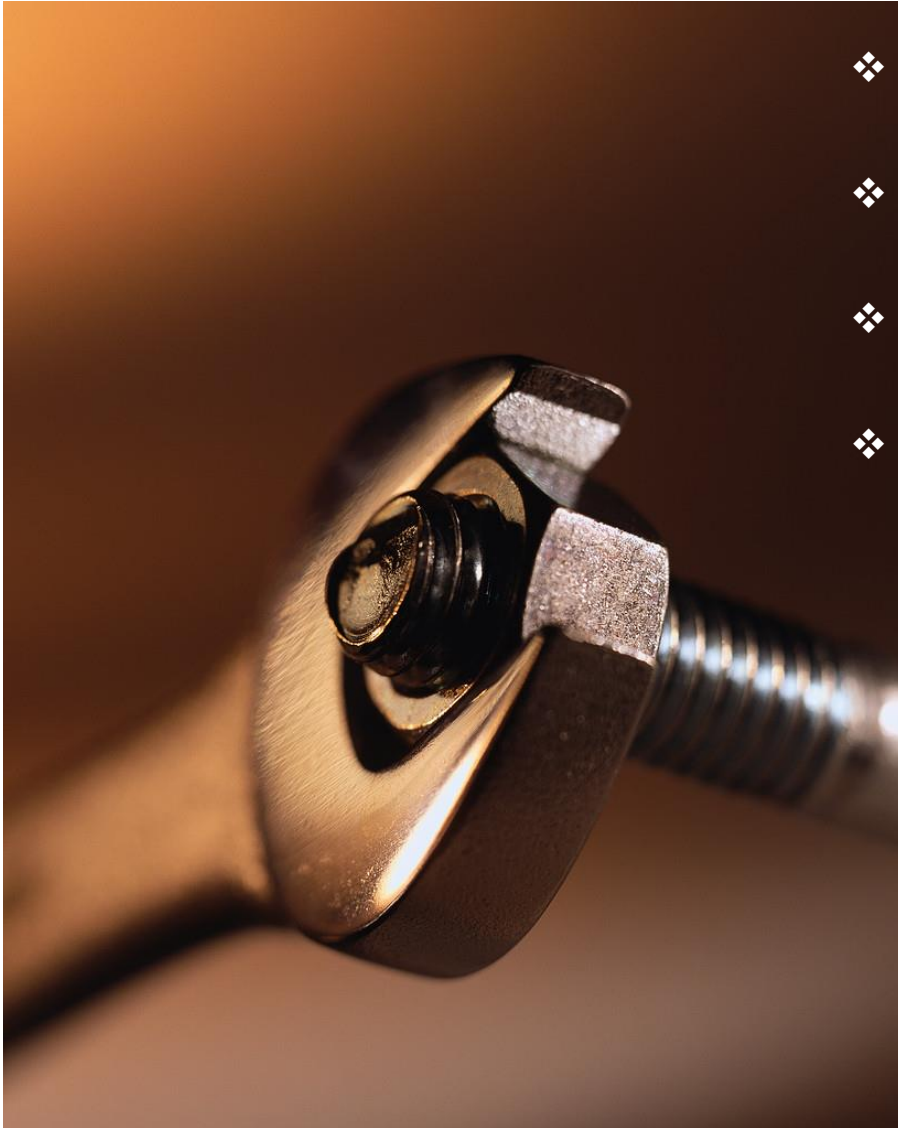




Analysing Nanostructures

Michael Rappolt

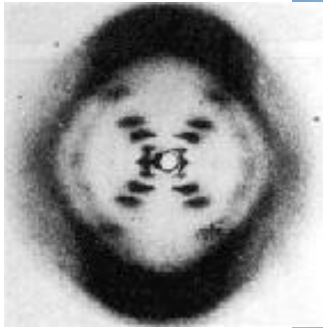
Tools for Analysing the Nano-World



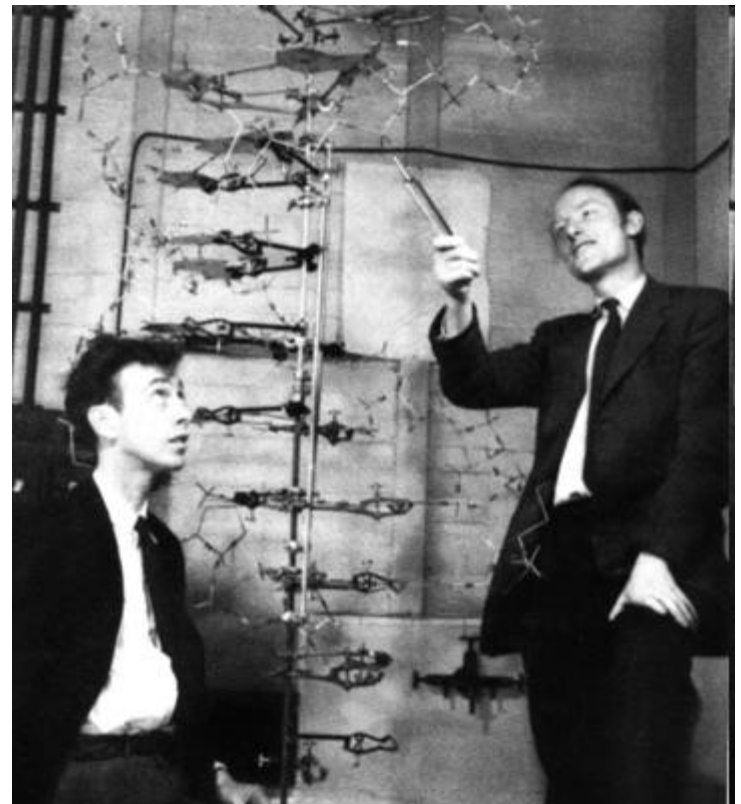
- ❖ Electron Microscopy (EM)
- ❖ Atomic Force Microscopy (AFM)
- ❖ X-ray Diffraction
- ❖ Small and Wide Angle X-ray Scattering



Discovery of the DNA Structure



Rosalind Franklin's
X-ray diffraction photograph
of DNA and **Watson and Crick** in front
of their DNA model, 1953

