Biological Neutron Scattering Under Controlled Humidity at HZB

Thomas Hauß

Scientific Interests

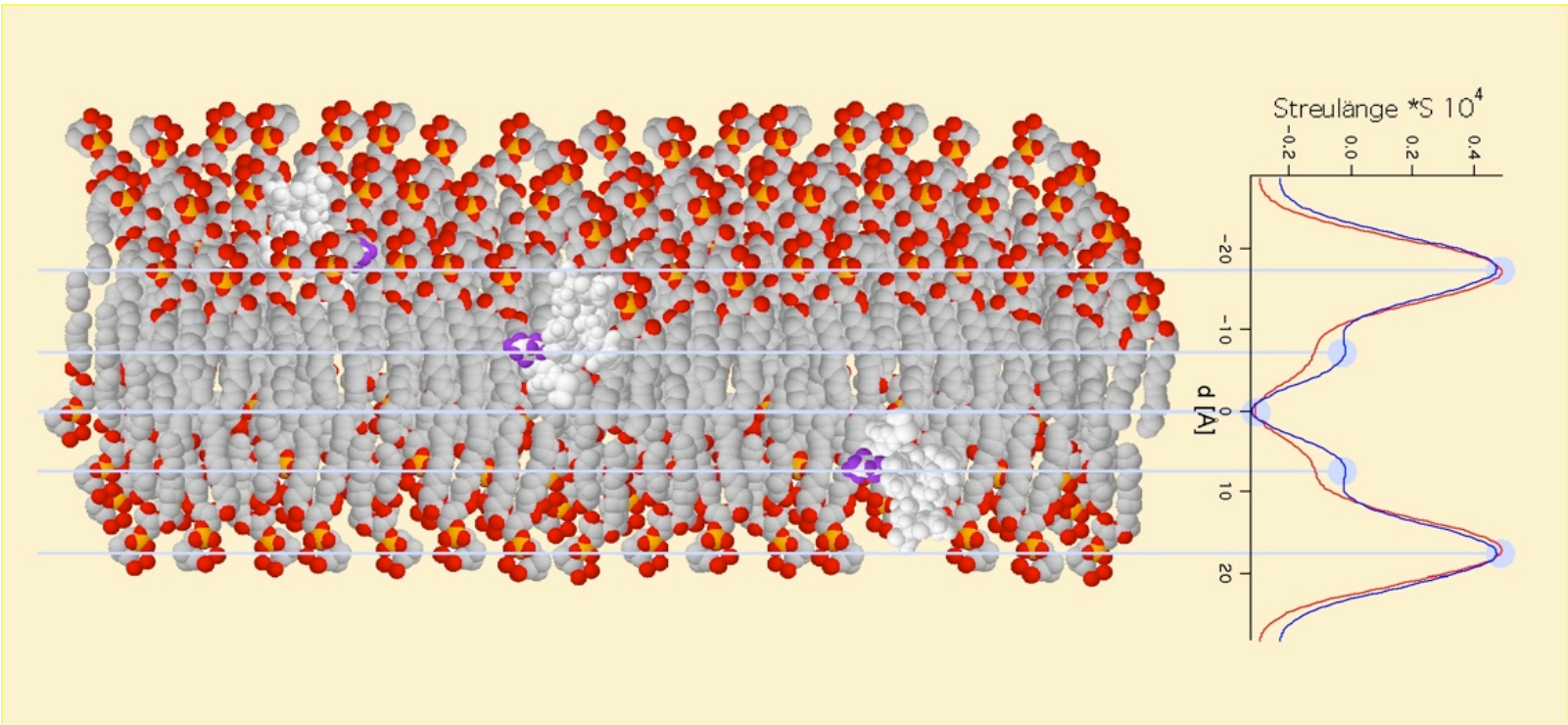
- Lipid Membrane Structure and Dynamics
- Biological Membranes in Interaction with
    - Peptides
    - Small Organic Molecules
- Membrane Protein Structure and Function

Experimental Neutron Scattering Methods

- Diffraction (Membrane Diffractometer V1)
- Reflectometry (Reflectometer V6, BioRef V18)
- Small Angle Scattering (V4, VSANS V16)
- Inelestic- and Quasielastic Scattering (NEAT V3)

Example: Membrane Diffraction

Localisation of specifically deuterated β-amyloid(25-35) peptide



Model membrane POPC : POPS (92 : 8)

