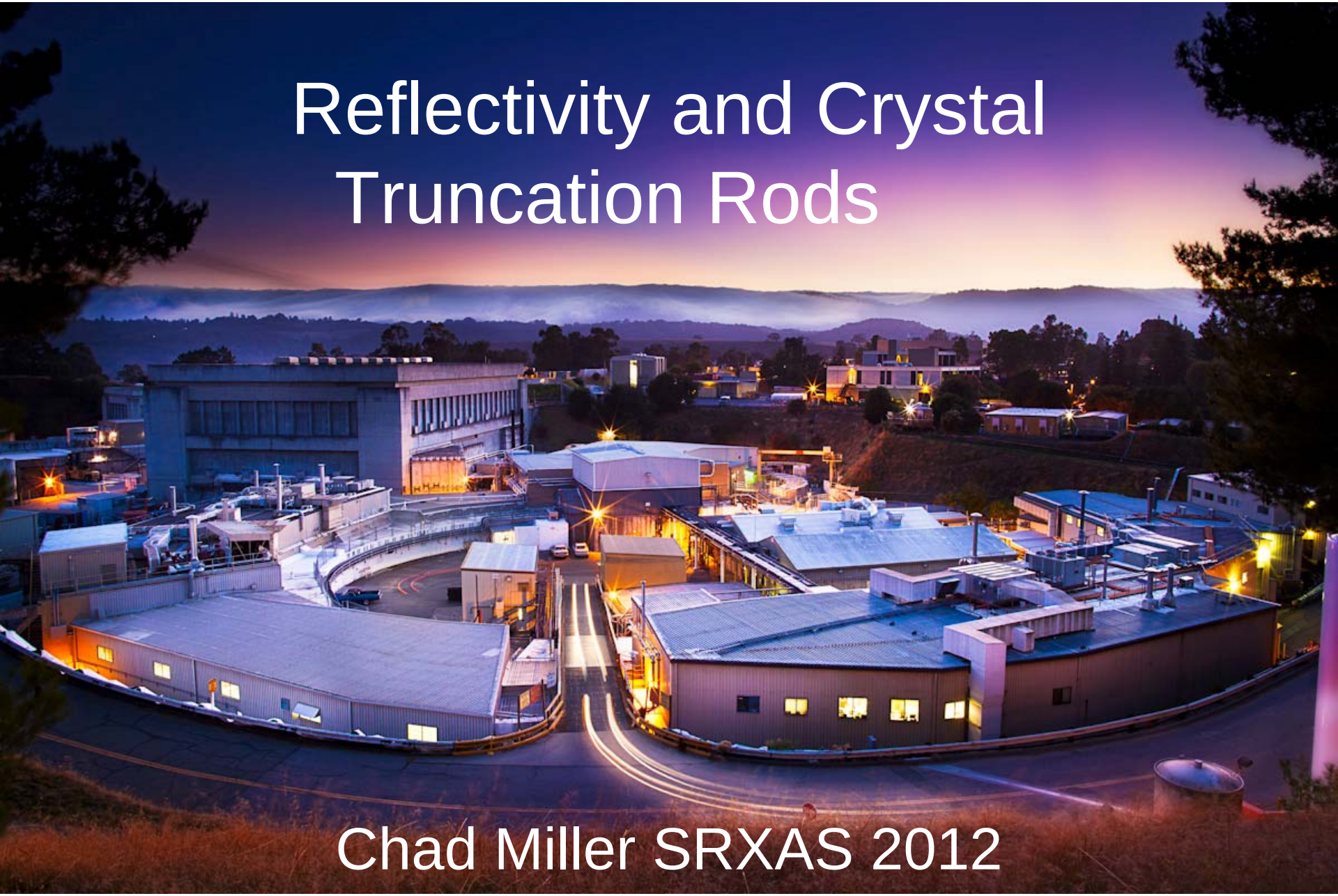

Reflectivity and Crystal Truncation Rods
Chad Miller SRXAS 2012

Reflectivity

Out-of-plane structure

Measures average density structure **normal** to the interface.
(layer thickness, density and roughness)

Need a very smooth surface

Crystal Truncation Rods

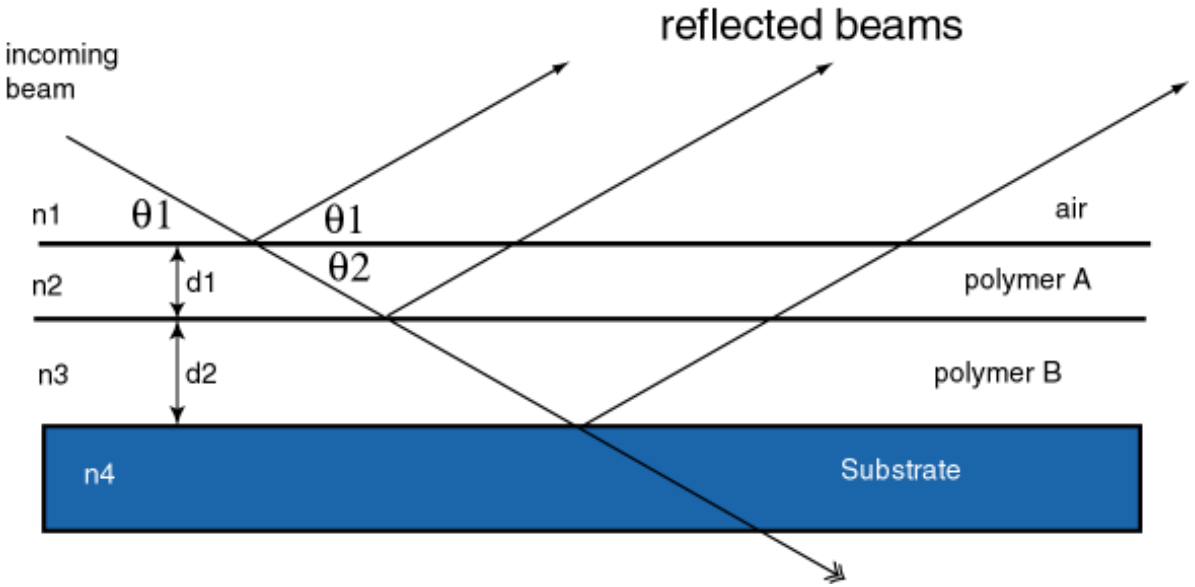
In-plane structure

Surface (Bragg) diffraction

Measures structure that is in registry with the substrate

Rod = intensity of Bragg peak as a function of qz.

