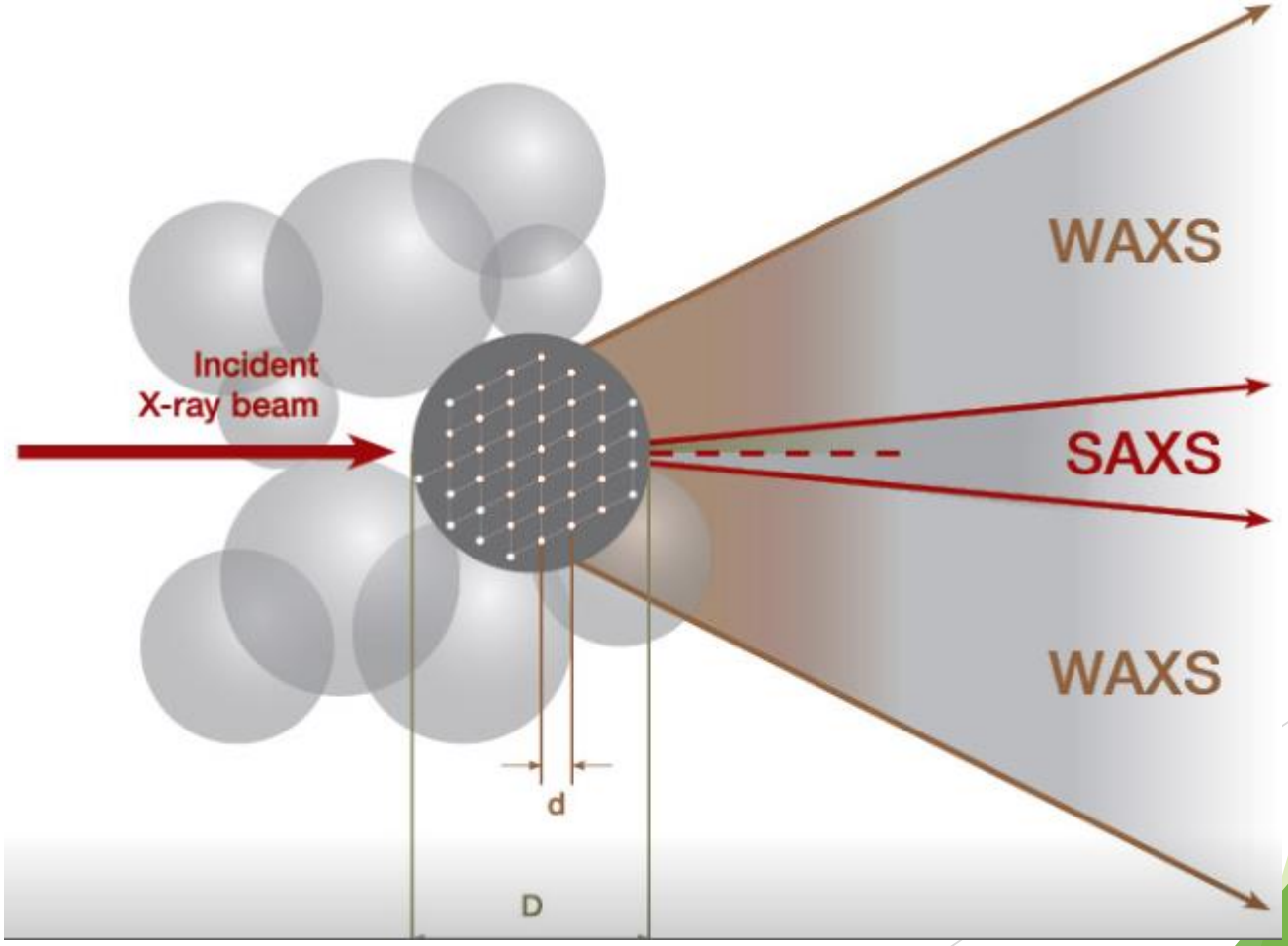
Instrumental presentation