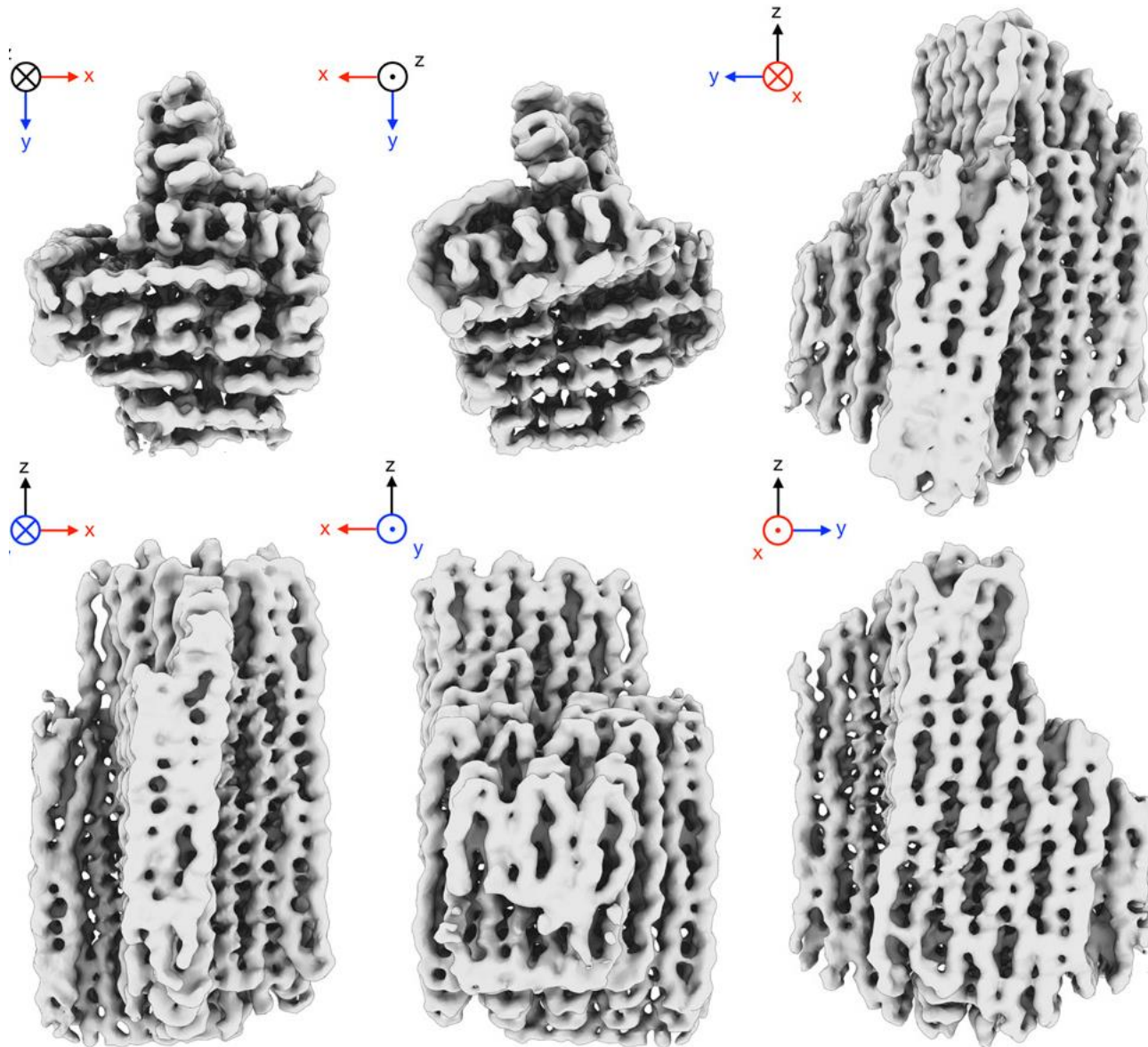


The Nobel Prize in Physiology or Medicine 1962
Francis Crick, James Watson, Maurice Wilkins



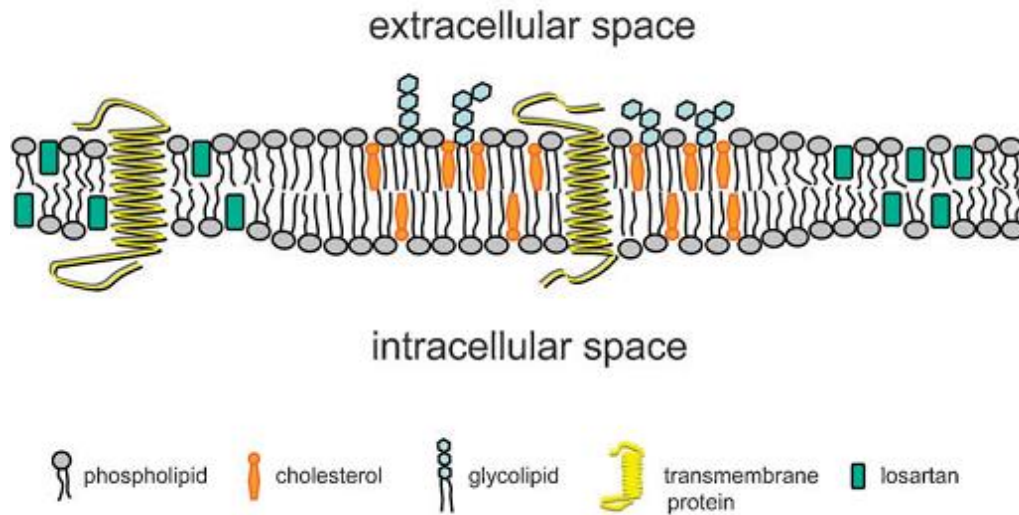
UNIVERSITY OF LEEDS

Electron Microscopy: DNA Origami

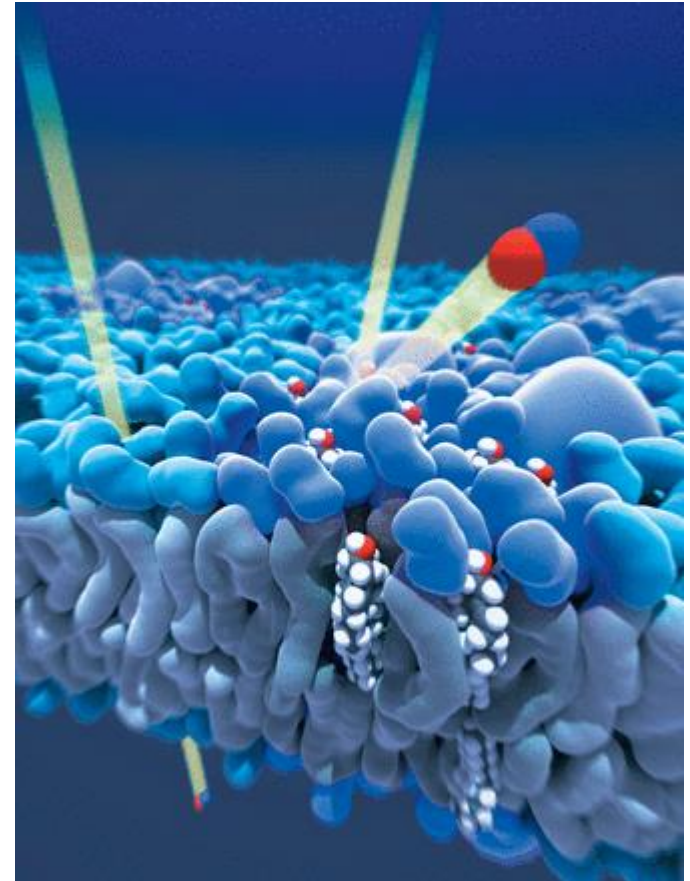


Bai, X. -C.; Martin, T. G.; Scheres, S. H. W.; Dietz, H. (2012). PNAS 109: 20012–20017

Membrane Rafts = Protein Platforms



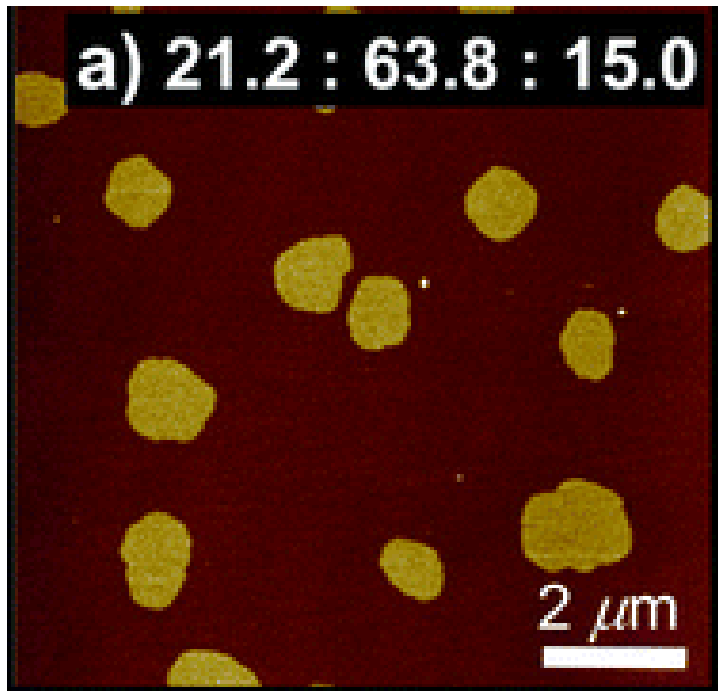
Hodzic, A., Zoumpoulakis, P., Pabst G., Mavromostakos, T., and Rappolt, M. (2012): PCCP 14



