UNIVERSITY OF COPENHAGEN

Neutron reflectivity's day

Hanna Wacklin
ESS

Today you will learn about specular scattering and non-specular scattering.

Scattering length and contrast matching in Soft Matter.

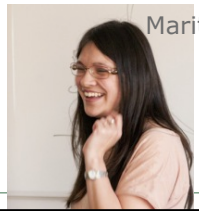
Theory of Reflection.

Tommy Nylander
LU

Optics apply to Light, Neutrons and X-rays are all waves. Reflect over the different information that can be extracted from each of these waves

Learn to READ a reflectivity curve

Some cases in neutron reflection.



Marité Cárdenas
KU

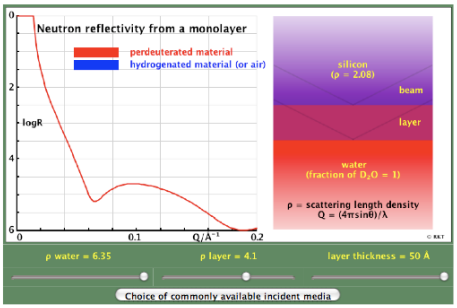
Summer School 2013
Marite Cardenas HCØ D312

UNIVERSITY OF COPENHAGEN

Faculty of Science

What is reflectivity?

Reflectivity refers to the fraction of incident radiation (amplitude) that is reflected by a surface.



Why is reflectivity interesting for us?

Reflectivity reveals interfacial structure
- air-water
- air-solid
- solid-liquid

1. Layer thickness
2. Layer composition
3. In plane structure

Summer School 2013
Marite Cardenas HCØ D312

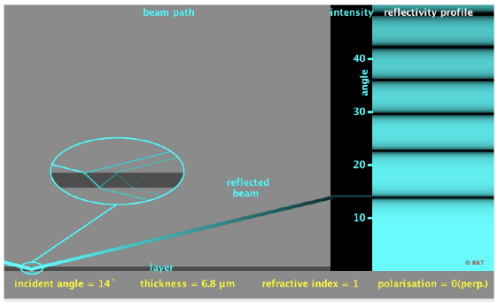
Light, X-rays and Neutrons can be treated as waves: Same principles apply to any of them!

What are the advantages of X-rays and neutrons over light?

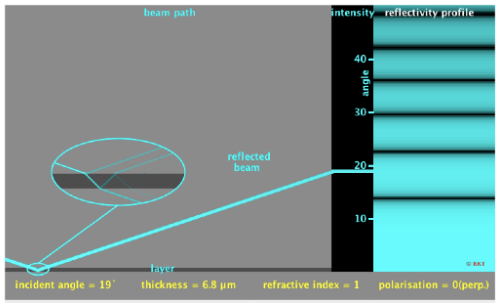
x-rays and neutrons have much shorter wavelength than light

-> they can explore much smaller spacing (of the order of molecular dimensions).

UNIVERSITY OF COPENHAGEN

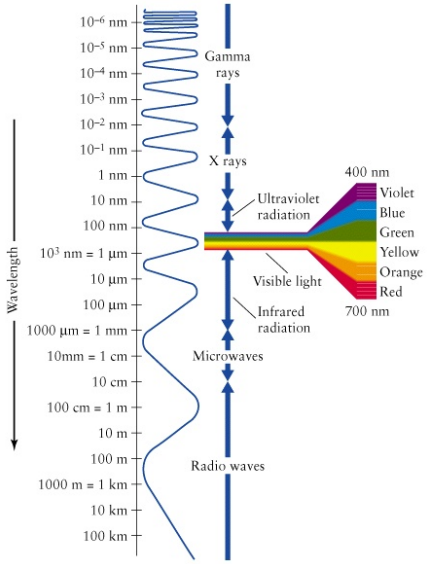


Taken from http://rktchem..ox.ac.uk/research.html



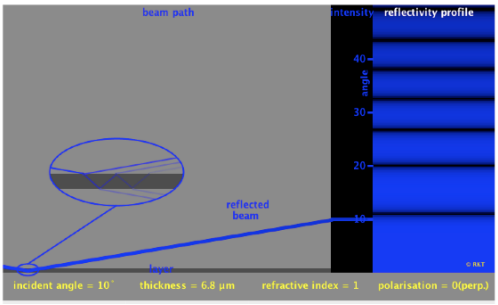
Taken from http://rktchem..ox.ac.uk/research.html

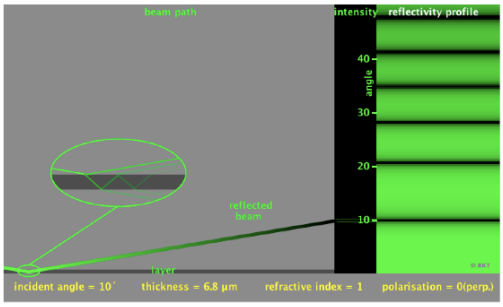
Or take advantage of radiation wavelength