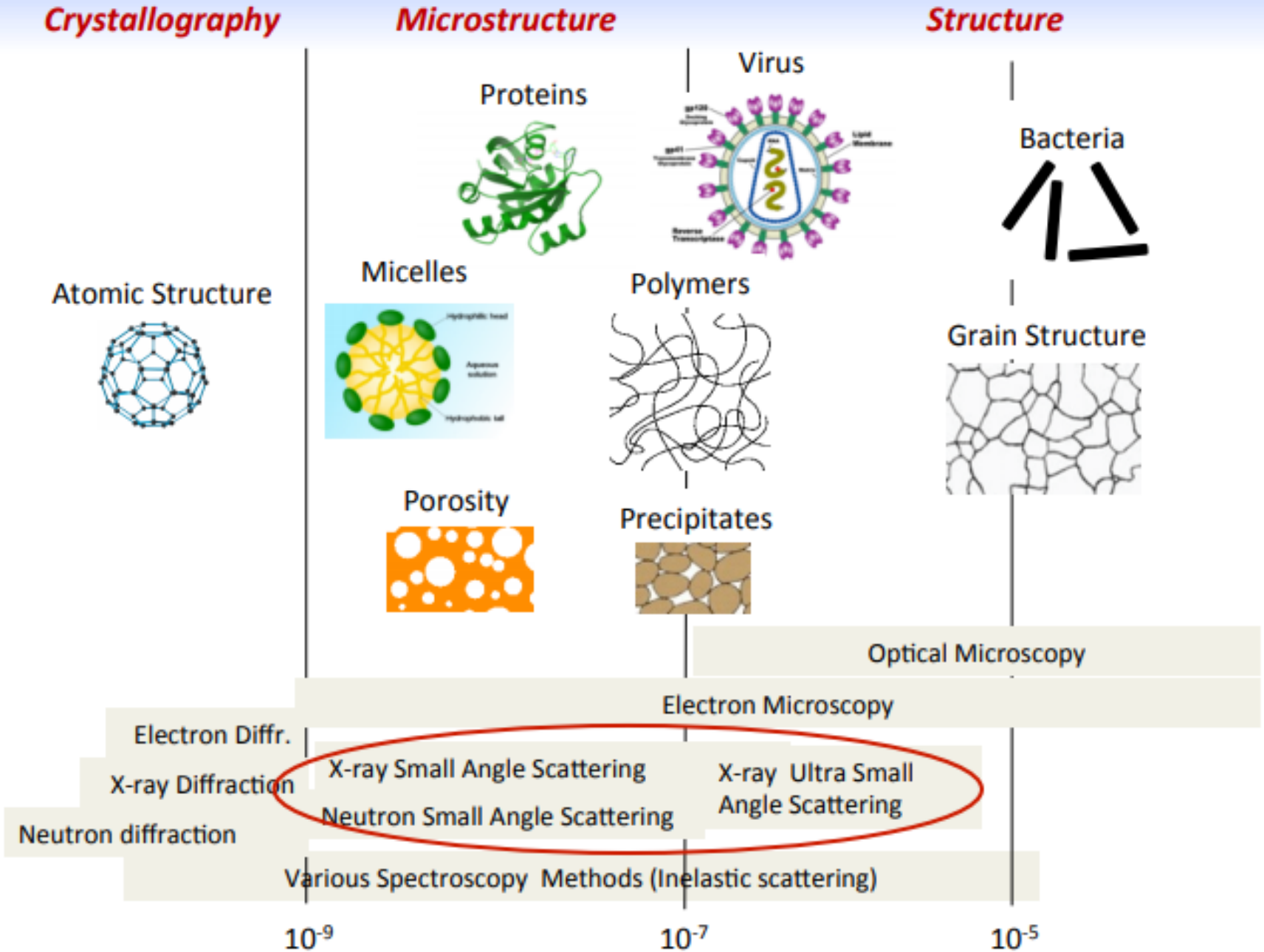
Small Angle X-RAY Scattering (SAXS)