Cholesterol is enriched
in lipid raft microdomains

Miersch et al. (2008) JBC 283

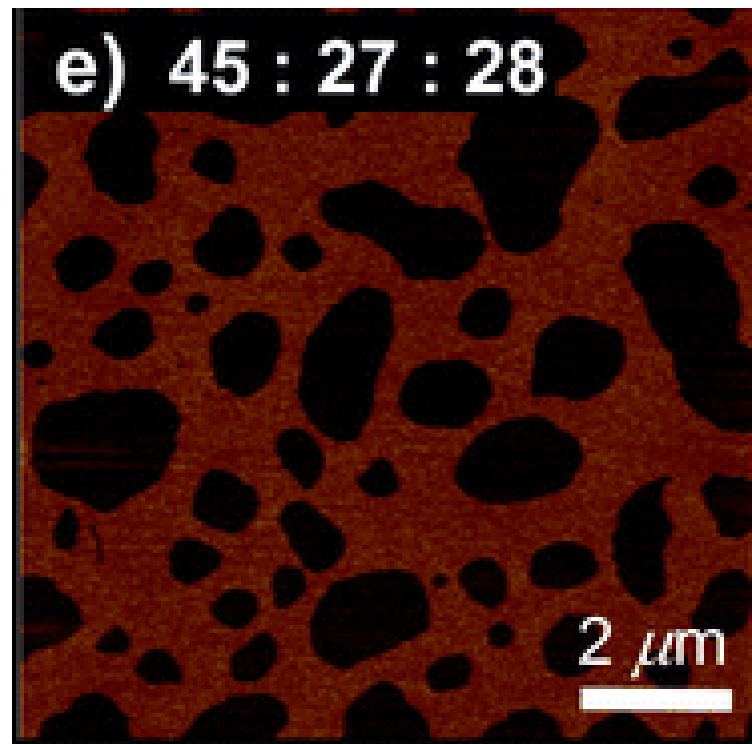
AFM: Looking at Membrane Rafts



SM/DOPC/Chol

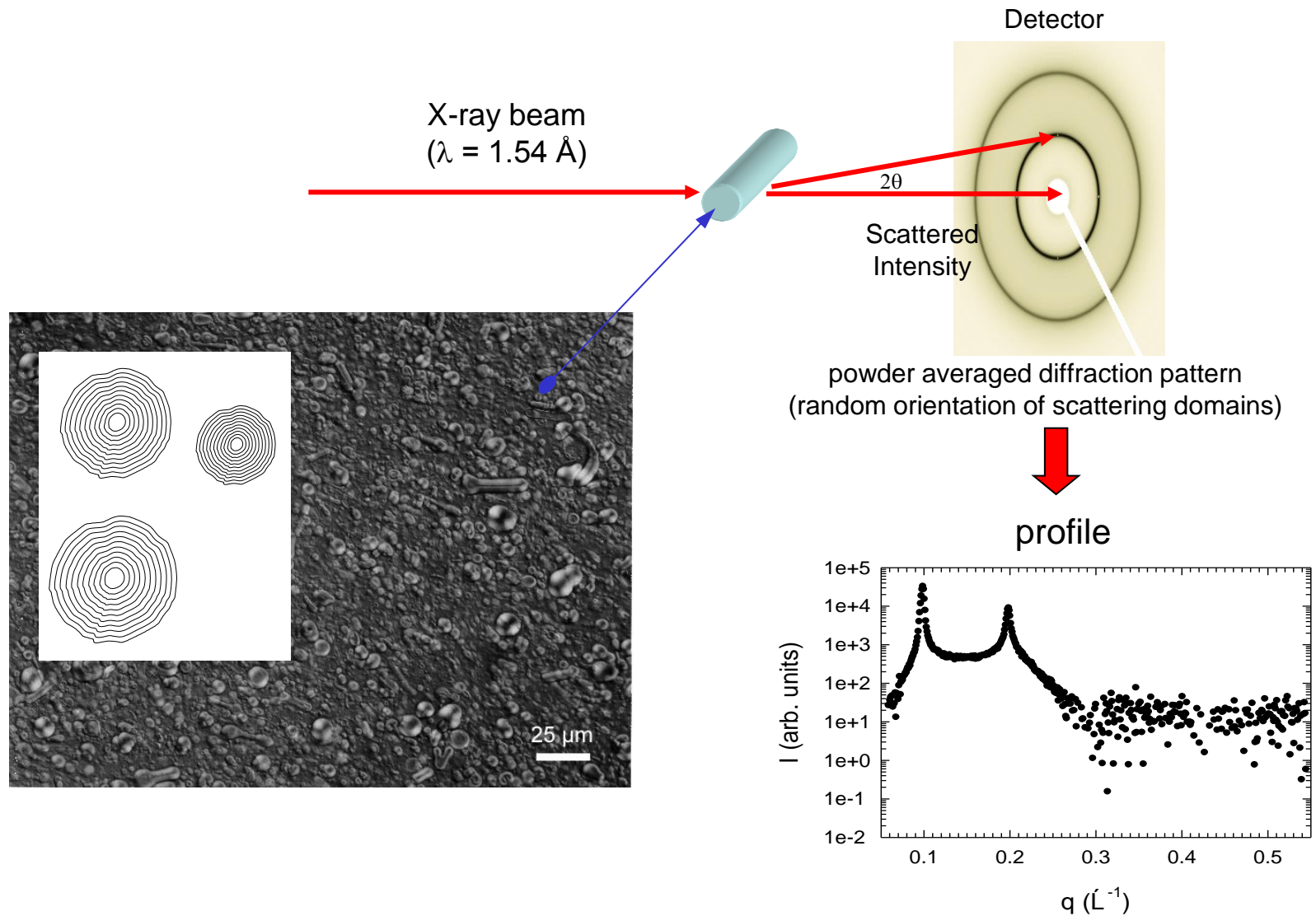
Mainly L_d phase (a)

Mainly L_o phase (f)