Principles of Reflectometry



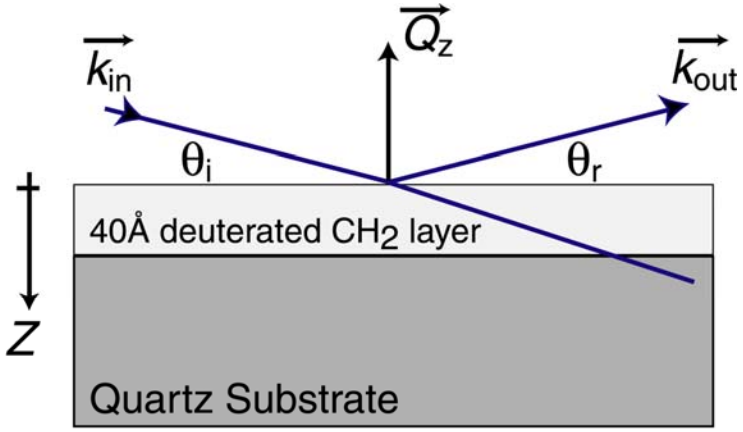
Thin film interference

Optical analogue

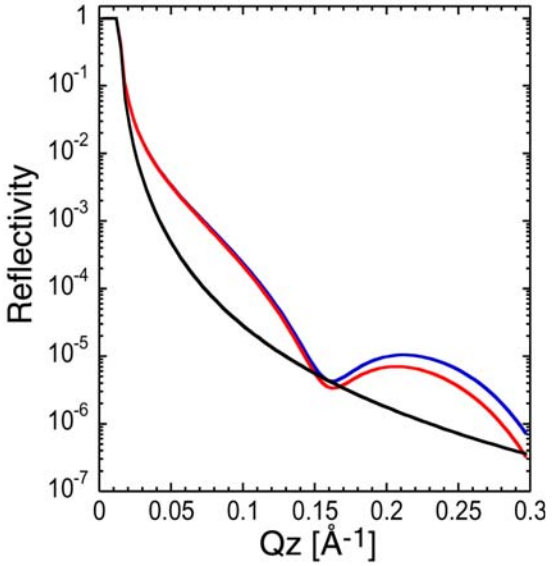
$n=1-\lambda^2\beta/2\pi$

β - scattering length density (SLD) of material

Neutron and X-Ray Reflectivity

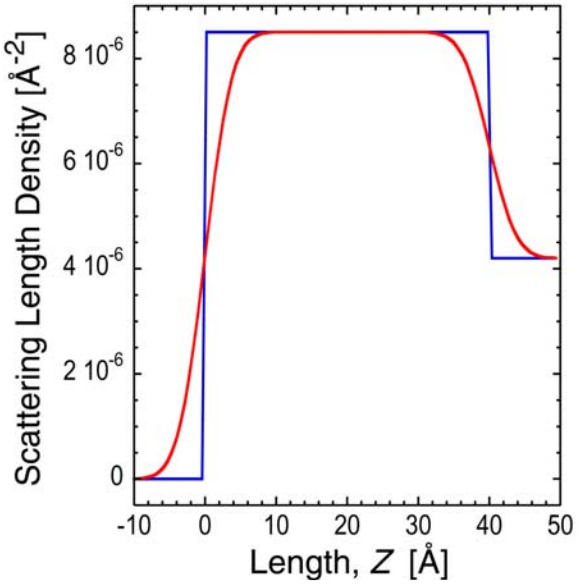


$$\theta i = \theta r$$



$$|\vec{Q}_z| = \frac{4\pi \sin[\theta i]}{\lambda}$$

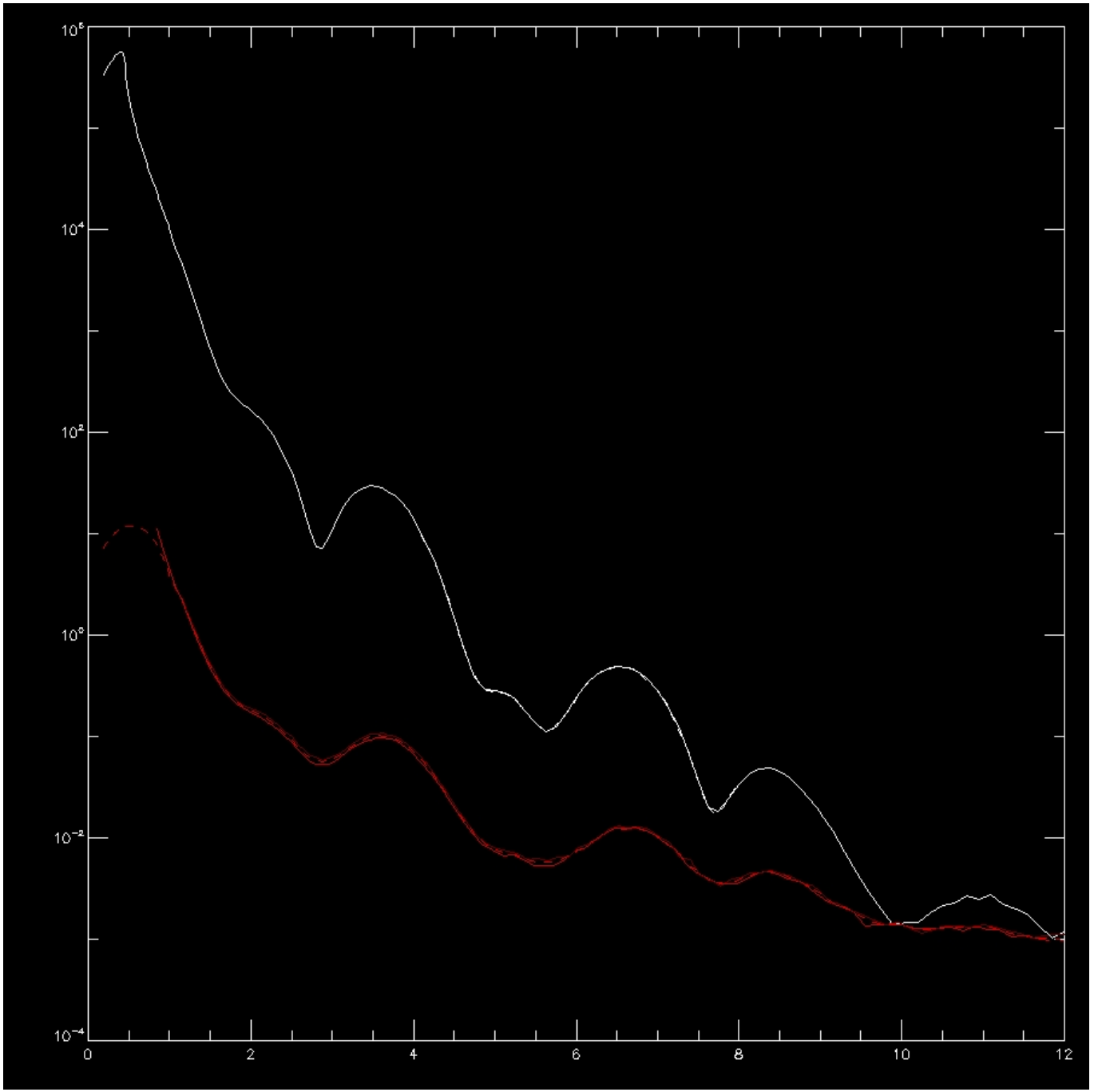
$$Q_z = k_{out} - k_{in}$$



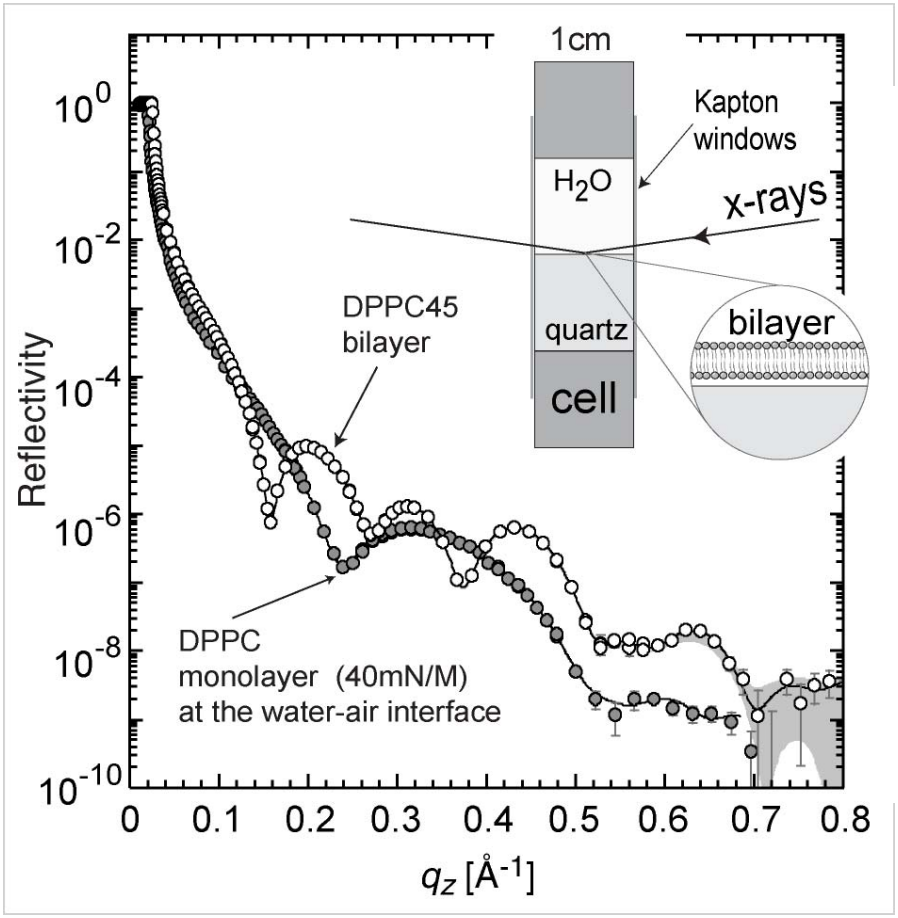
Measures:

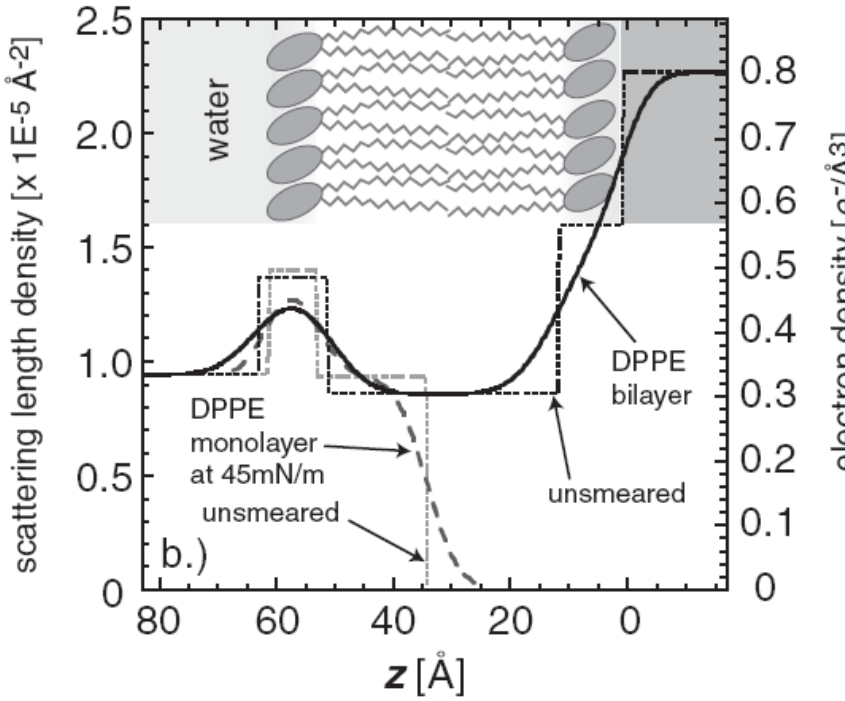
average density structure **normal** to the interface.

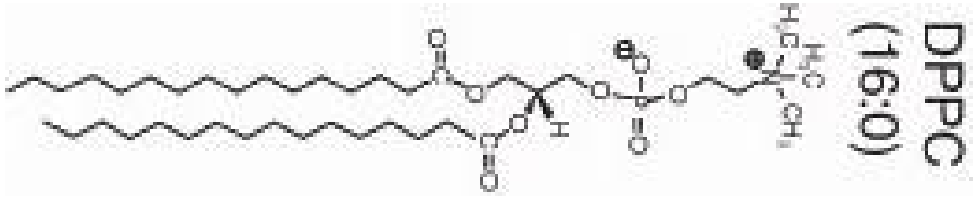
(layer thickness, density and roughness)