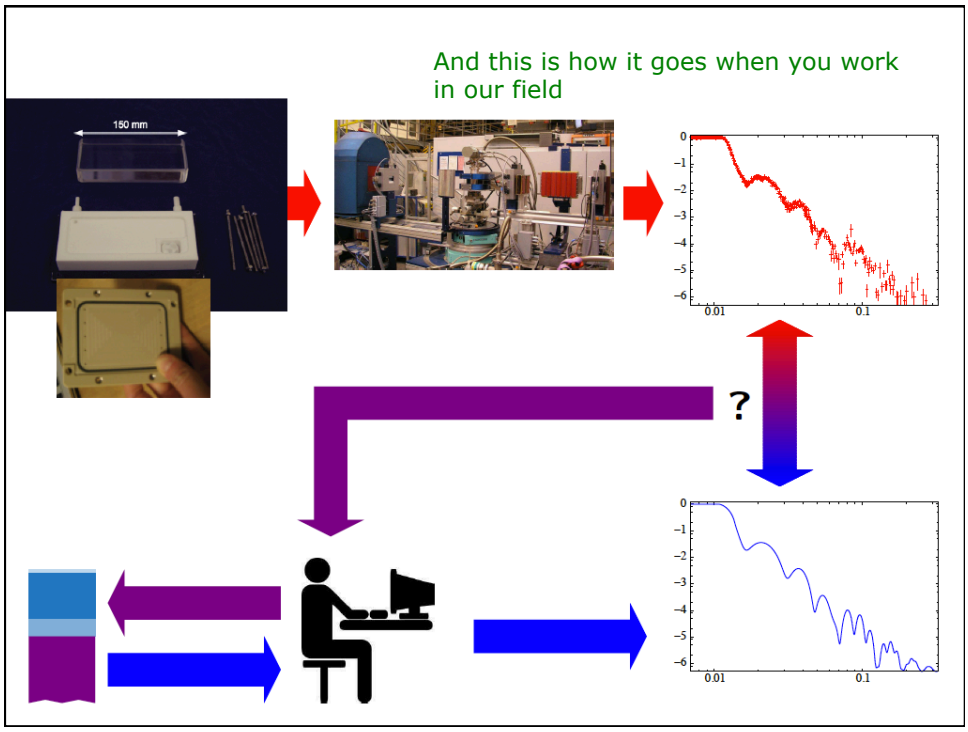
Neutrons do have different energies, right?

$q_z = 4 \pi / \lambda * \sin\theta$





Taken from http://rktchem..ox.ac.uk/research.html



The refractive index

The real part can be expressed as:

$$n = 1 - \lambda^2/2\pi * \rho$$

For X-ray,

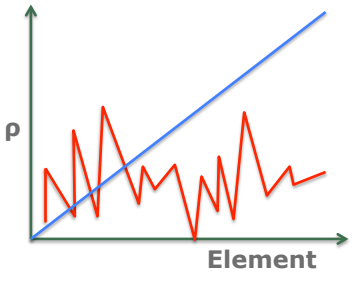
$\rho = \Sigma\, n_i\, f_i\, e^2 / mc^2$

f_i is the atomic factor for specie I

For Neutron,

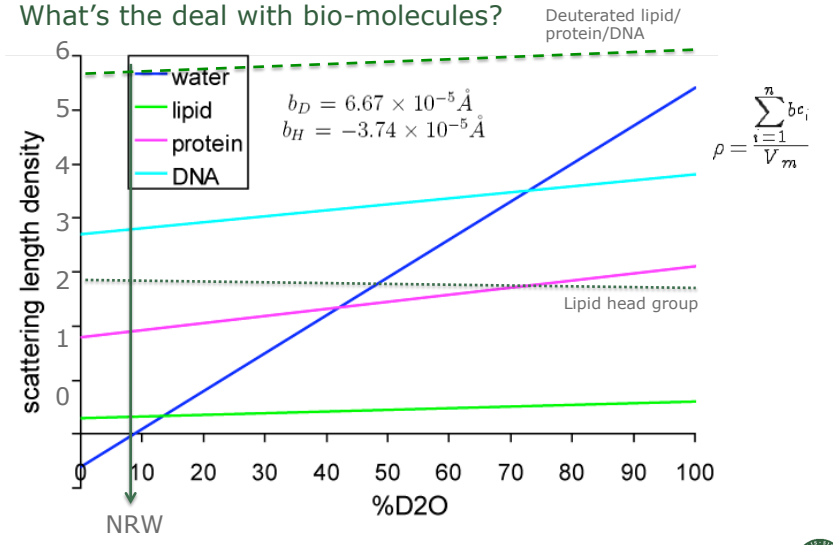
$\rho = \Sigma\, n_i\, b_i$

n_i is the number density for the nuclear specie i
b_i is the scattering length of nuclear specie i