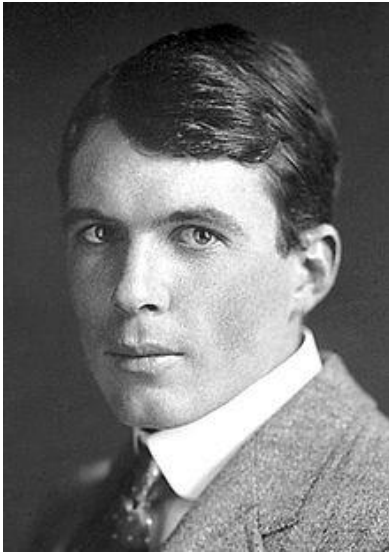


Simon Connell et al. 2013
Faraday Discussion 161

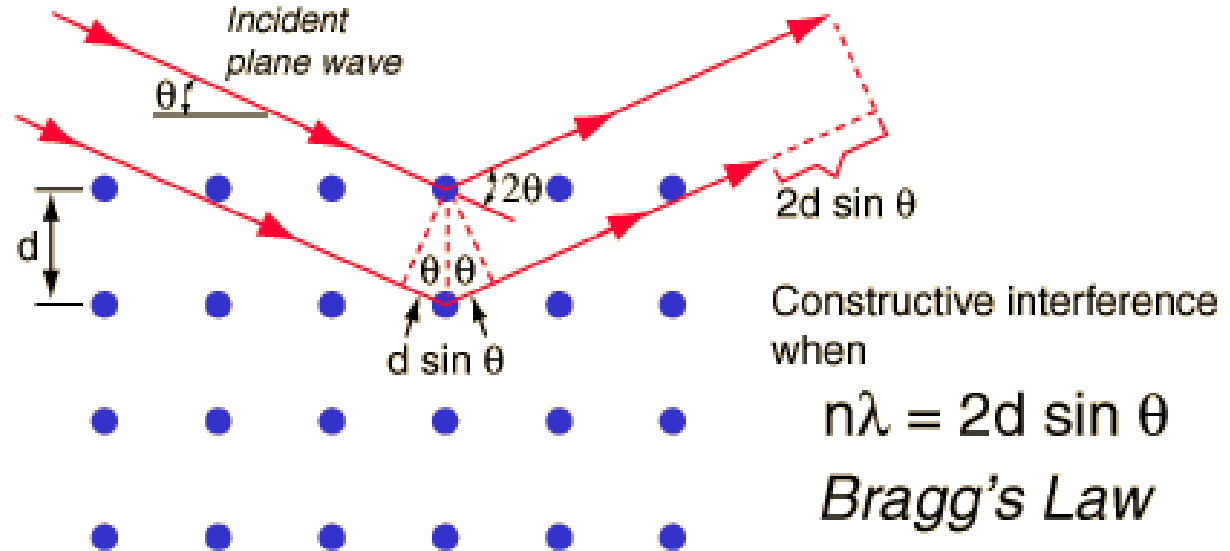
X-ray Scattering Set-Up



Bragg's Law from 1912



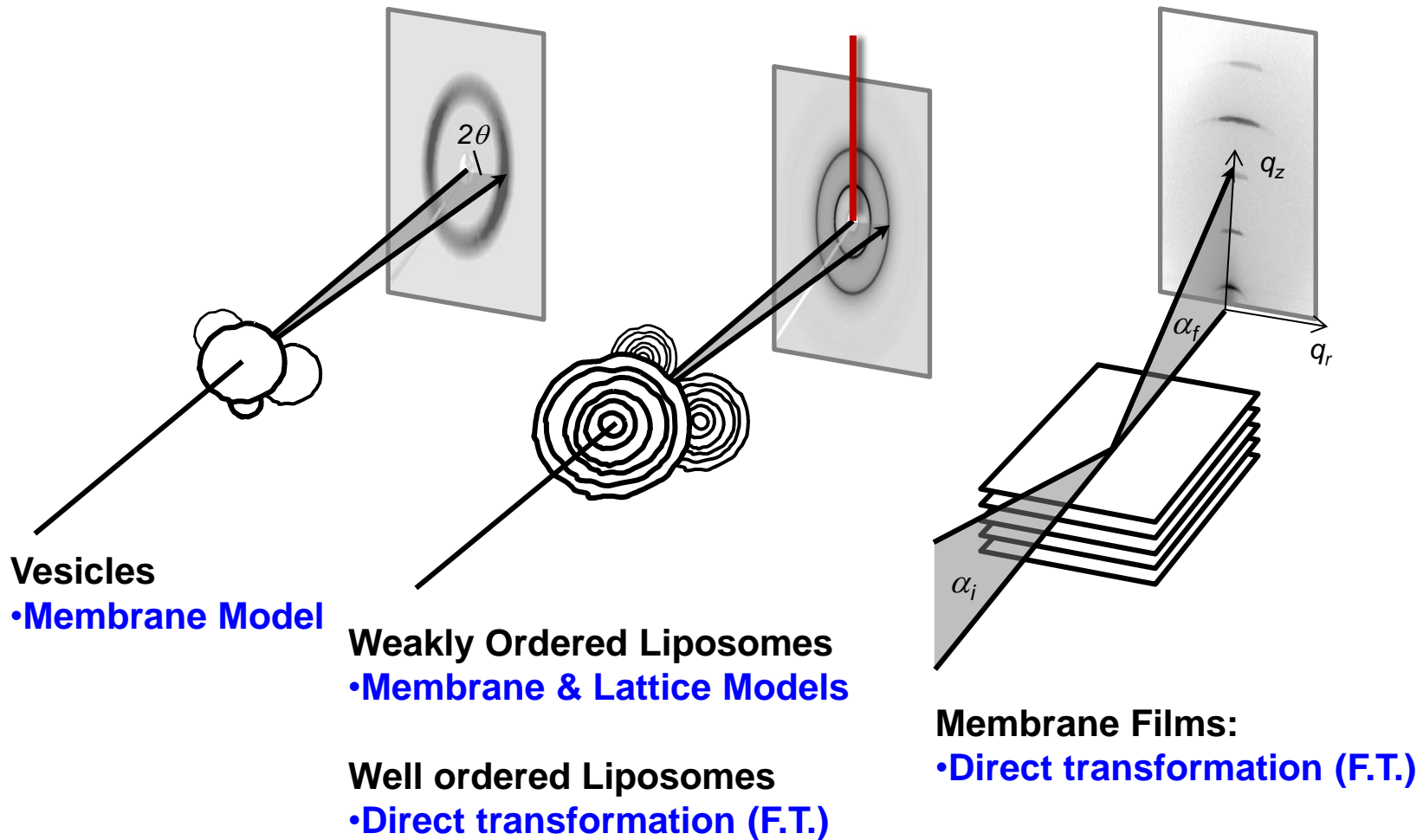
William Lawrence Bragg



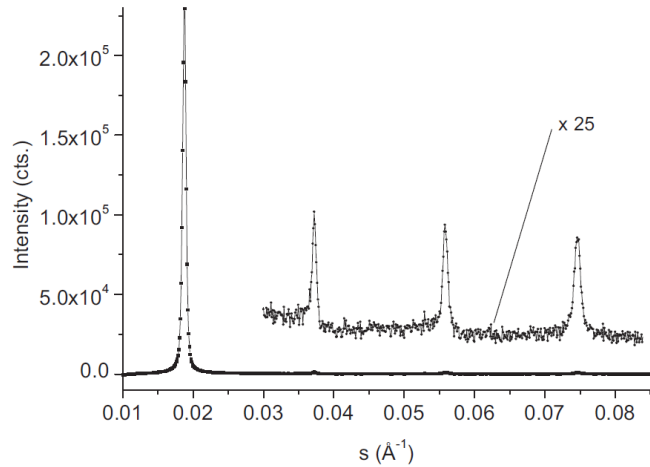
$$d = \text{const.} \cdot \lambda / 2 \sin \Theta \quad (1')$$

$$d = \text{const.} \cdot \lambda / 2\Theta \quad (2), \text{ for } \Theta \ll 1$$