10^{5}
10^{4}
10^{2}
10^{0}
10^{-2}
10^{-4}
0
2
4
6
8
10
12

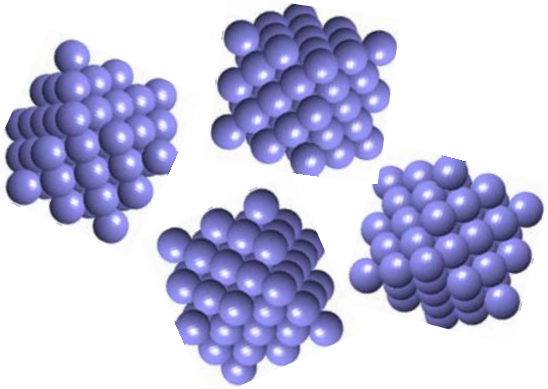
REFL: Lipid monolayer vs. bilayer



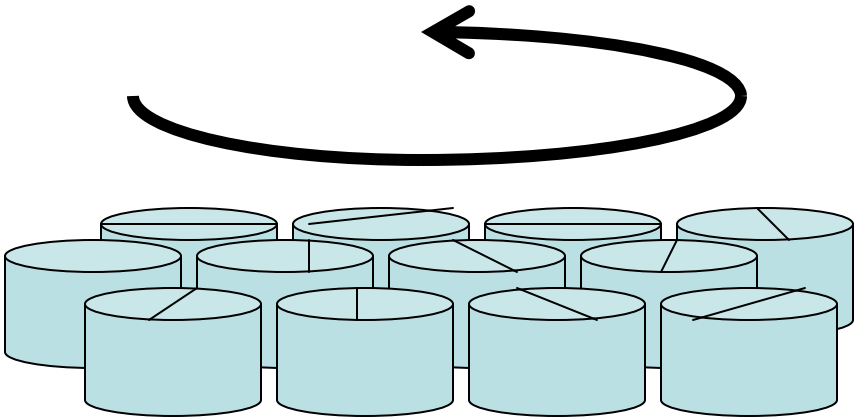




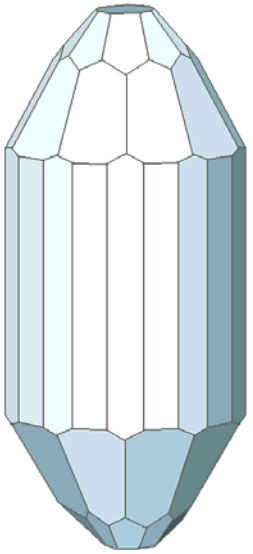
3D vs. 2D powders vs. single crystals



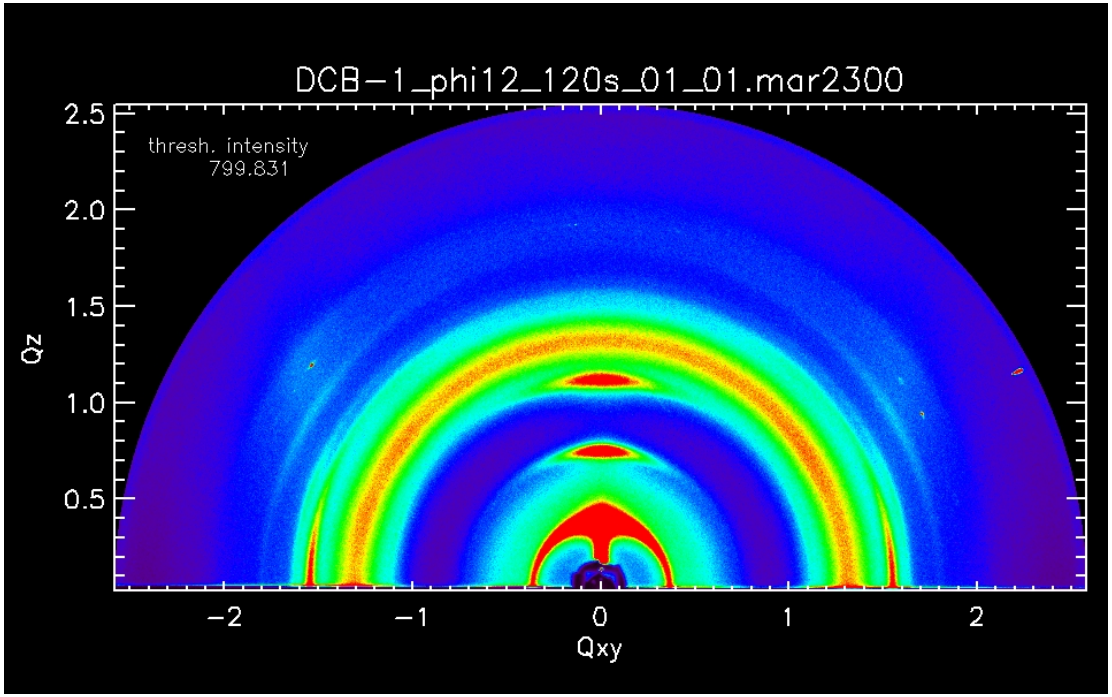
“3D Polycrystalline Powder”



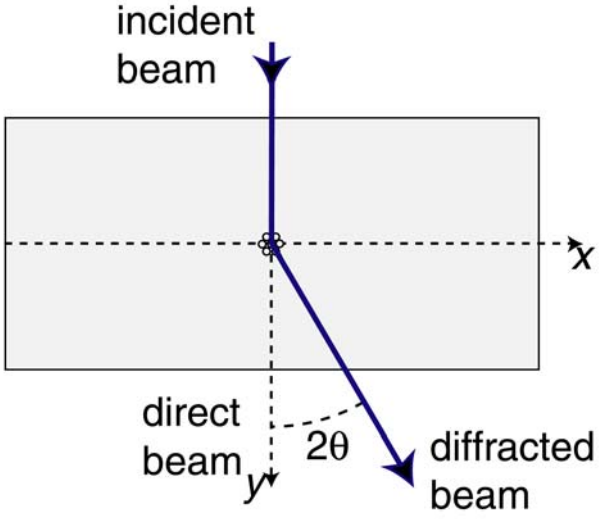
“2D Polycrystalline Powder”

