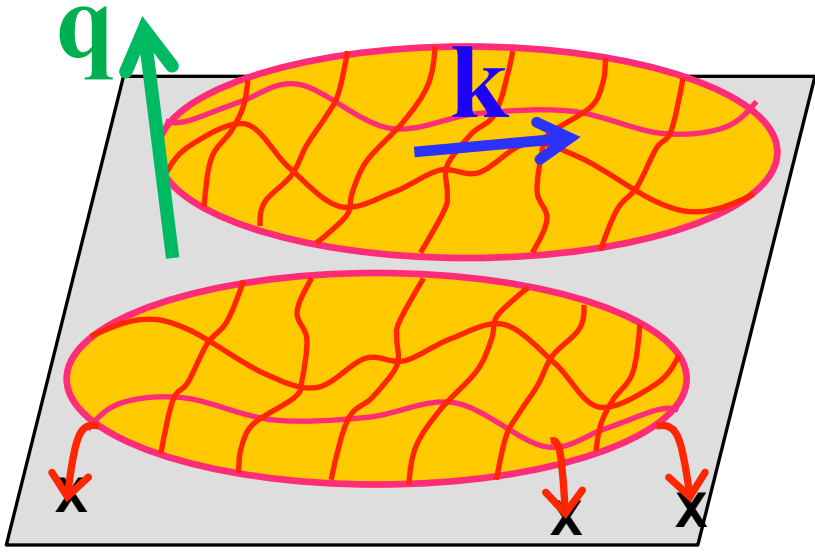


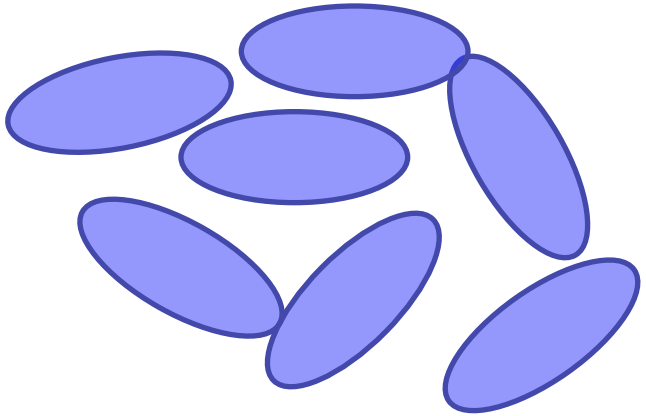
GINSE Relaxation Times



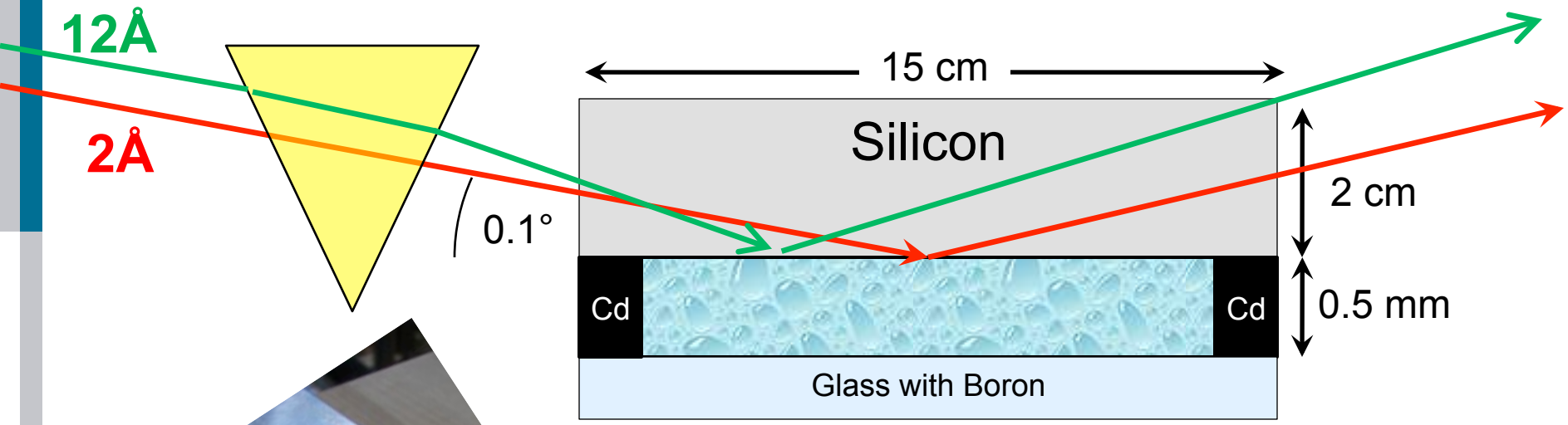
Seifert Dispersion

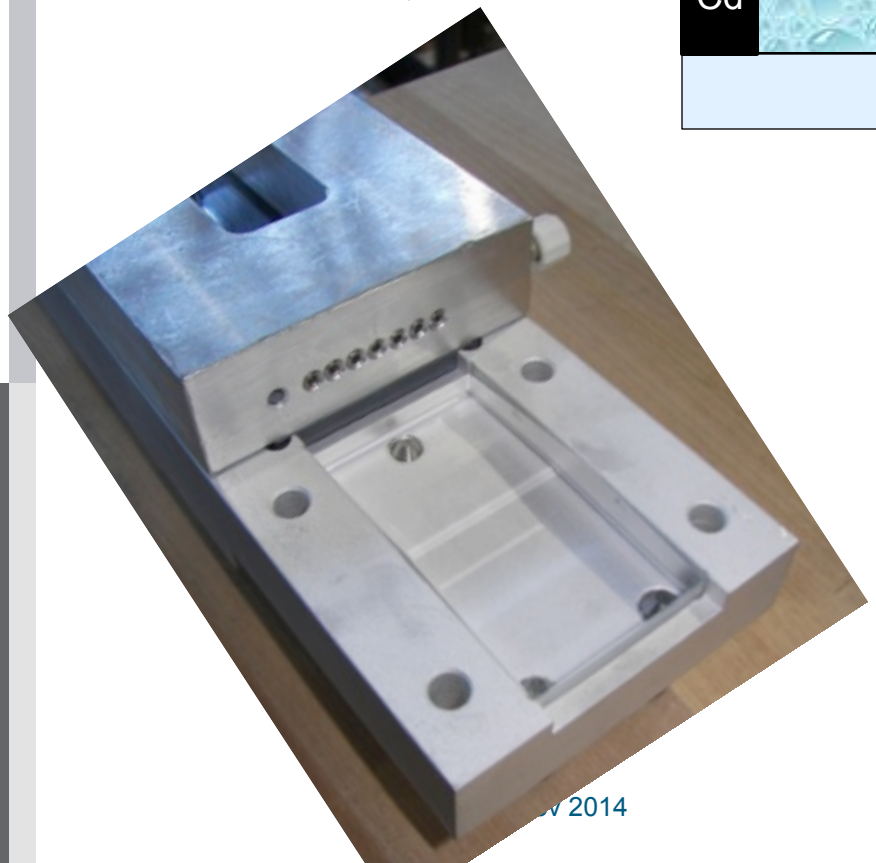