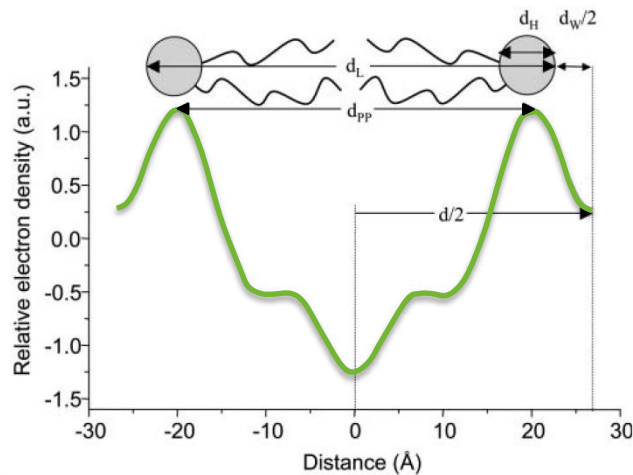
Diffuse Scattering and Diffraction



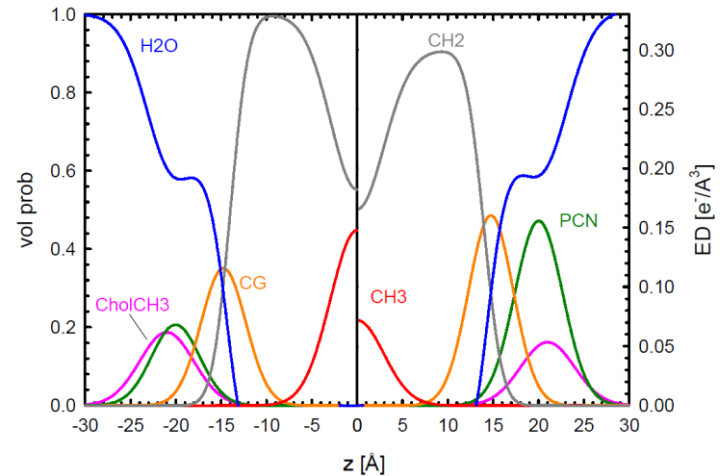
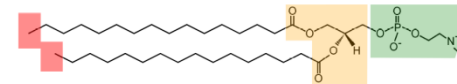
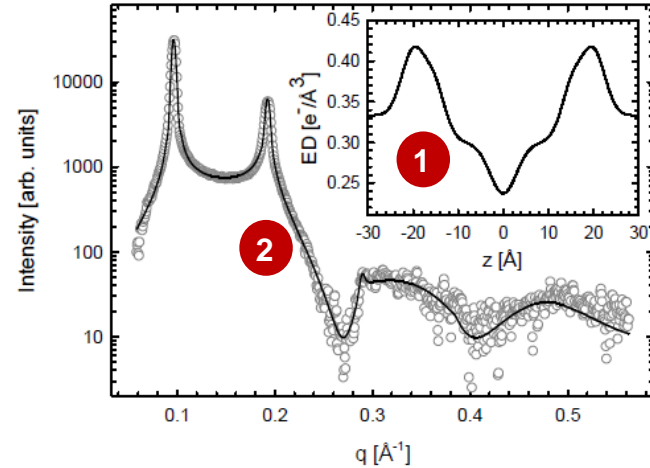
Fourier Transform & Modelling



Direct transformation (F.T.)



Rappolt, M. et al. (2003): Biophys. J. 84, 3111

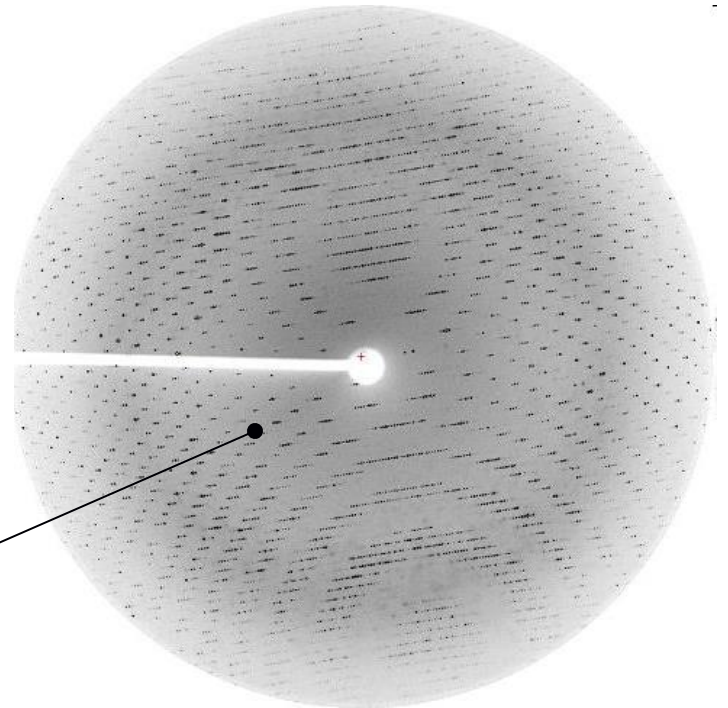
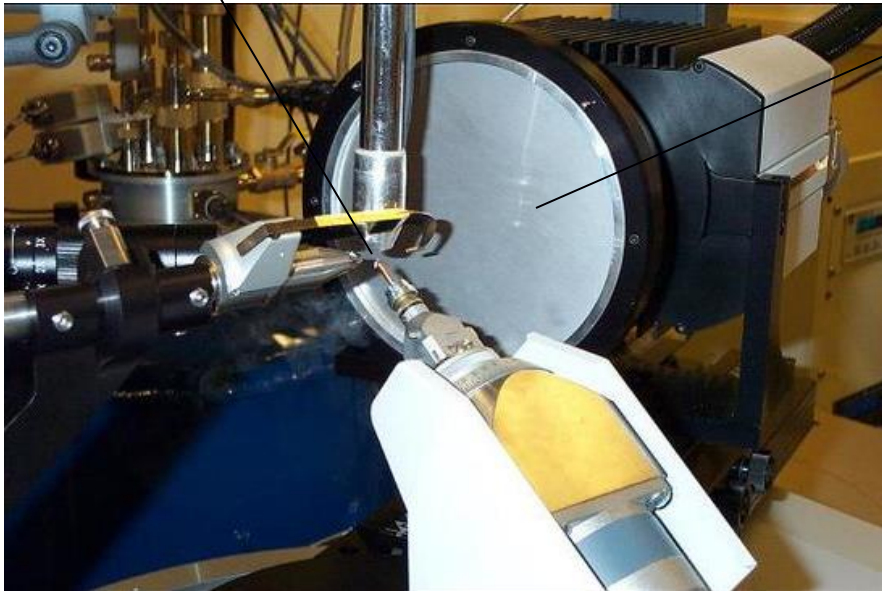
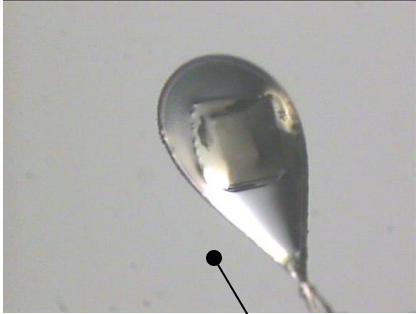


Pabst, G., Rappolt, M. et al. (2000): PRE 62, 4000
 Rappolt, M. et al. (2004): Recent Res. Devel. Vol.3, 363
 Heftberger, P. et al. (2013): J. Appl. Cryst., in press



UNIVERSITY OF LEEDS

Protein Crystallography



Protein Structure, e.g. Ribosome

Chemistry



The Nobel Prize in Chemistry 2009

"for studies of the structure and function of the ribosome"