Dante, Hauß, Dencher, Biophy J 2002
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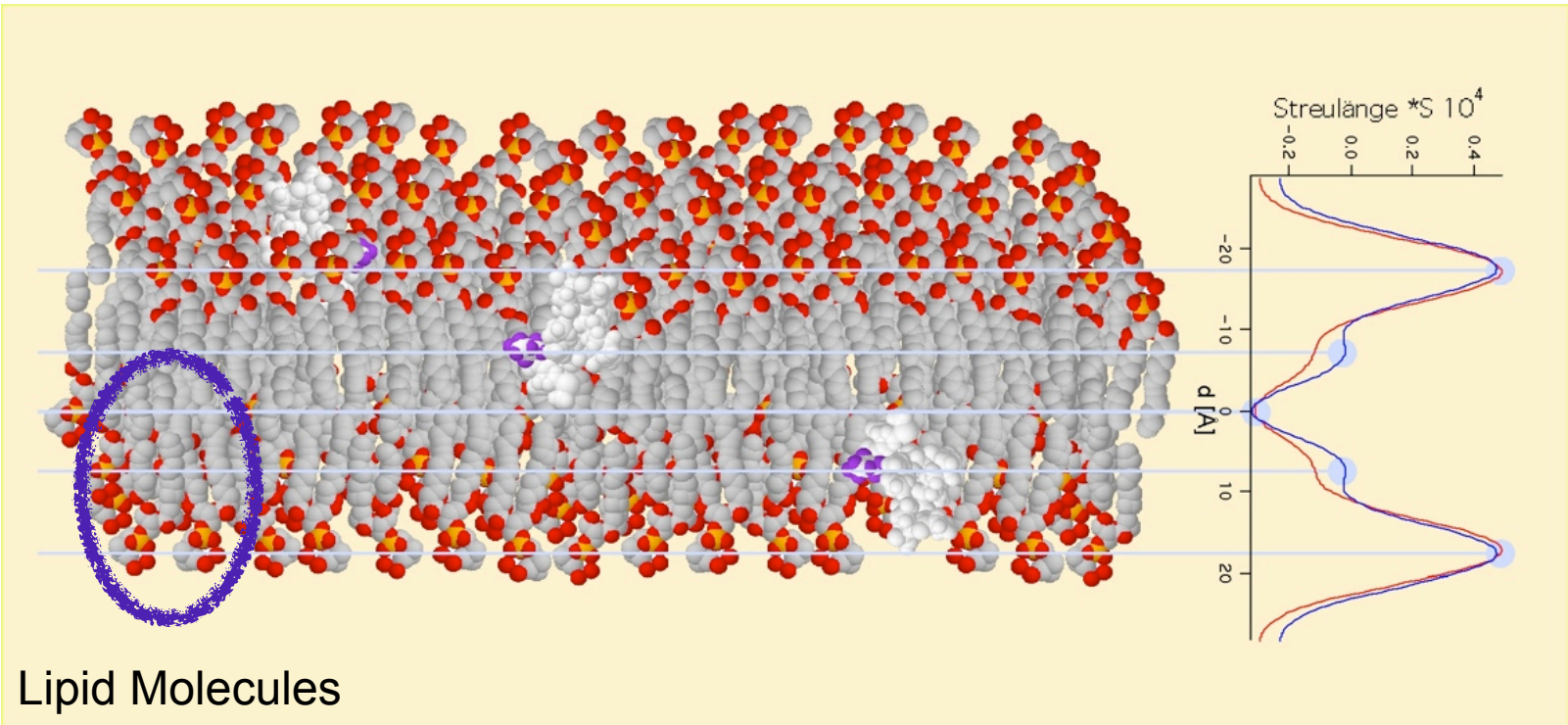

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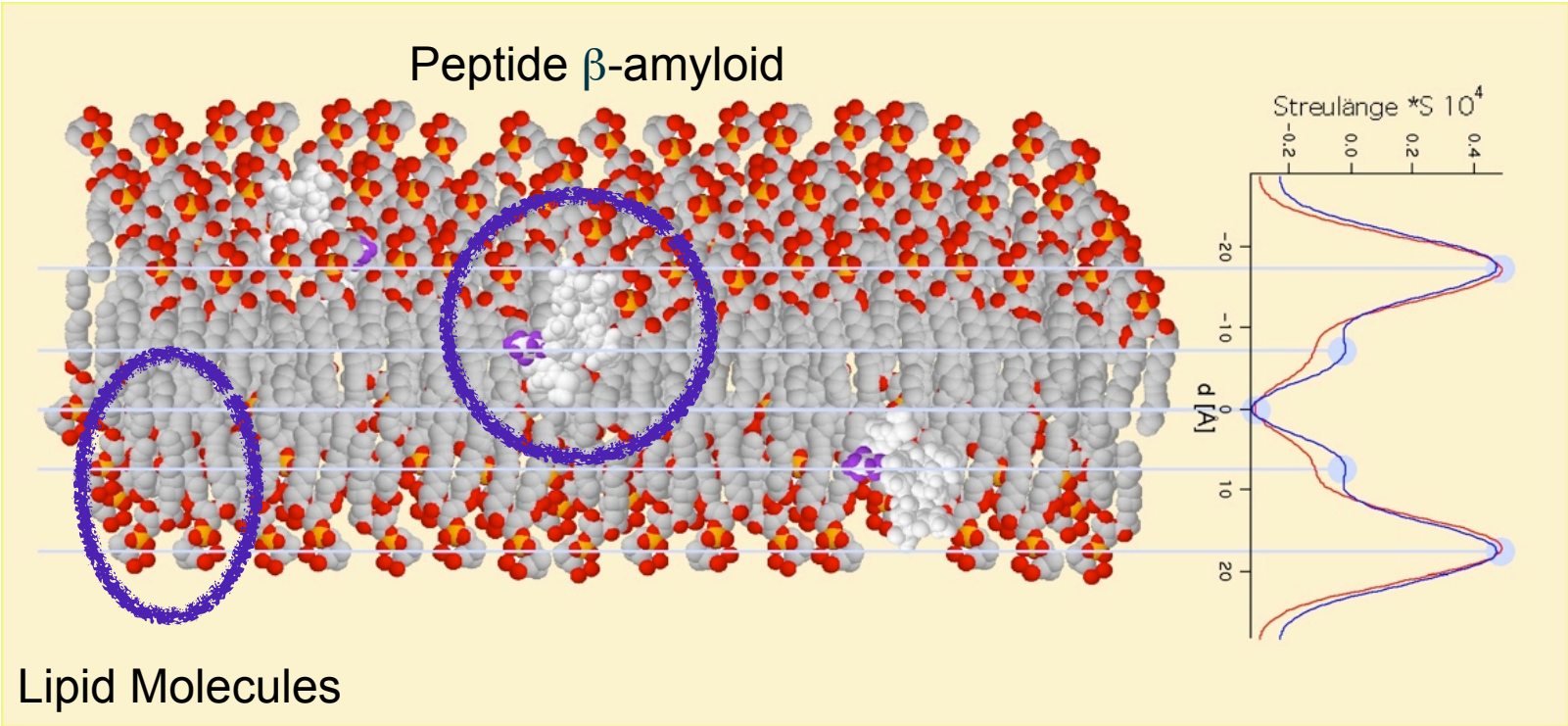