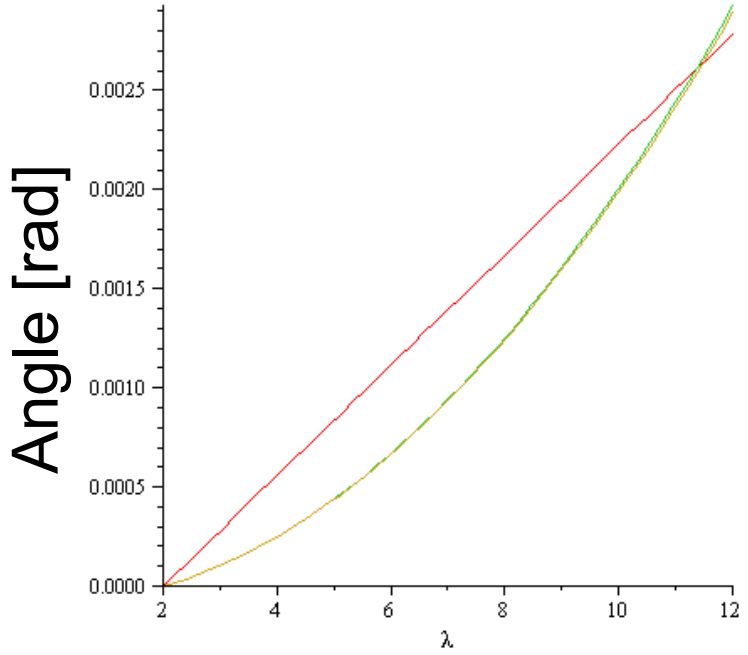




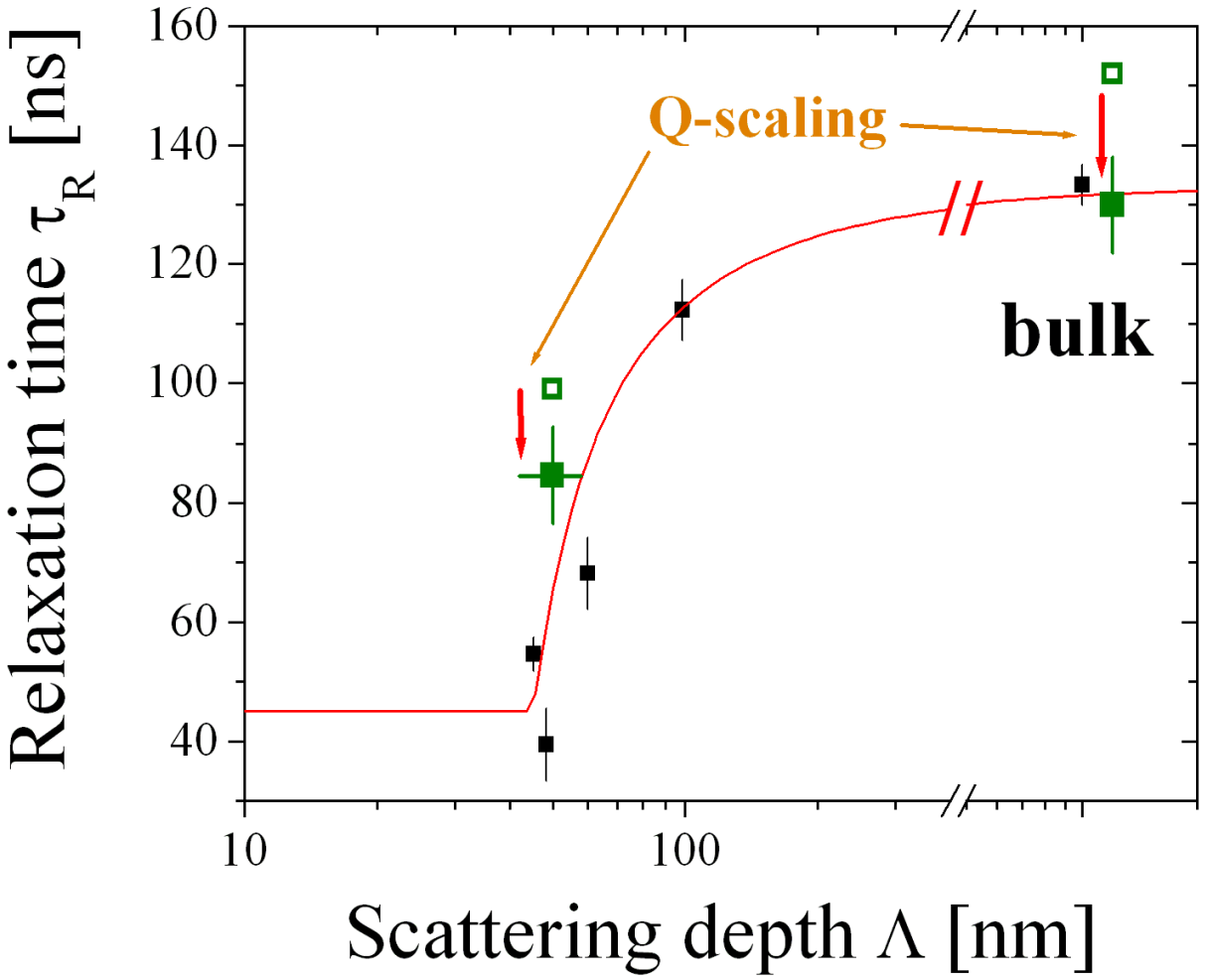
The Solution: **Prism**







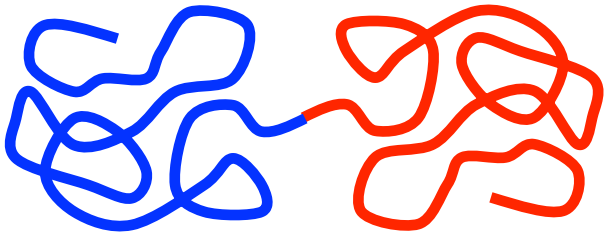
Comparison Oak Ridge – FRM-2

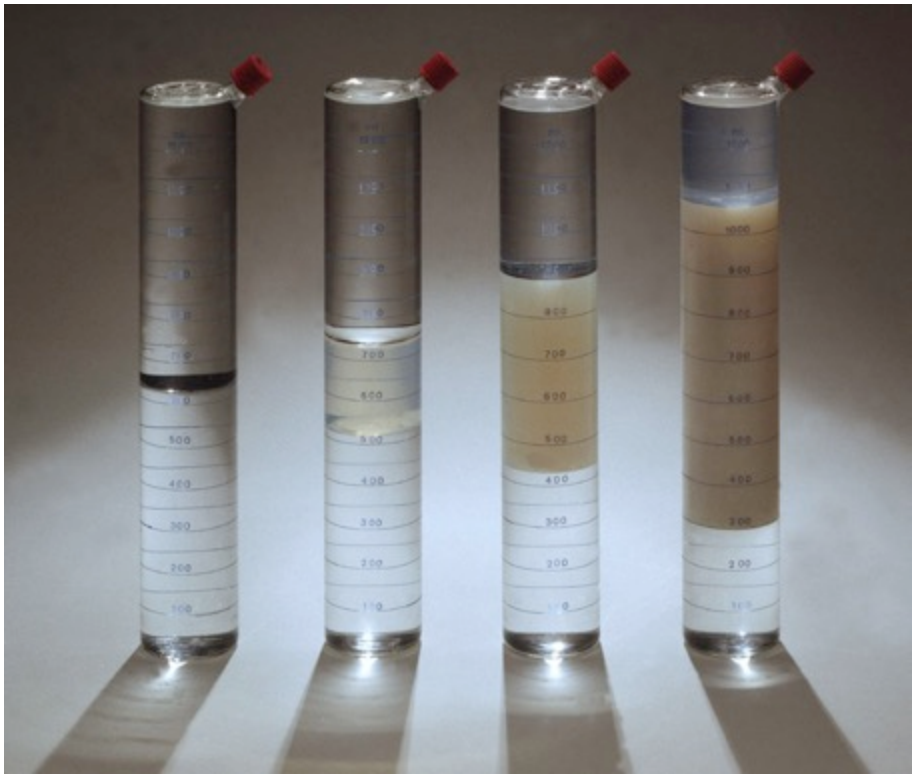