Photo: MRC Laboratory of Molecular Biology

Venkatraman Ramakrishnan

🕒 1/3 of the prize

United Kingdom

MRC Laboratory of Molecular Biology
Cambridge, United Kingdom



Credits: Michael Marsland/Yale University

Thomas A. Steitz

🕒 1/3 of the prize

USA

Yale University
New Haven, CT, USA;
Howard Hughes Medical Institute



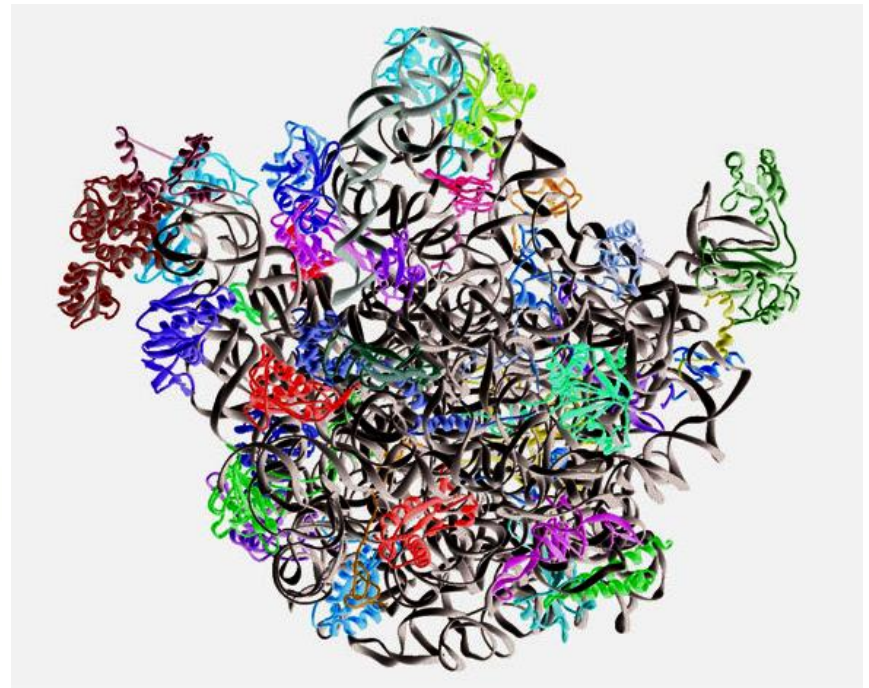
Credits: Micheline Pelletier/Corbis

Ada E. Yonath

🕒 1/3 of the prize

Israel

Weizmann Institute of Science
Rehovot, Israel

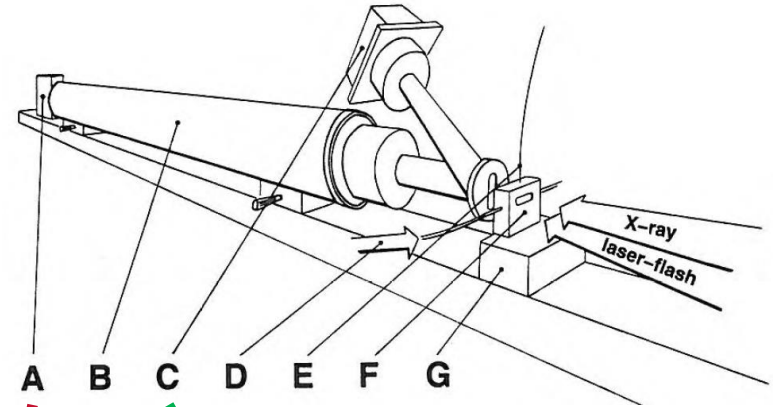


More than 20 years of work are in this stucture!



UNIVERSITY OF LEEDS

SAXS and WAXS

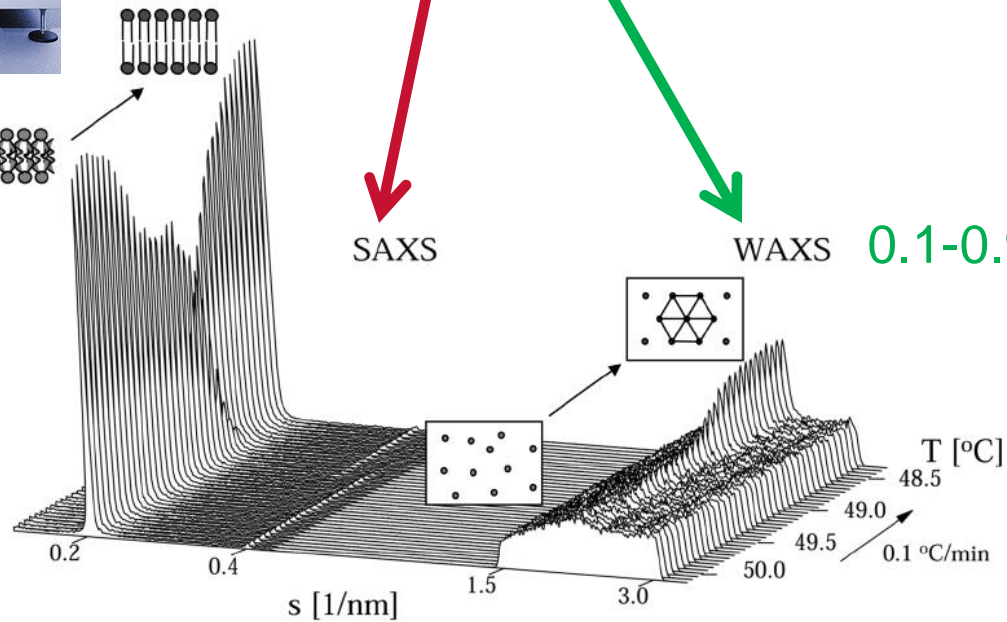


1-100 nm

SAXS

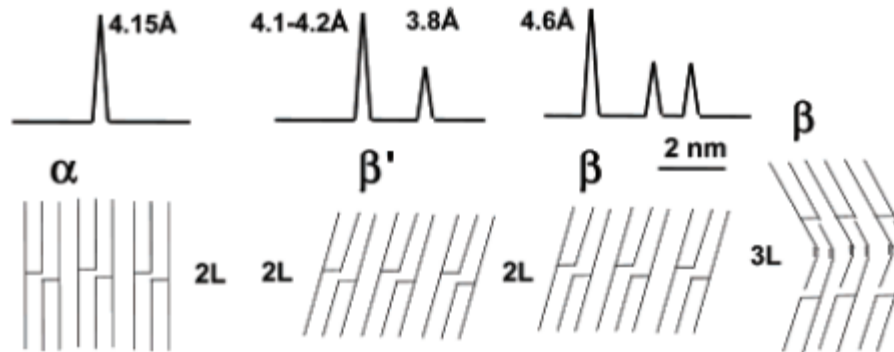
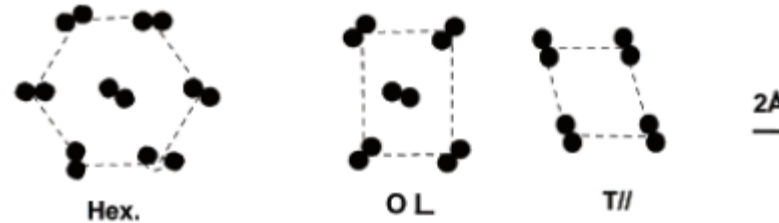
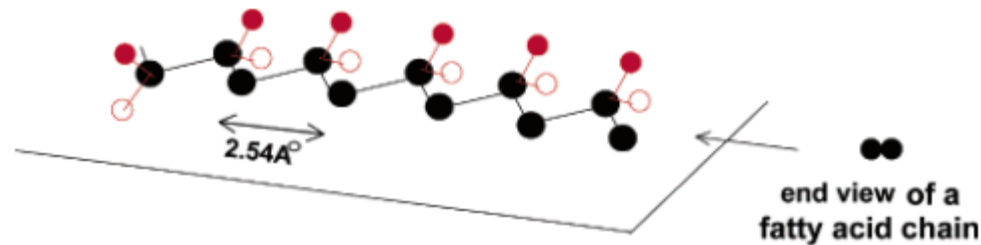
WAXS