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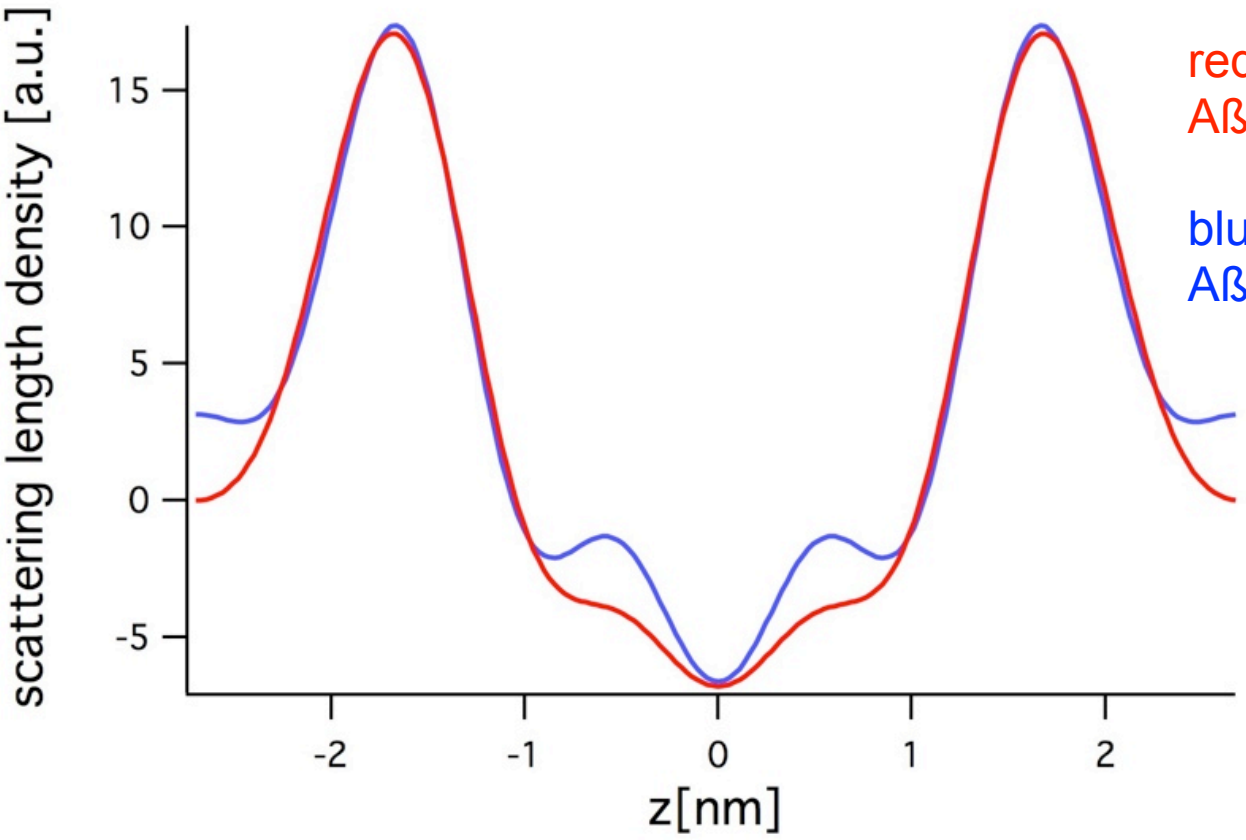