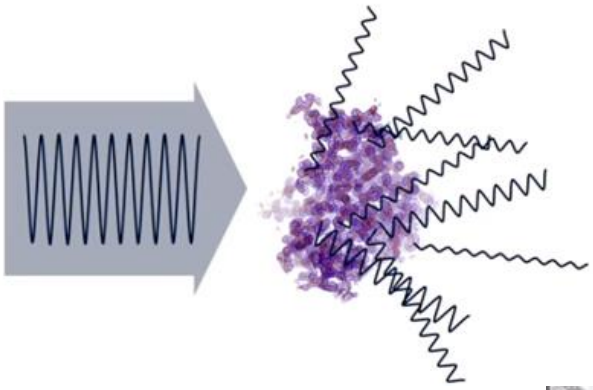
Arijit Jana

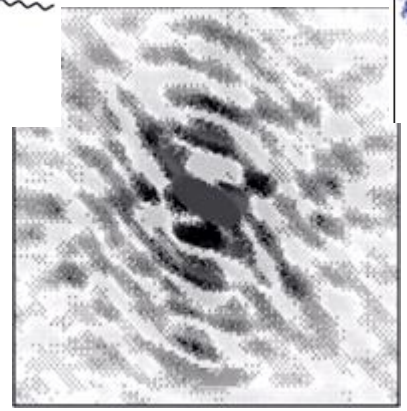
30.11.2019

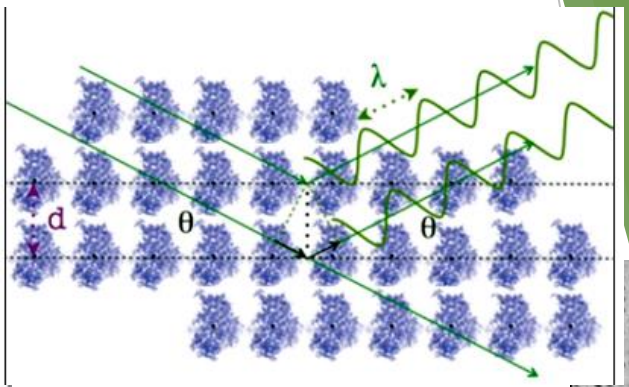
Probing Different Length-Scales

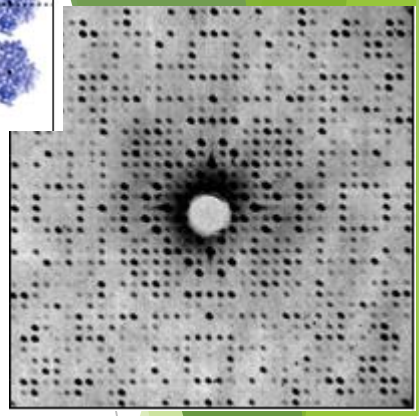


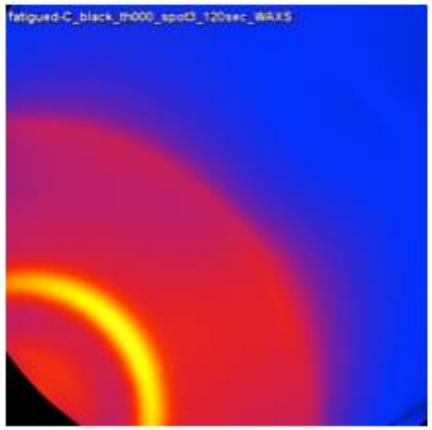
X-Ray Scattering / Diffraction ??