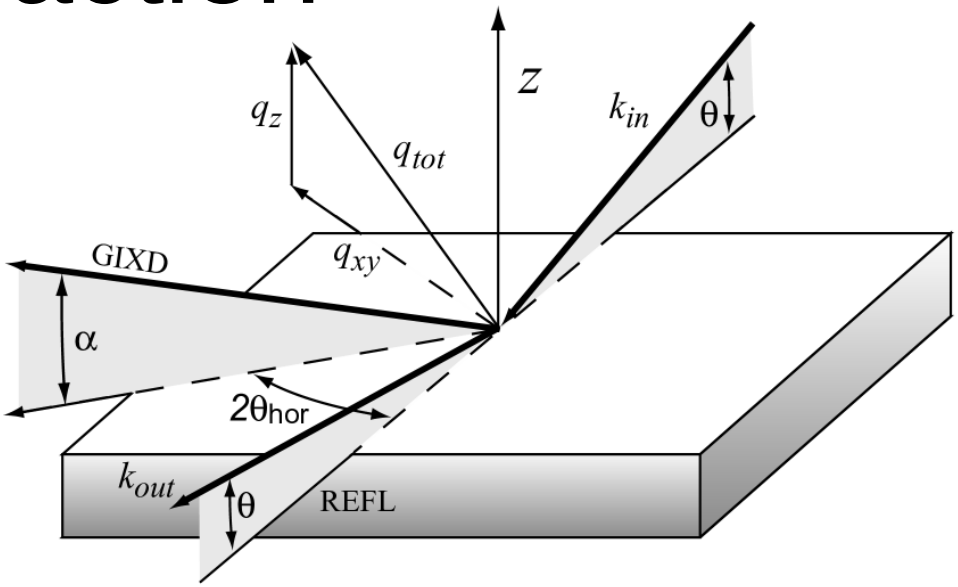


single



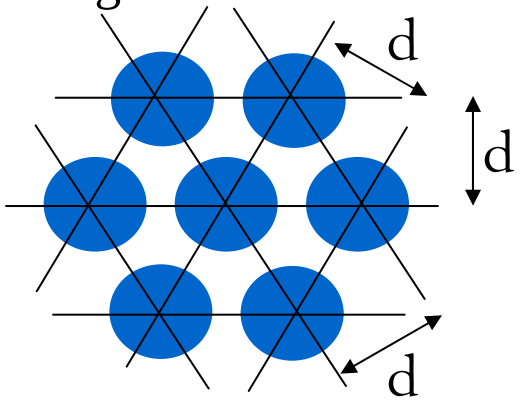
X-ray Grazing Incidence Diffraction



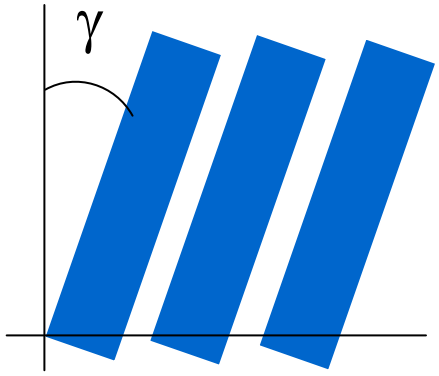


Hexagonal Unit Cell

Top View

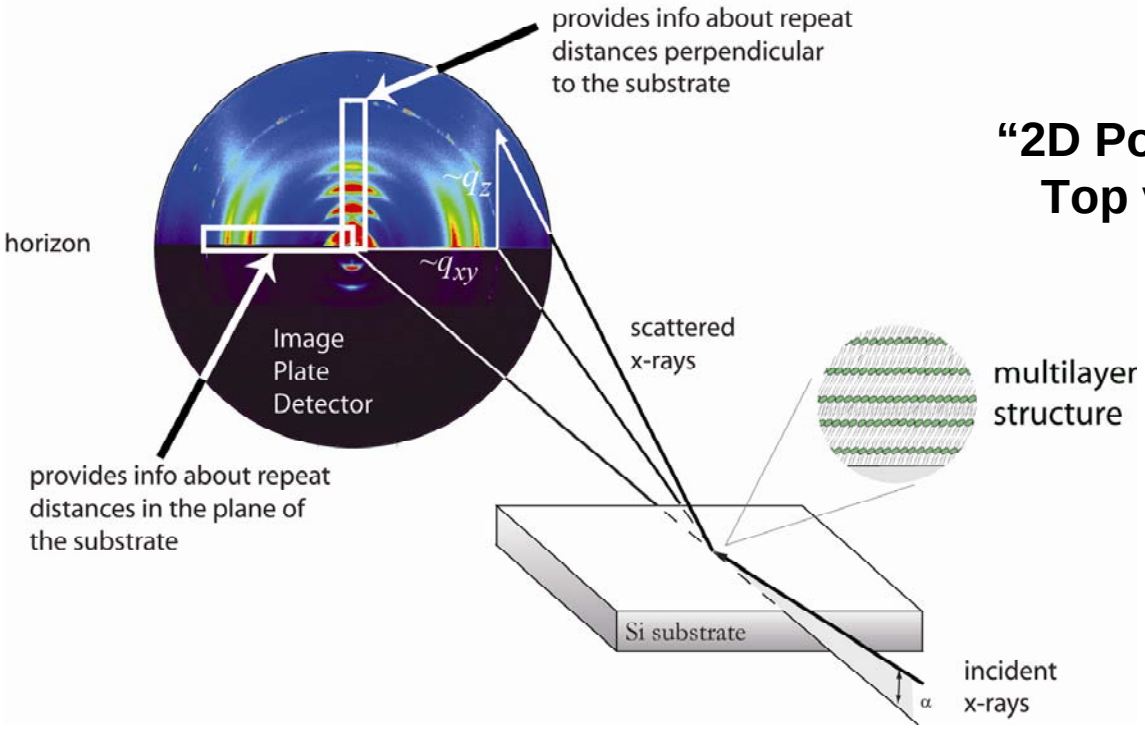


Side View

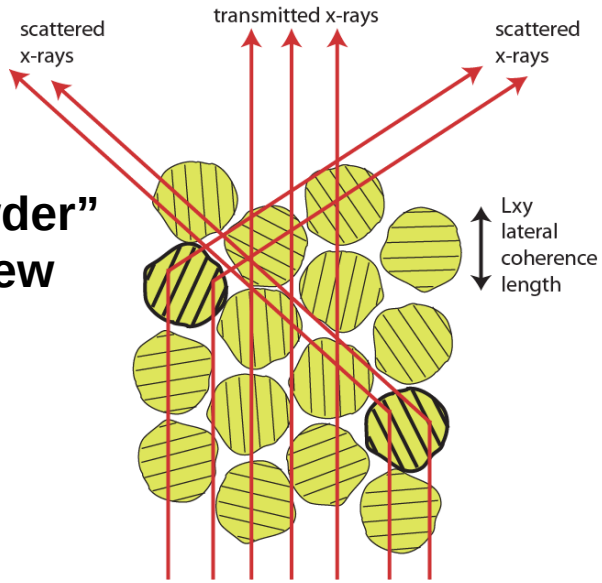


Grazing Incidence X-Ray Diffraction (GIXD)

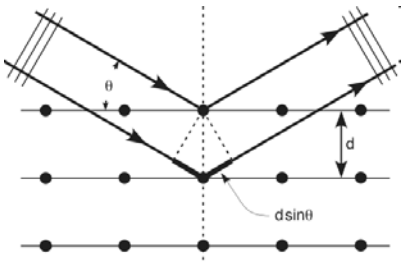
GIXD can provide information about any lateral or normal ordering within the system. For the GIXD experiments, the x-ray beam was adjusted to strike the surface at a grazing angle incident angle.