red:
Aß per-protonated

blue:
Aß Leu34-d10

Model membrane POPC : POPS 1% Cholesterol

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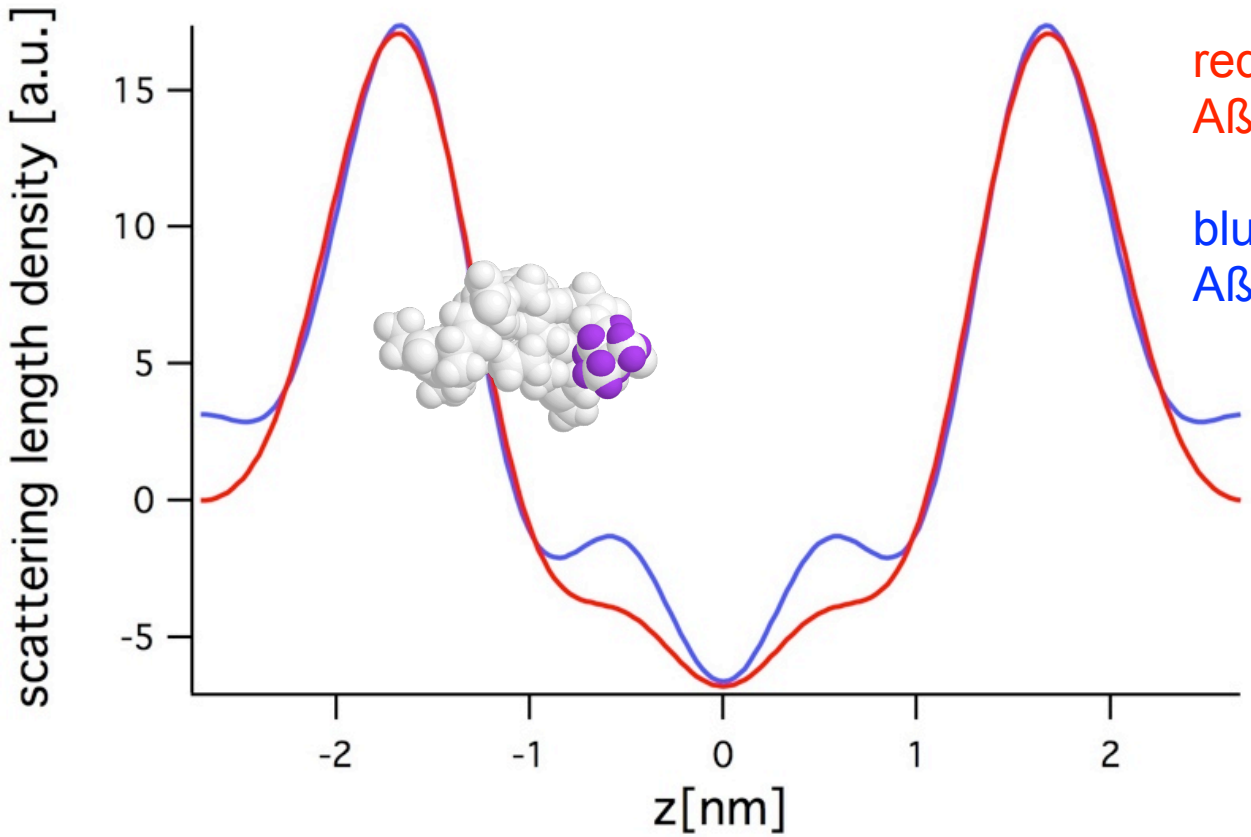

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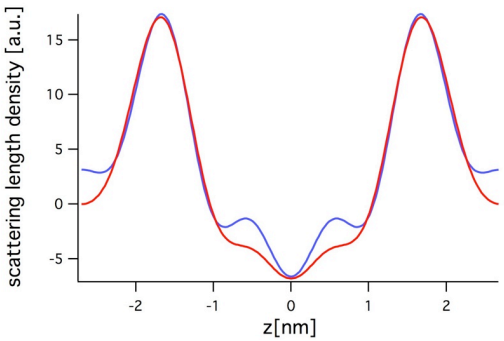
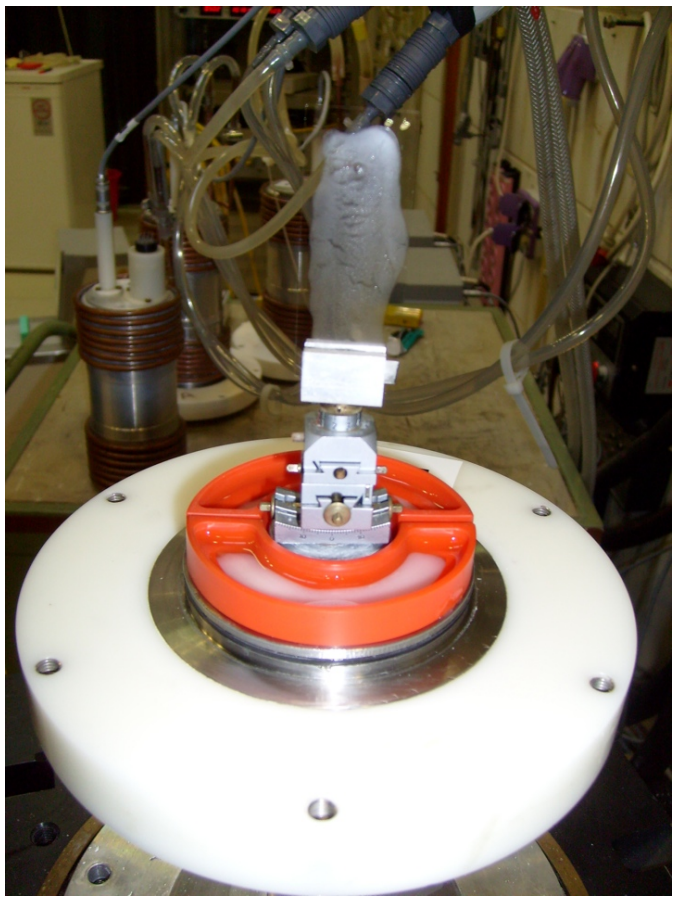