0.1-0.9 nm



Packing & Stacking with Triacylglycerides (TAGs)

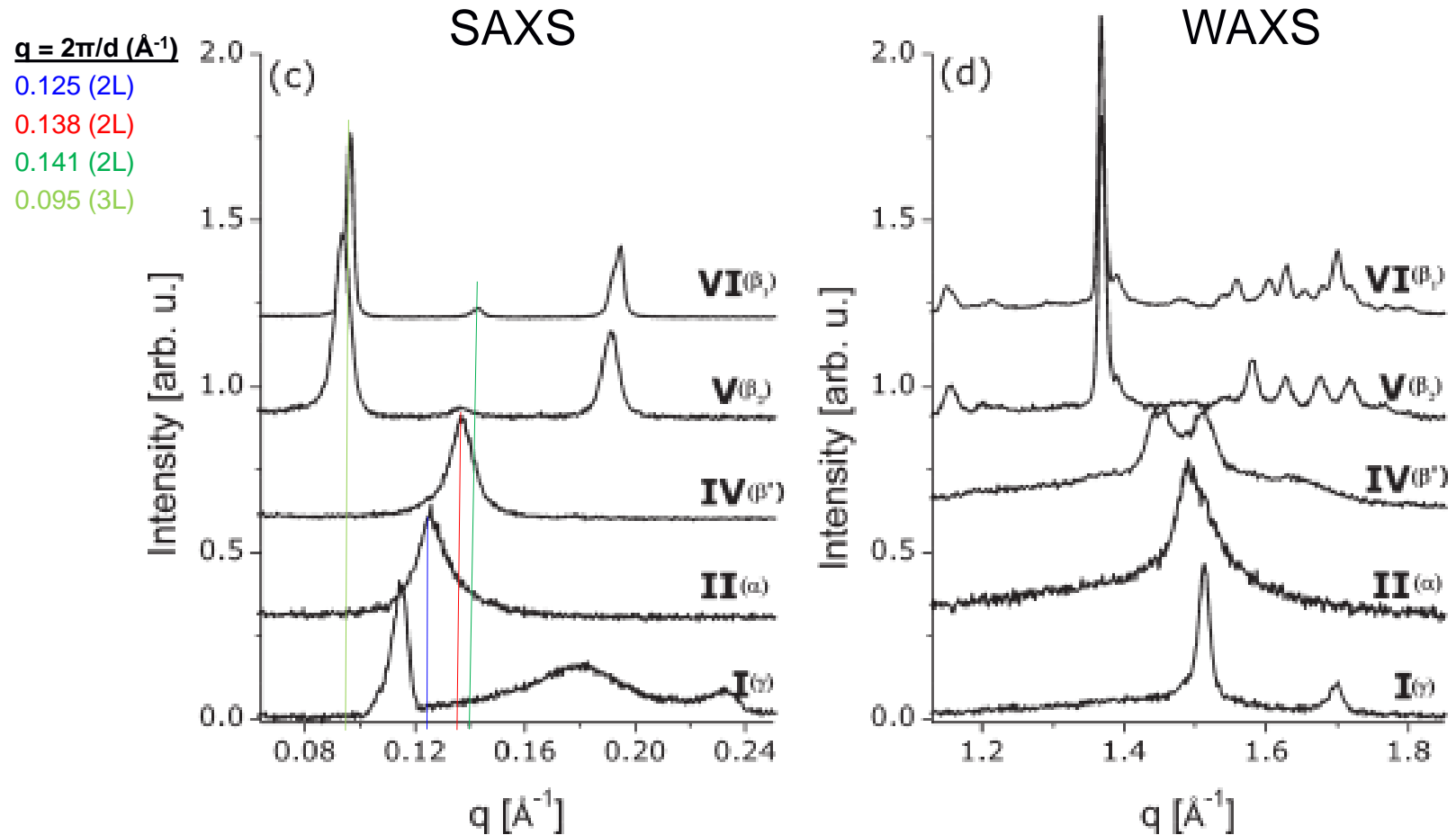
Packing



Stacking

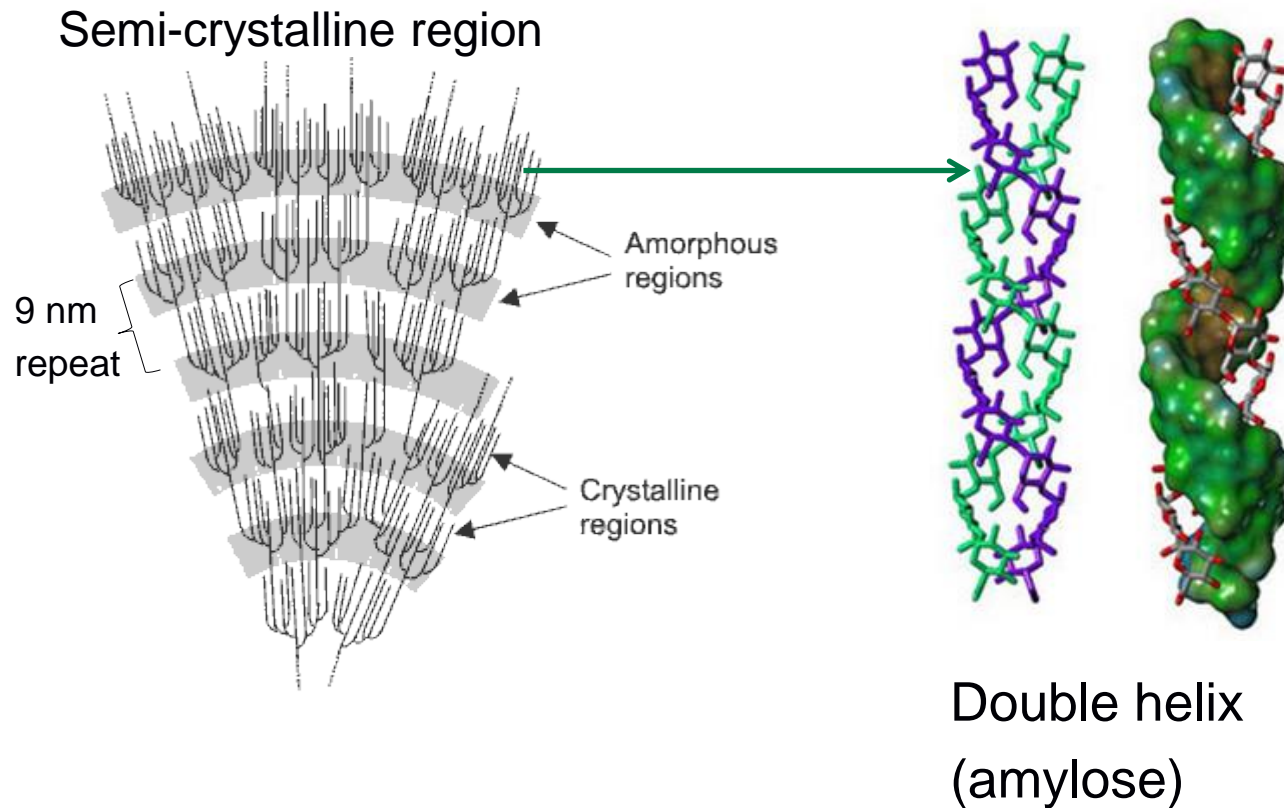
Polymorphism TAGs: Different possibilities of lateral packing of the hydrocarbon chains.