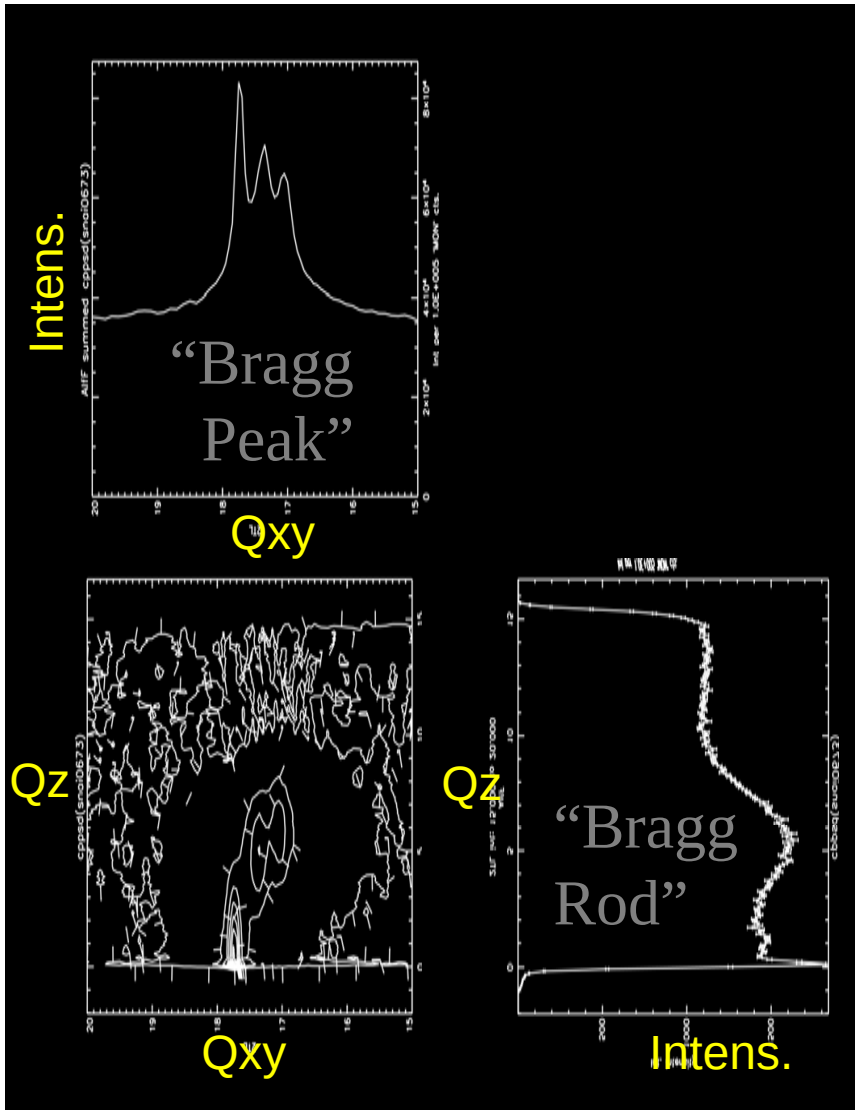
"2D Powder" Top view



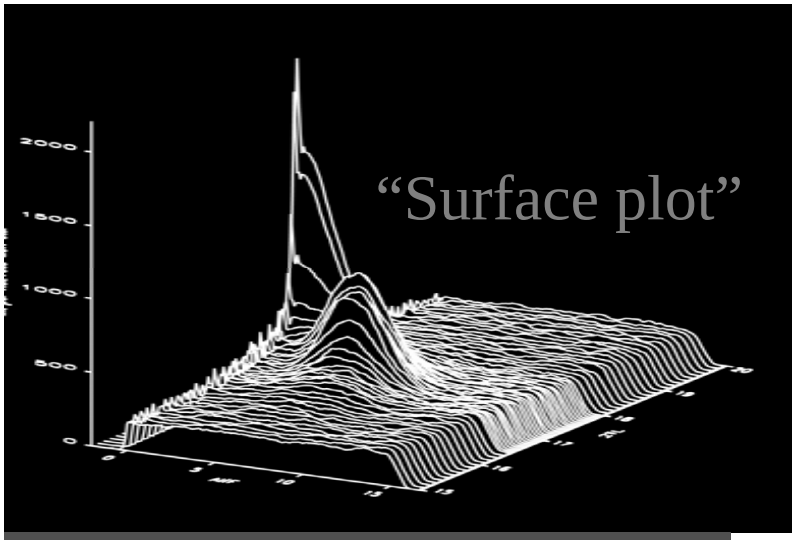
Bragg Diffraction

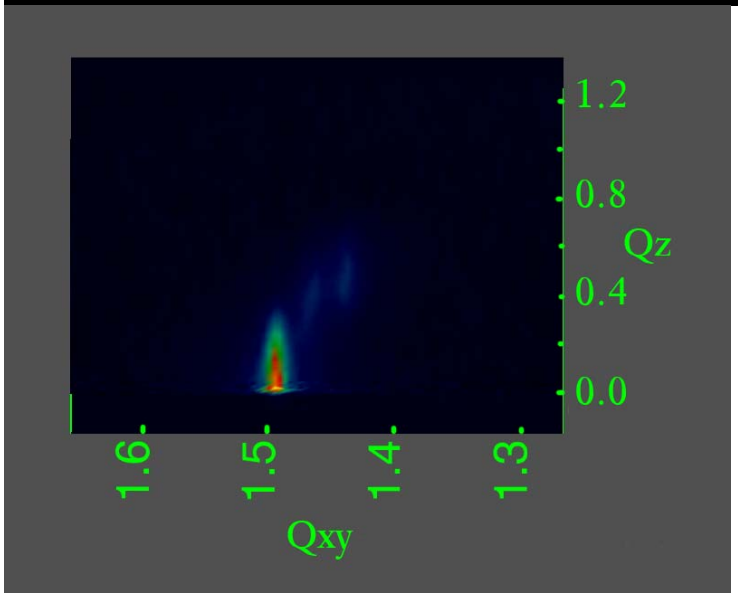


Typical GID Data: Lipid Monolayers at the Air-Water Interface



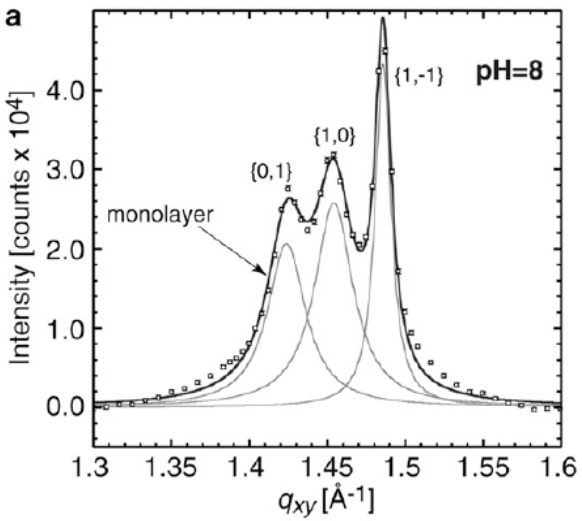
"Contour Plot"