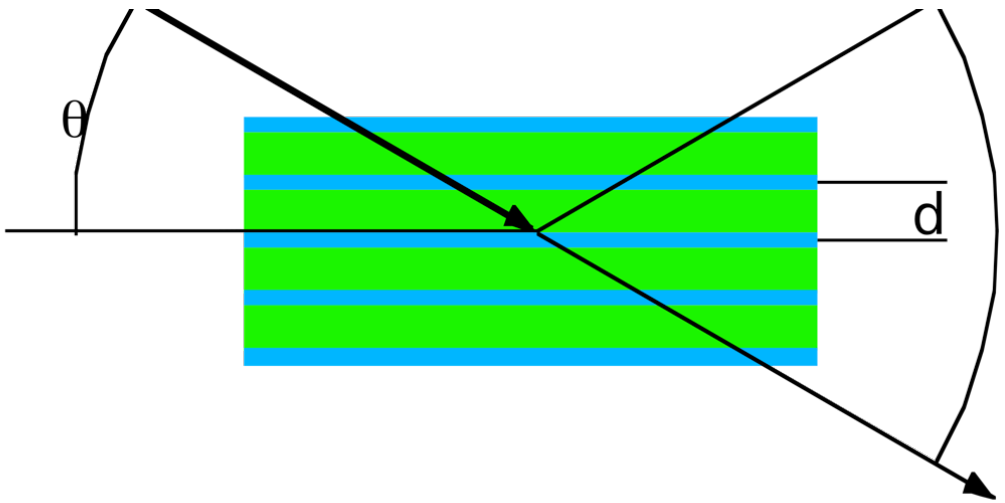
Example: Membrane Diffraction

Membrane Diffractometer V1

Example: Membrane Diffraction



Sample on the
Membrane Diffractometer



Bragg equation: $n\lambda = 2d\sin(\theta)$ λ : neutron wavelength

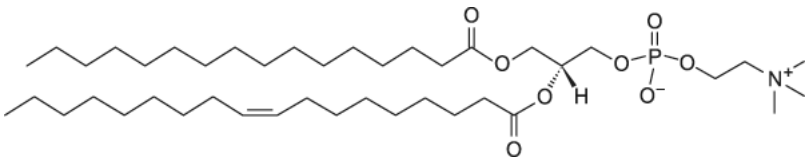
measured intensity: $I(h) = |F(h) \cdot e^{-i\varphi}|^2$ φ: phase angle

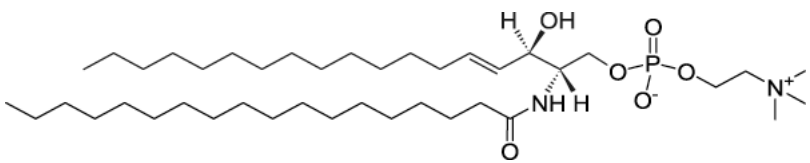
Example: Membrane Diffraction

Closed Humidity Chamber
at the Membrane Diffractometer

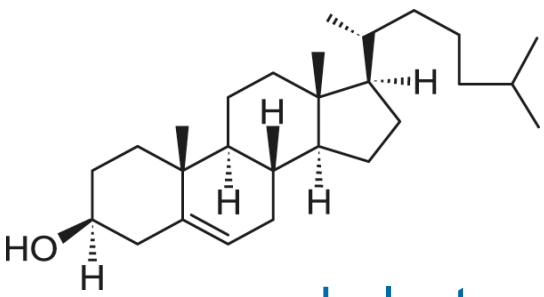
A More Complex Lipid Model Membrane: Lipid Rafts

POPC





c16-sphingomyelin (porcine brain)