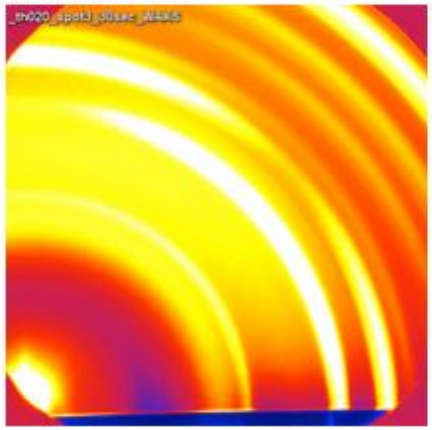


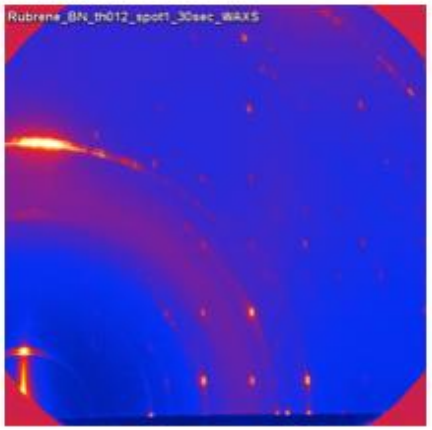












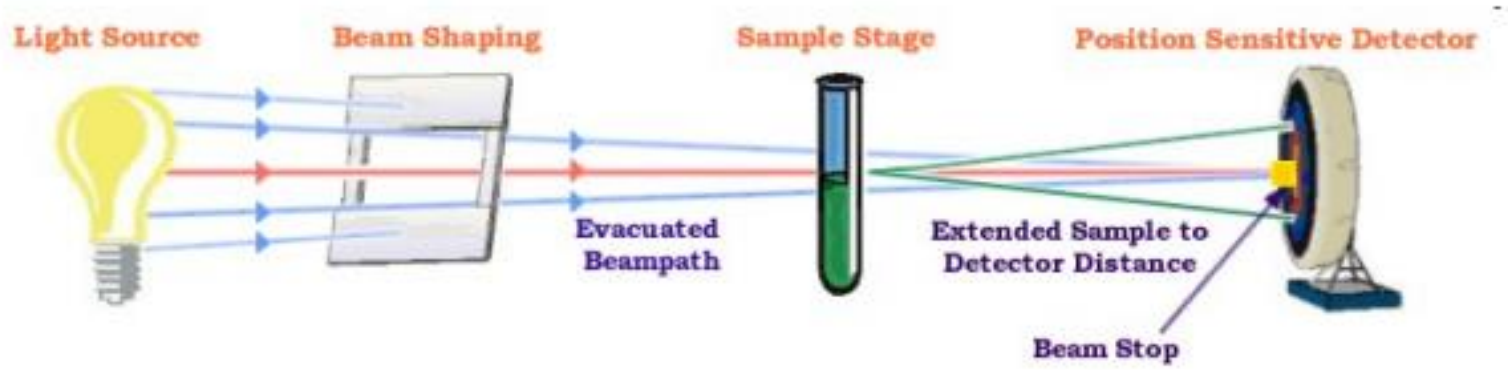
disordered | some ordering | oriented, textured | single crystal

less order ⟵ ⟶ more order

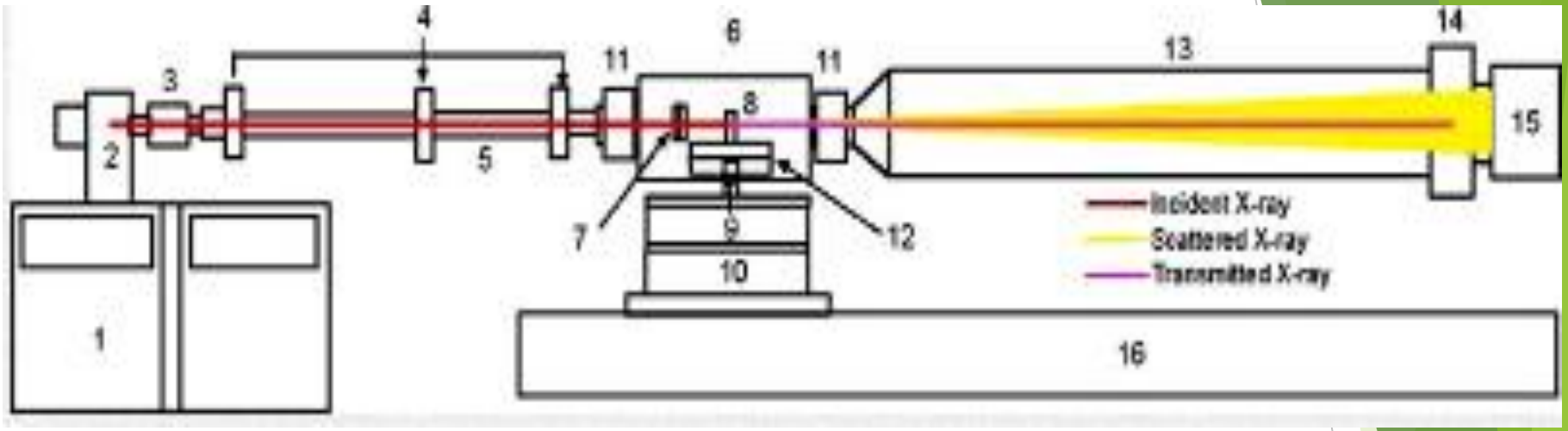
An Overview :