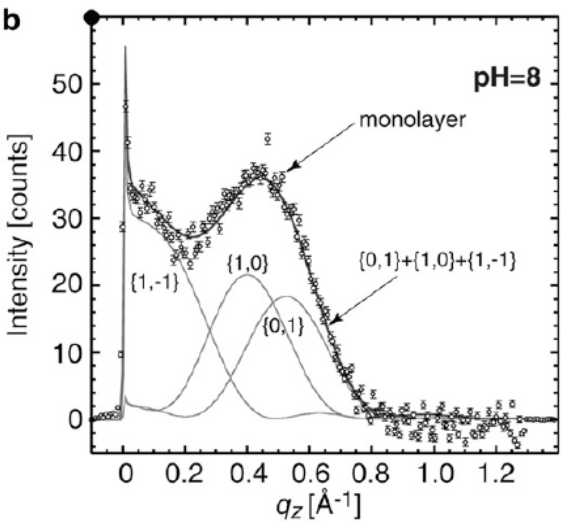


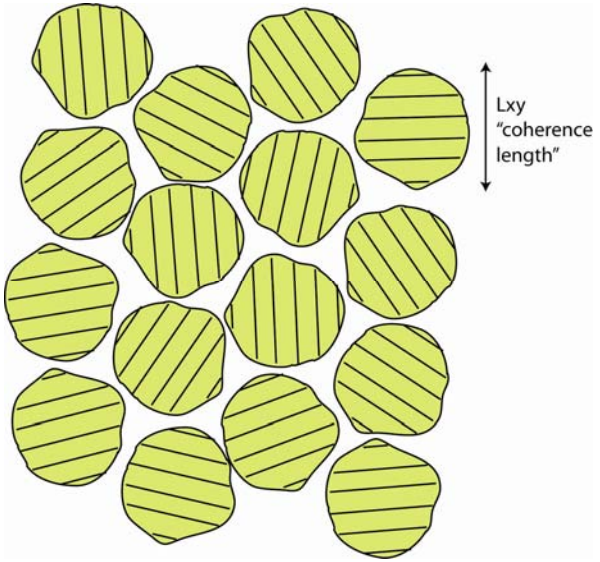


Peak

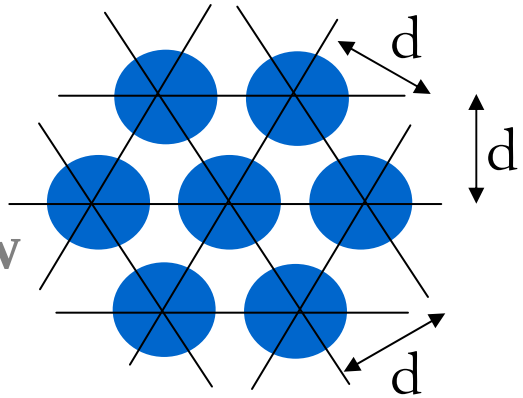
ROD



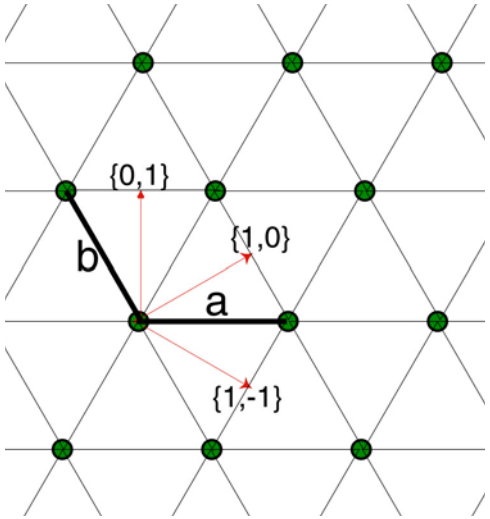




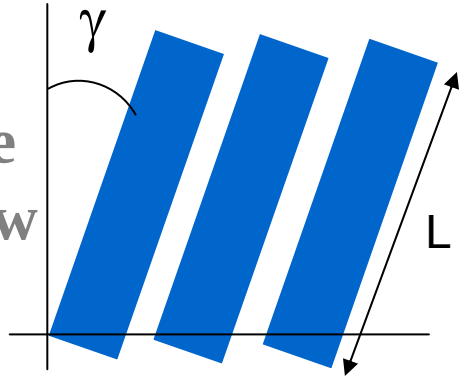
Oblique Unit Cell



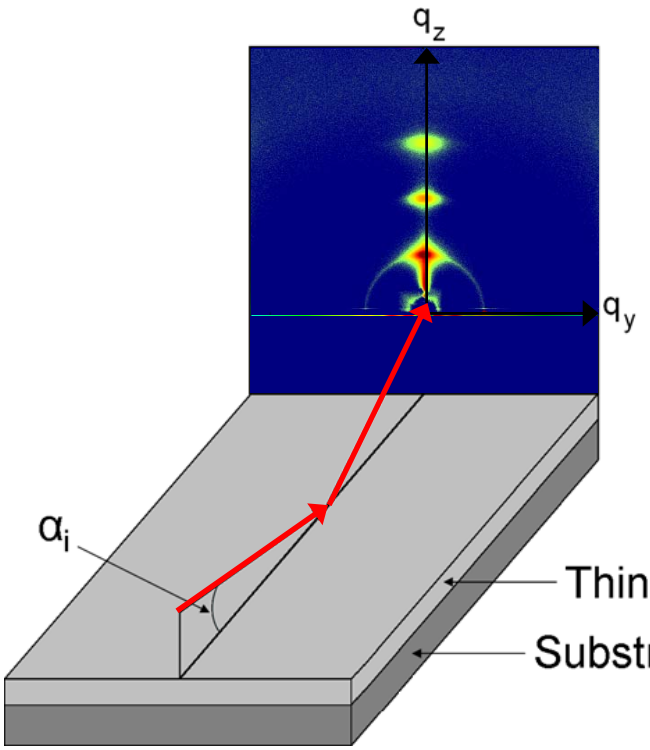
Top View

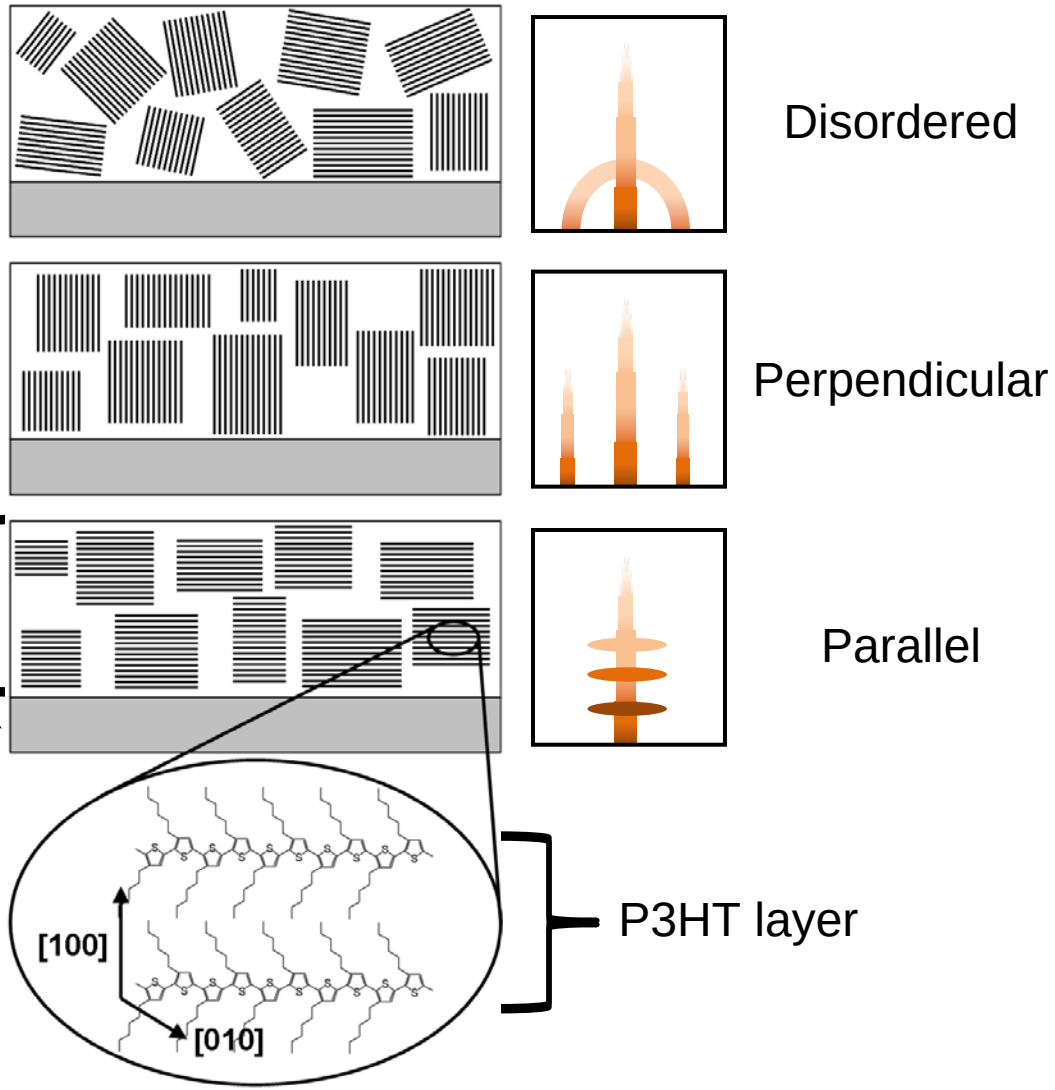


Side View



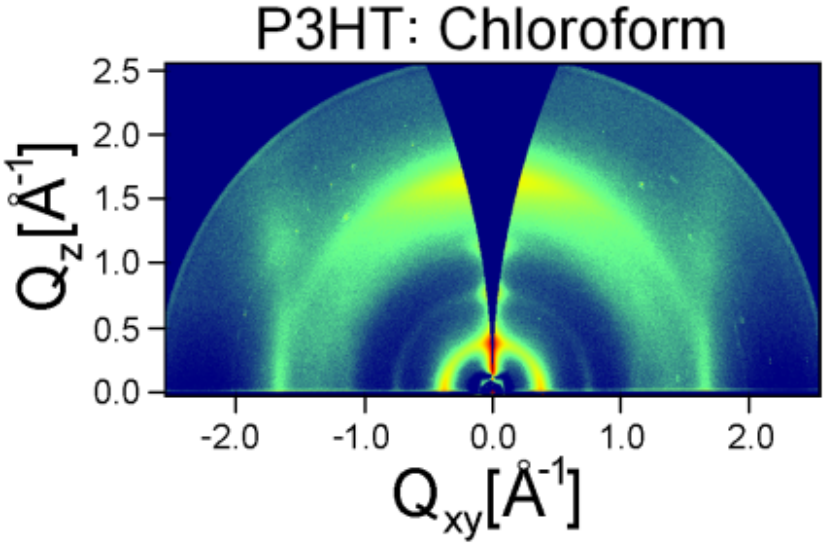
Grazing Incidence X-ray Scattering