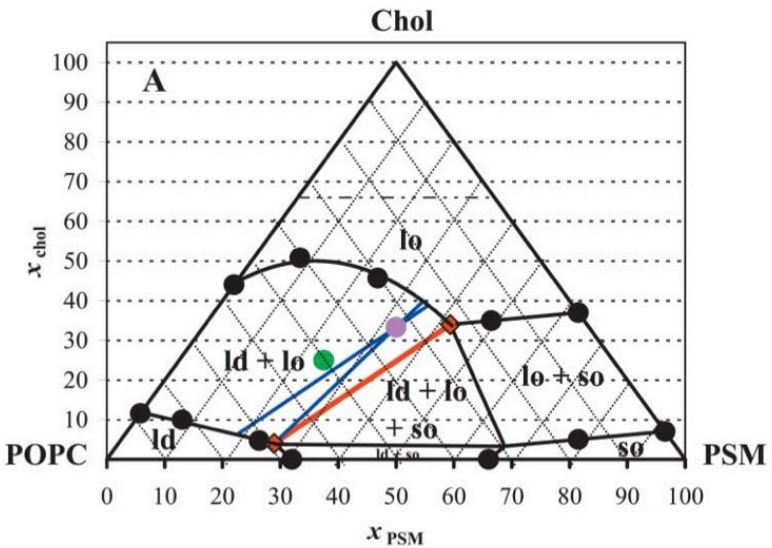


cholesterol

lipid „raft“-mixture

POPC : SM : Chol

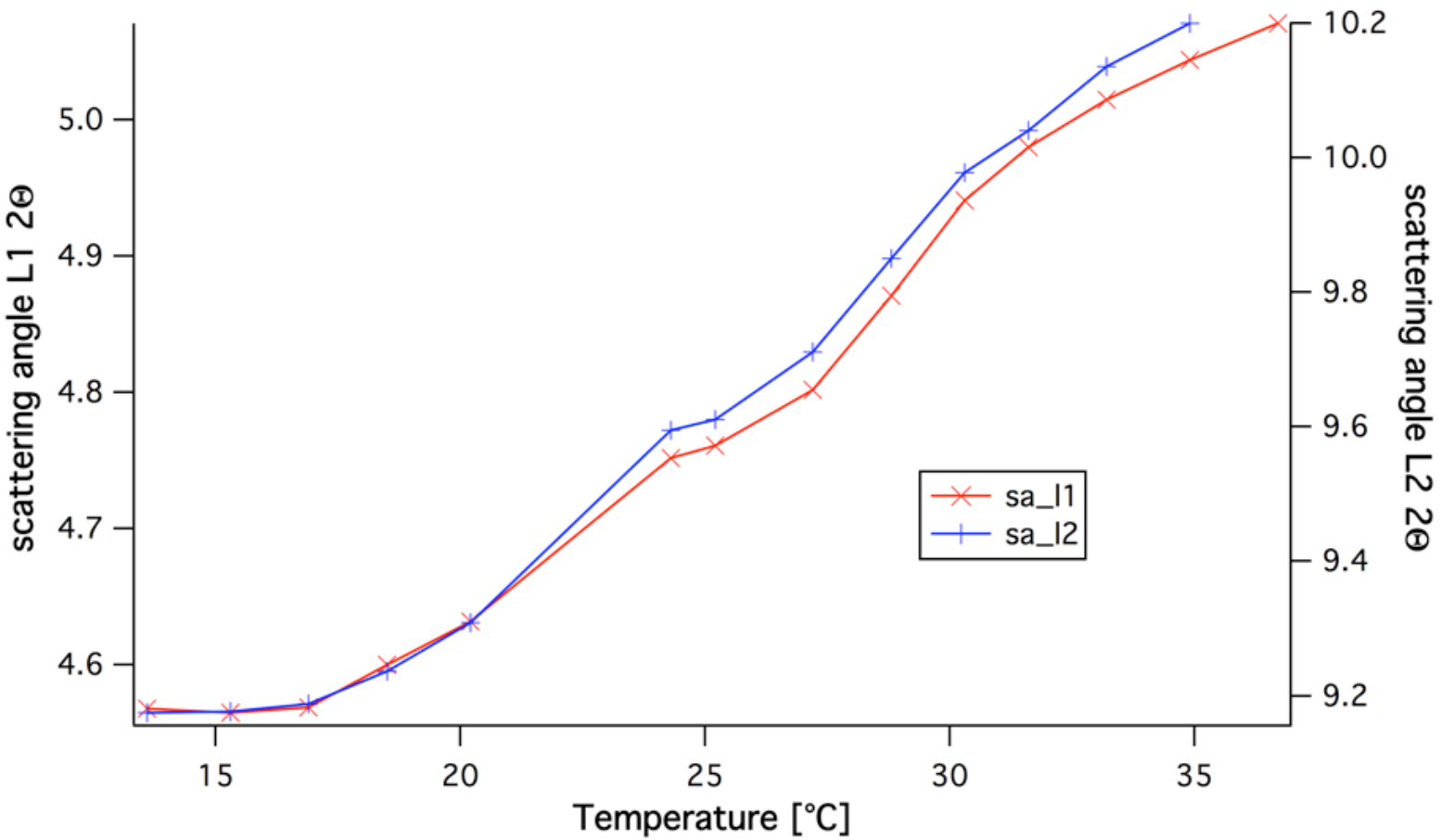
1 : 1 : 0.67 mol%



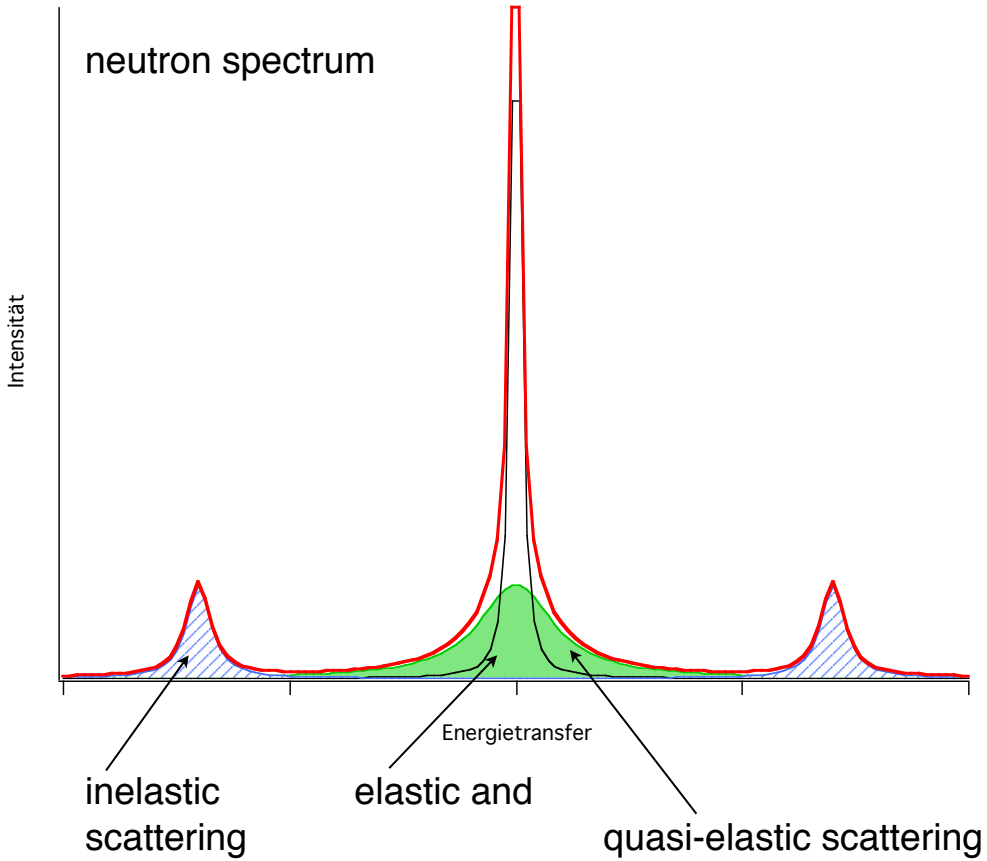
phase diagram @ 23°C

de Almeida Biophys J 2003

Temperature dependence of d-spacing