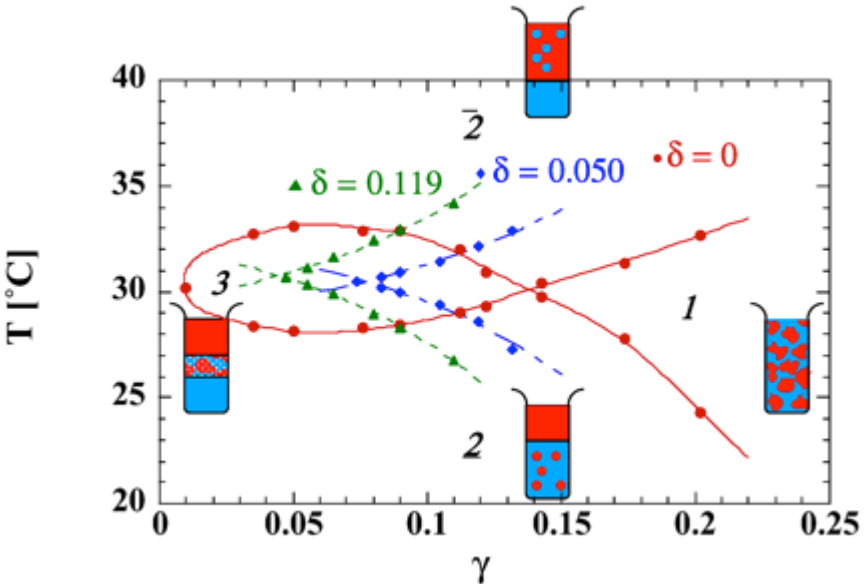
Polymer Boosting Effect

Non-Ionic Surfactant: C_iE_j

Polymer: Macro-Surfactant



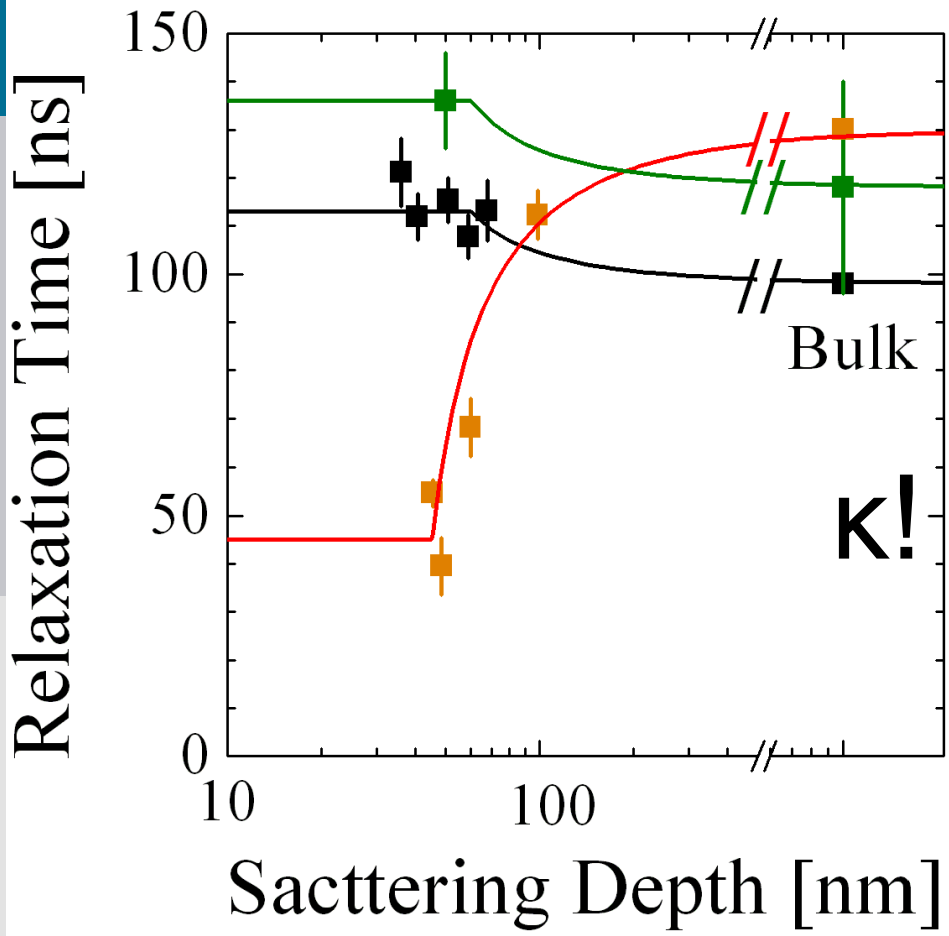


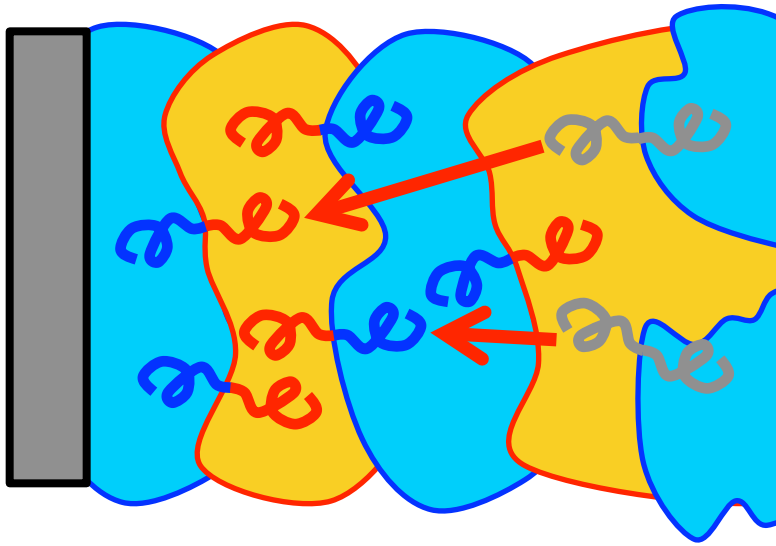