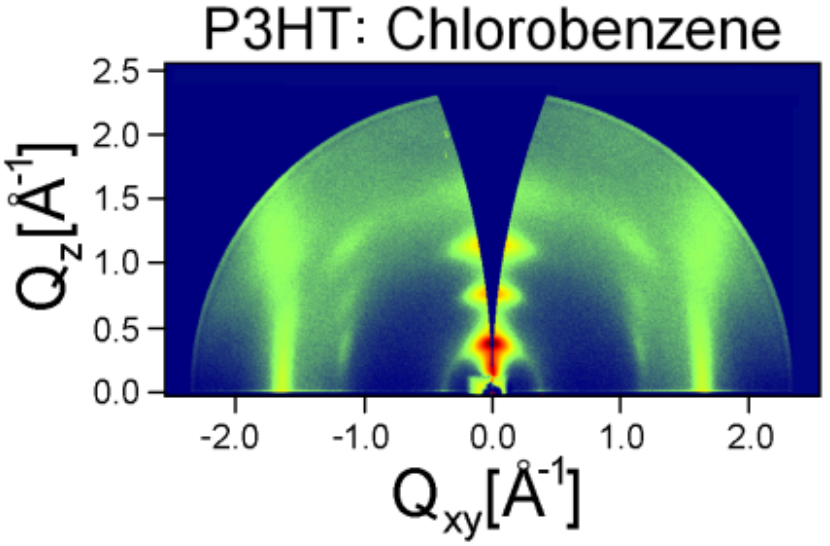


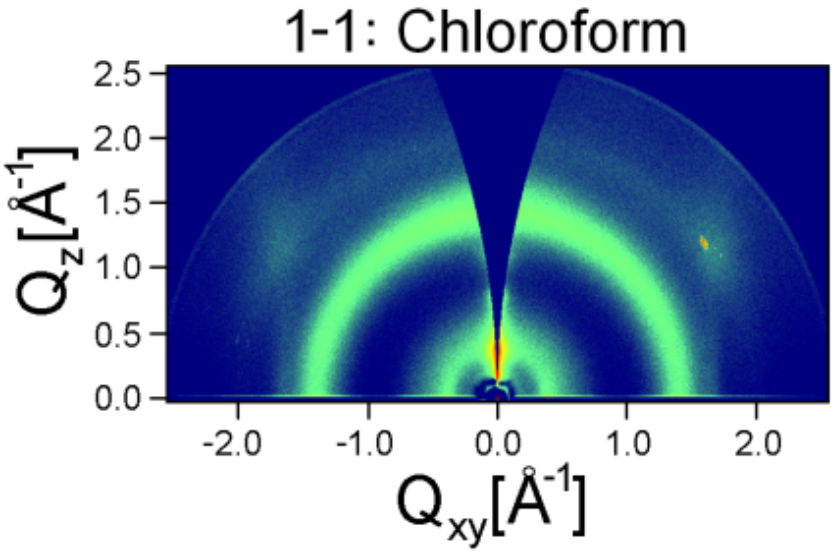


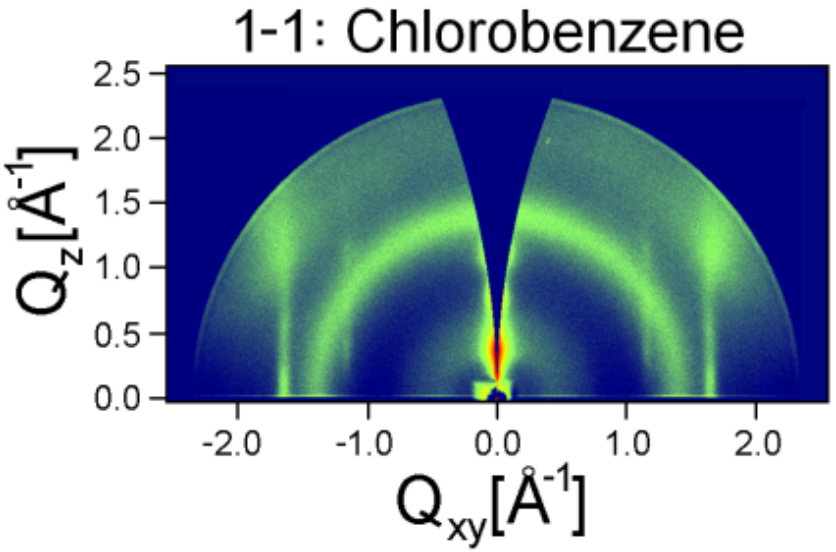
Smaller scattering angle
→ Larger features

Polymer Thin Films





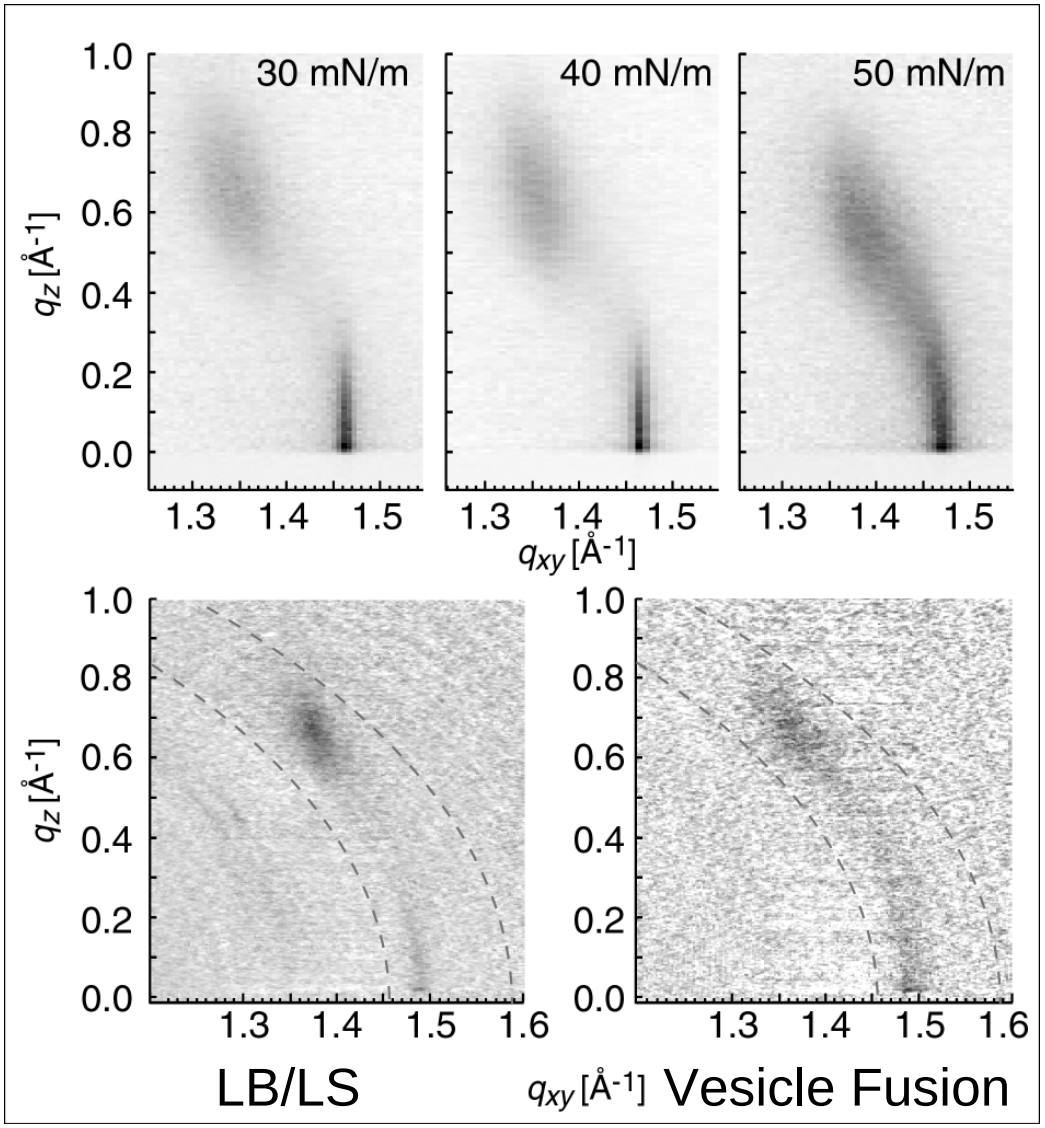


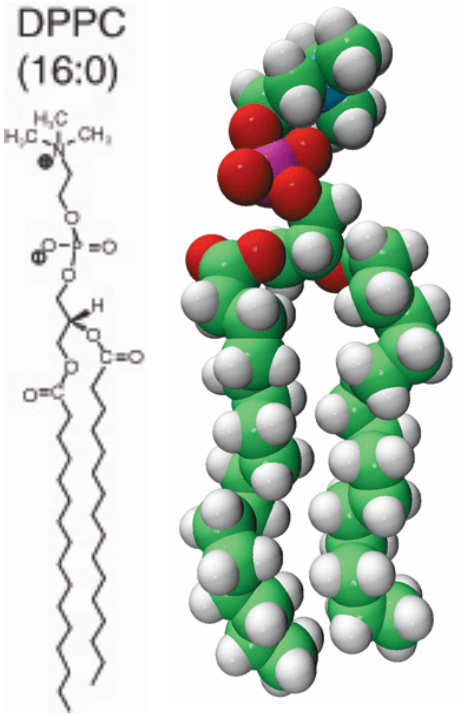


GIXD of DPPC Mono- and Bi-Layers

Mono-Layers
Air-Water
Interface

Bi-Layers
Solid-Liquid
Interface





DPPC Bragg Peaks