Example: Quasielastic- and Inelastic Scattering



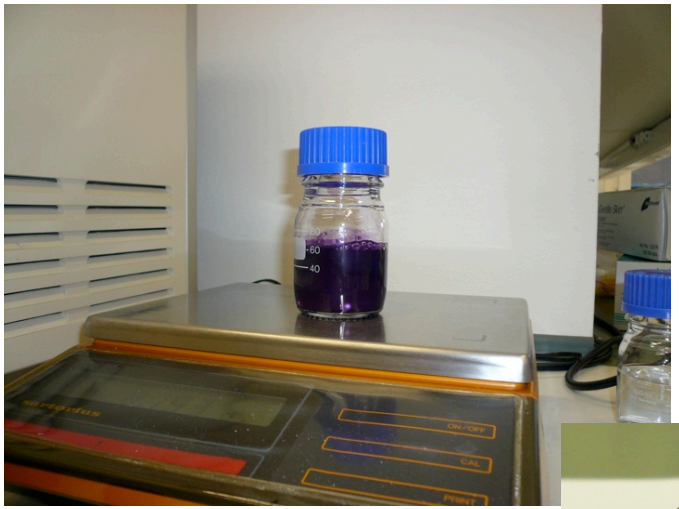
mostly scattering from Protons
incoherent scattering cross section
H: 80 x 10^{-24} cm^2
D: 2 x 10^{-24} cm^2

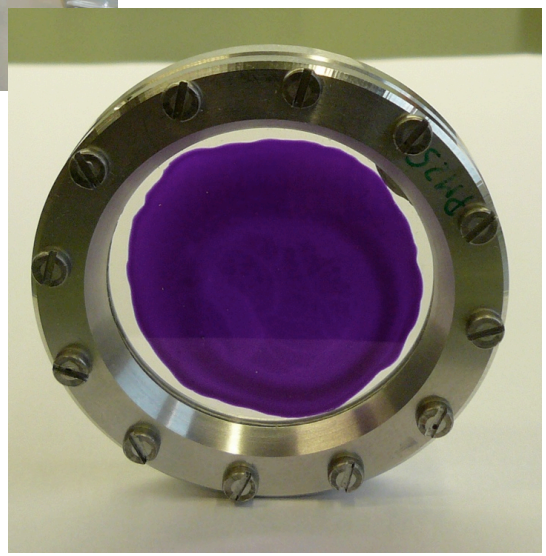
stochastic
diffusive
quasi-diffusive
motions (nm range)