UNIVERSITY OF COPENHAGEN

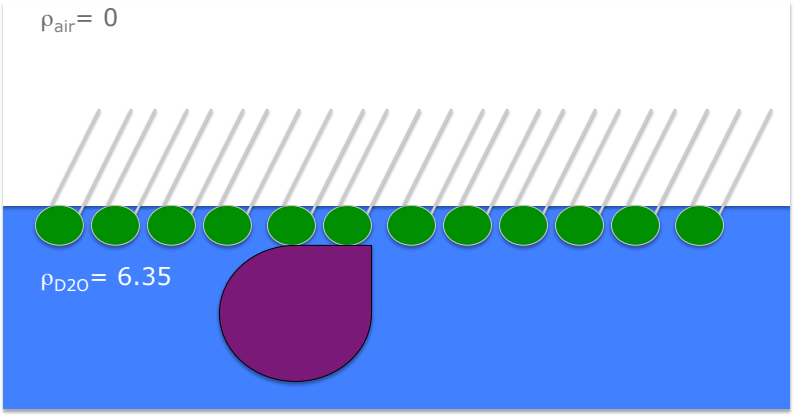
What's the deal with bio-molecules?



WHY such dependency for protein/DNA as compared to lipid? H/D exchange!

UNIVERSITY OF COPENHAGEN

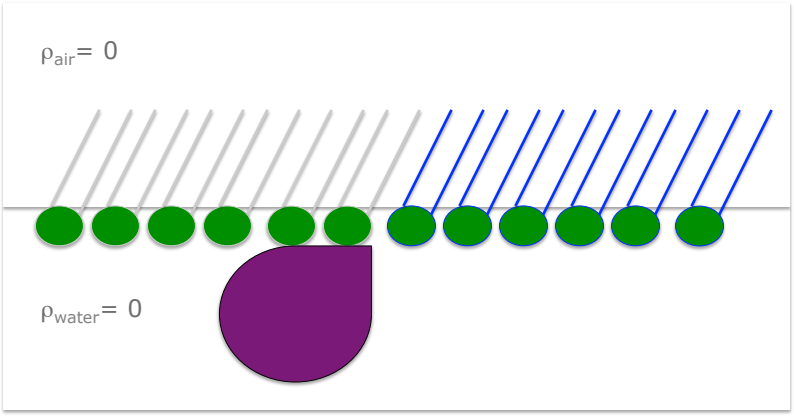
The art of contrast matching



ρ_{water} can be adjusted by the ratio of H_2O/D_2O. The lipid chain can also be fully or partially deuterated.

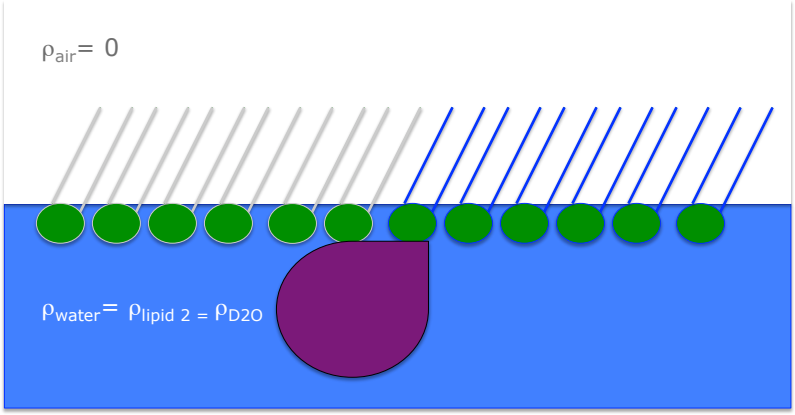
UNIVERSITY OF COPENHAGEN

The art of contrast matching

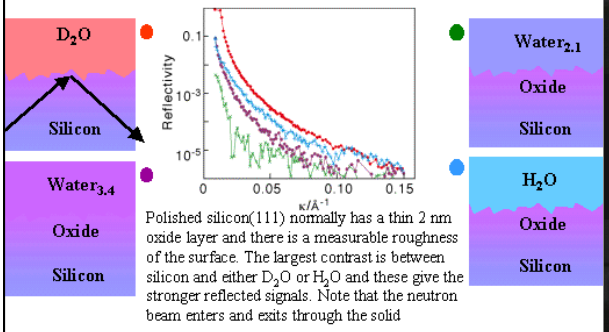


UNIVERSITY OF COPENHAGEN

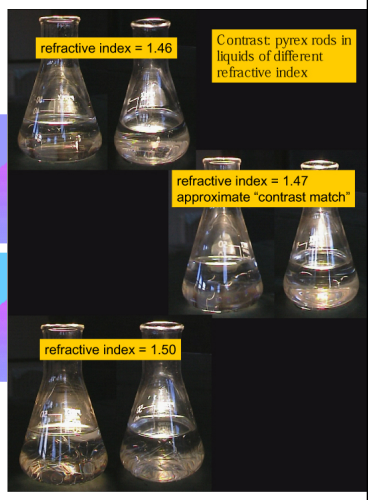
The art of contrast matching



The art of contrast matching



Polished silicon(111) normally has a thin 2 nm oxide layer and there is a measurable roughness of the surface. The largest contrast is between silicon and either D_2O or H_2O and these give the stronger reflected signals. Note that the neutron beam enters and exits through the solid



Taken from http://rktchem..ox.ac.uk/research.html

SO NOW YOU SHOULD BE READY FOR THE REAL STUFF!