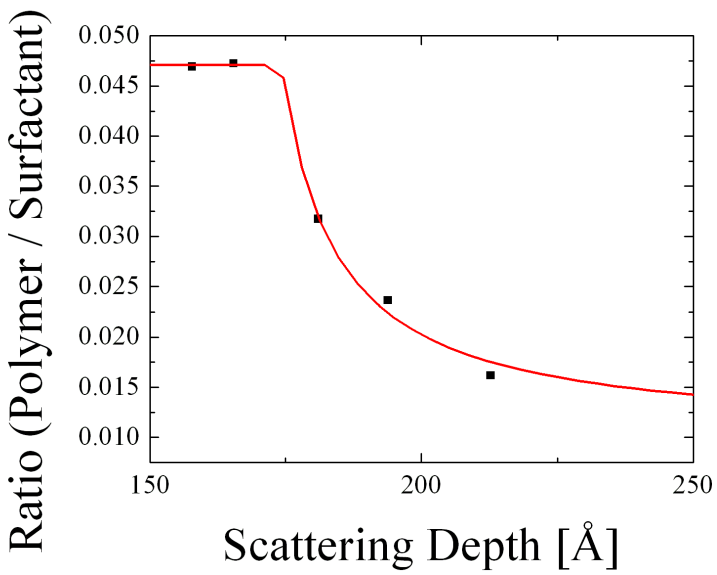
SANS:

- Polymer is anchored in the film
- Bending rigidity of the membrane is increased

Dynamics with Polymer







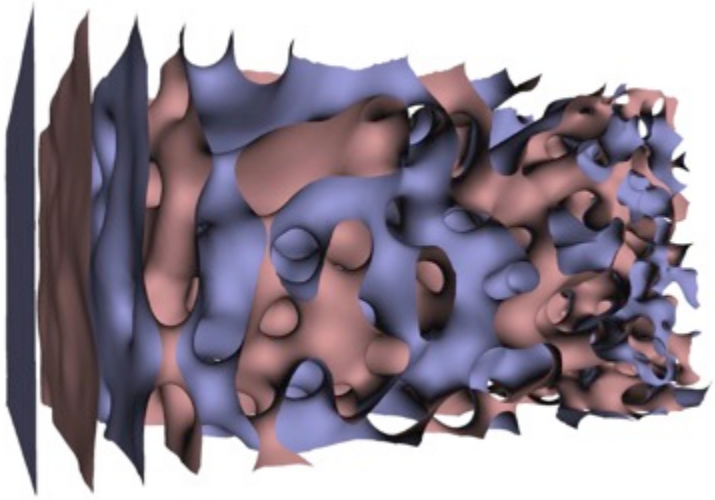
Summary

No Polymer:

- At surface: Lubrication Effect

With Polymer:

- At surface: Amplification of viscosity increase



Improvements of resonator

- Hide resonator structure better below crit. angle
- Go back to 2(?) double layers for lower bckgr.
- Increase planarity (now: 1λ → 0.1λ)

- We still hope for a gain of 30 !

- Prove gain factor experimentally !

Science case:
Tribology at surfaces. Single lipid bilayers.
Membrane proteins.