with characteristic time scale
in the ps to ns range

Example: Quasielastic- and Inelastic Scattering

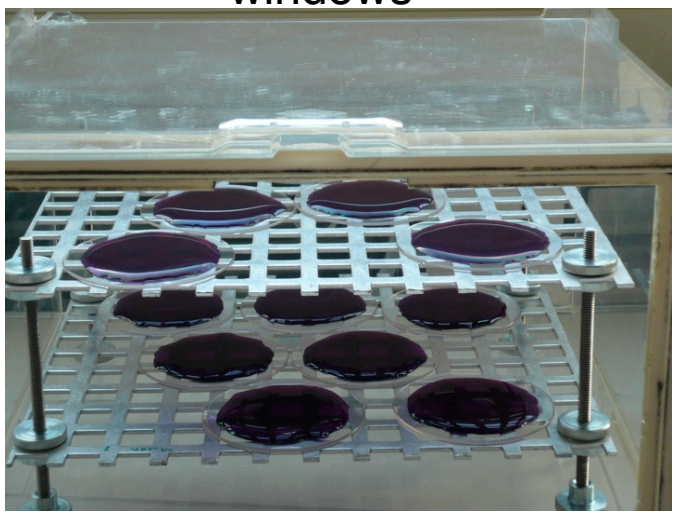
purple membranes in large amounts





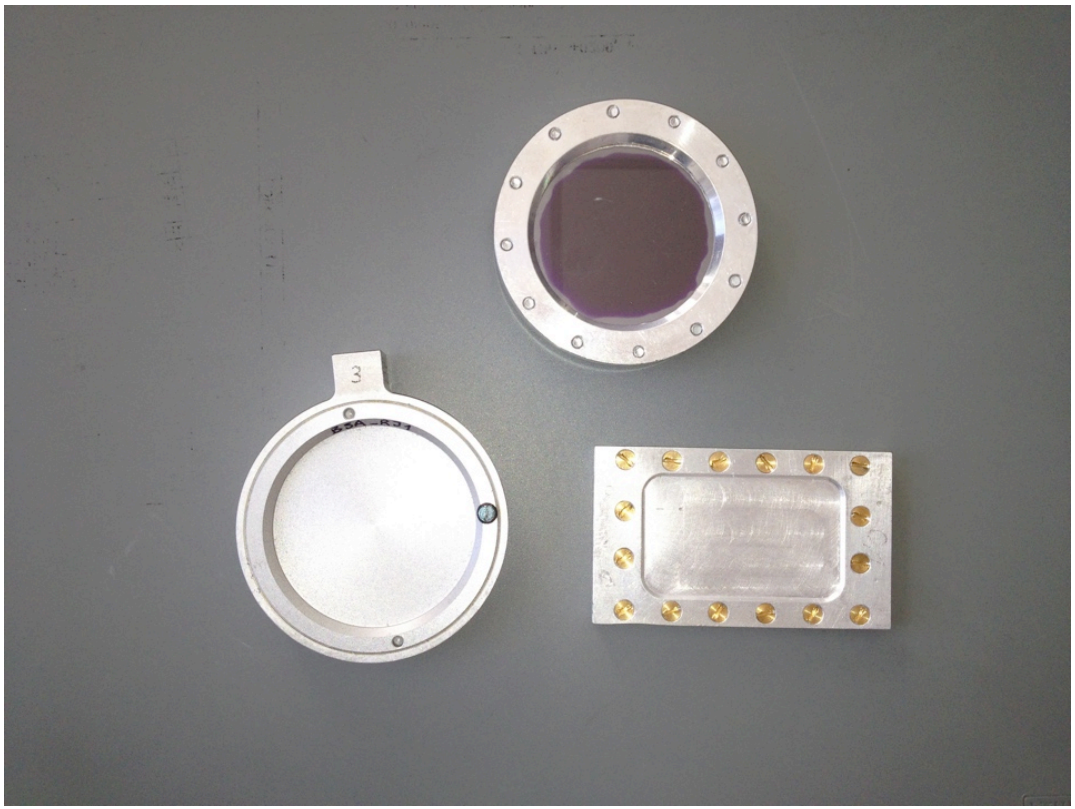
20 mg PM in D_2O at pD 6.6
equilibrated at 98% rH
OD ~ 3

equilibrating PM films on sapphire windows



Example: Quasielastic- and Inelastic Scattering

other sample containers



Our demands on an excellent humidity chamber

- Long term stability in humidity and temperature
- Measurements up to 100% r.H (or as close as possible)
- Computer controlled setpoints of T and r.H.
- Ease of use

Thank You for Your Attention!

Scattering length of biological relevant elements

Element	σ [10^{-24} cm^2]	b [10^{-13} cm]	b [10^{-13} cm]	N
H	80.27	-3.74	2.8	1
D	2.05	6.67	2.8	1
C	0.001	6.65	16.8	6
N	0.5	9.36	19.7	7
O	0.0008	5.80	22.5	8
P	0.005	5.13	42.3	15
S	0.007	2.85	45.0	16
		neutrons	X-rays	

σ : incoherent scattering cross section

b : coherent scattering length