Cacao Butter



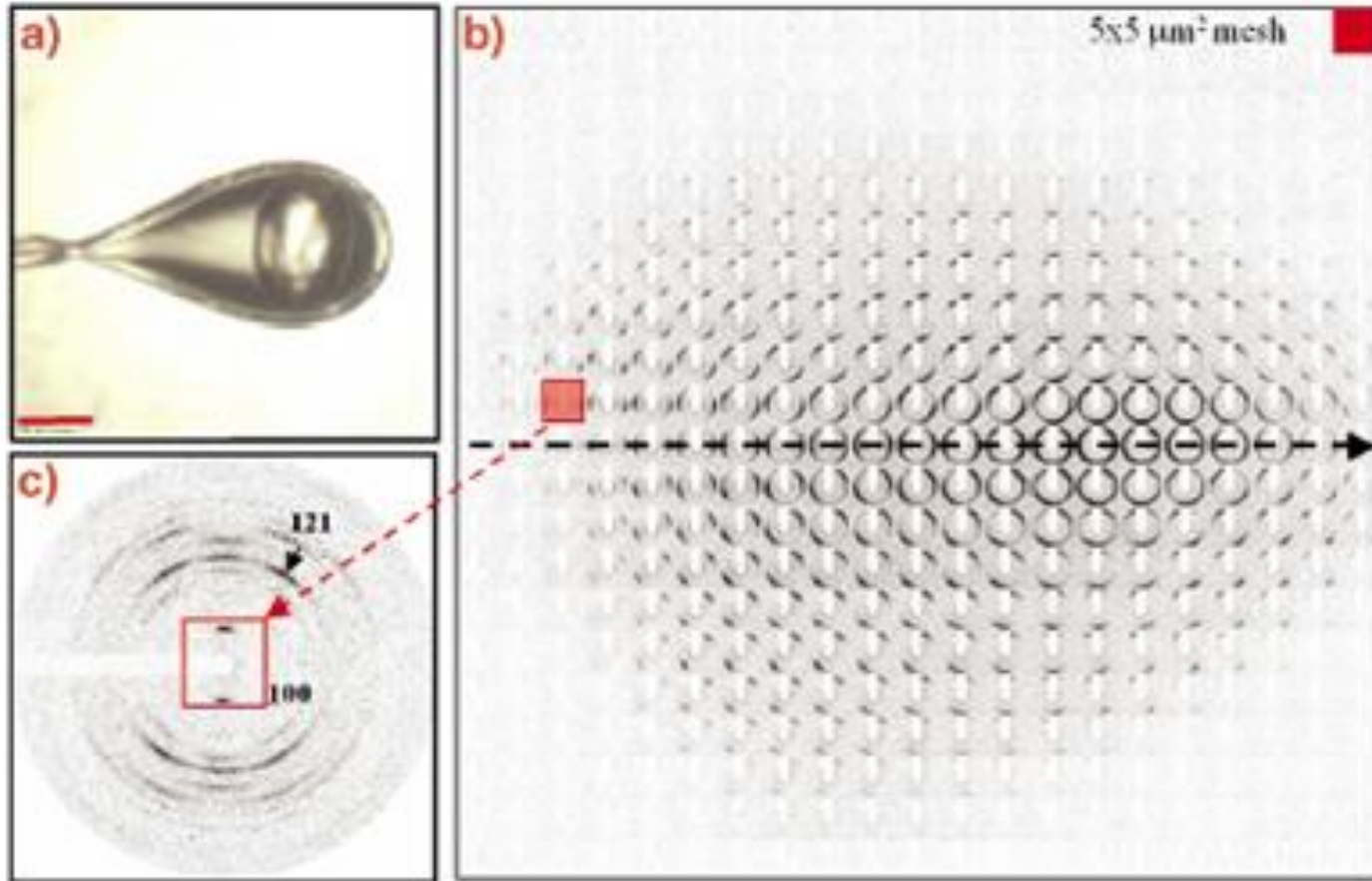
SAXS and WAXS patterns: I(γ), II(α), IV(β'), V(β_2), and VI(β_1) polymorphic phases of cocoa butter.

Starch Granule Structure



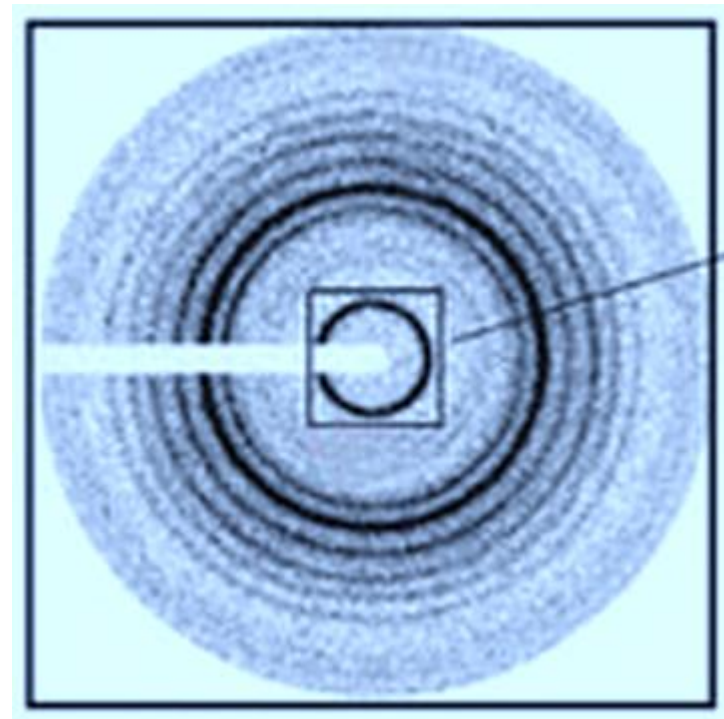
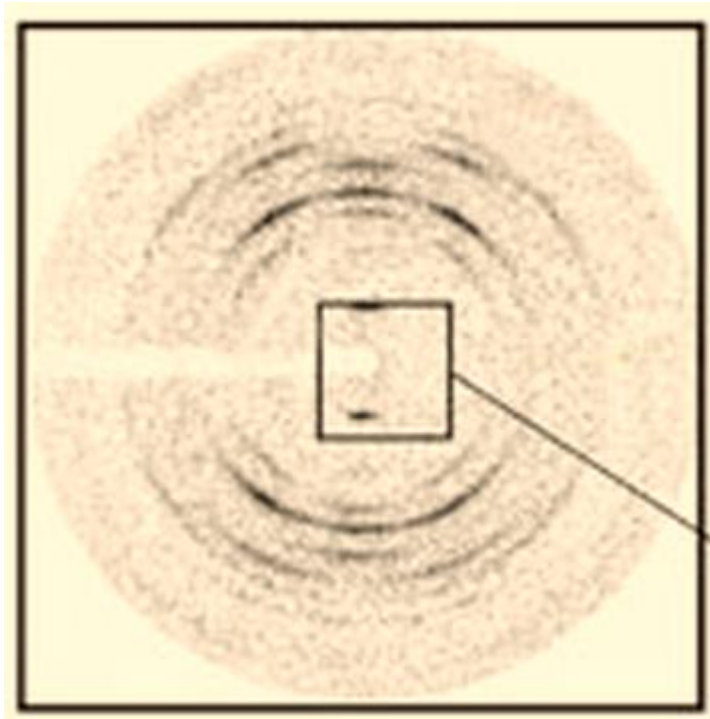
Sarkar & Pérez BMC Bioinformatics 13 (2012)

Starch Granule: Fibre Diffraction & SAXS



Riekell and co-workers, ID13, ESRF

Aligned and Non-Aligned Regions



Riekell and co-workers, ID13, ESRF

Thank You For Your Attention!



New camera **SAXSpace** in the *Lipid Biophysics Lab*
School of Food Science & Nutrition, University of Leeds, UK