- X-ray scattering techniques are a family of non-destructive analytical techniques which reveal information about the crystallographic structure, chemical composition, and physical properties of materials and thin films.
- These techniques are based on observing the scattered intensity of an X-ray beam hitting a sample as a function of incident and scattered angle, polarization, and wavelength or energy
- Materials that do not have long range order may also be studied by scattering methods that rely on elastic scattering of monochromatic X-rays.
- Small angle X-ray scattering (SAXS) probes structure in the nanometer to micrometer range by measuring scattering intensity at scattering angles 2θ close to 0°

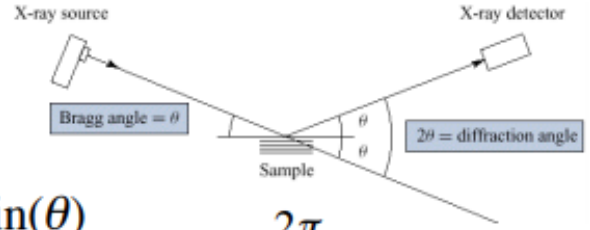
Conceptually, a SAXS experiment is simple: a sample is illuminated by X-rays and the scattered radiation is registered by a detector.



SAXS instruments

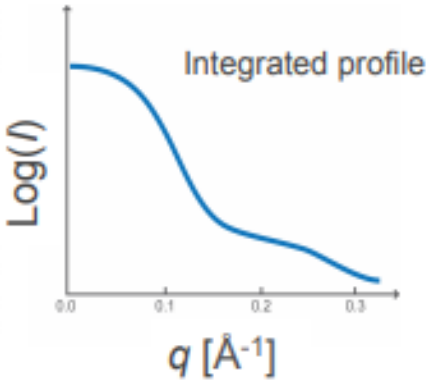


Sizes measured



$$q = 4\pi \frac{\sin(\theta)}{\lambda} \qquad d = \frac{2\pi}{q}$$

Q or q is wave vector transfer
D or d is characteristic length

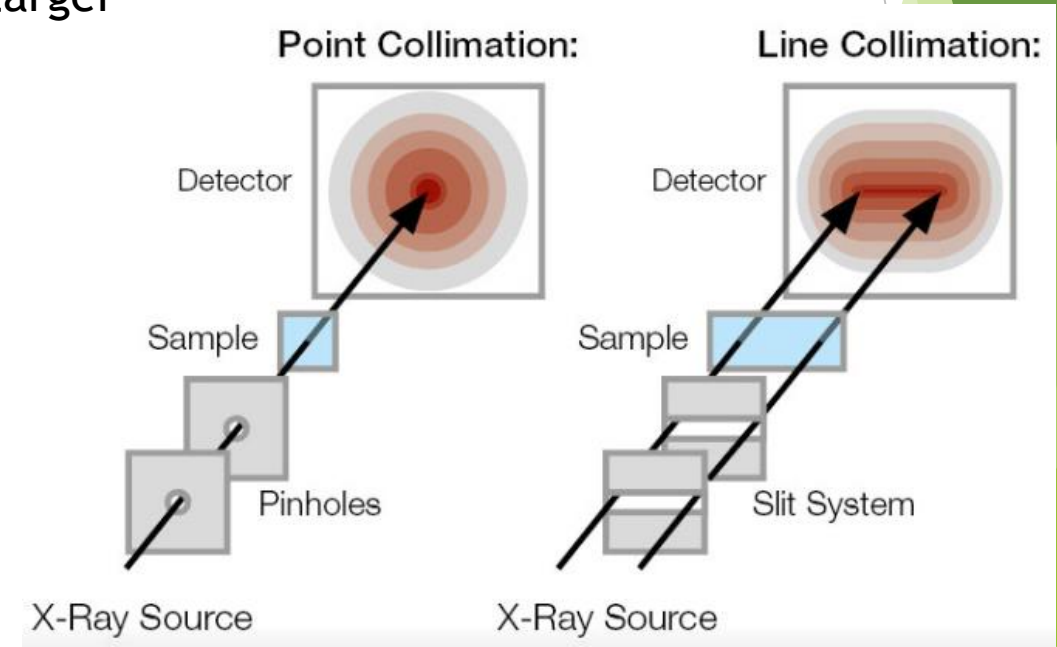


SAXS

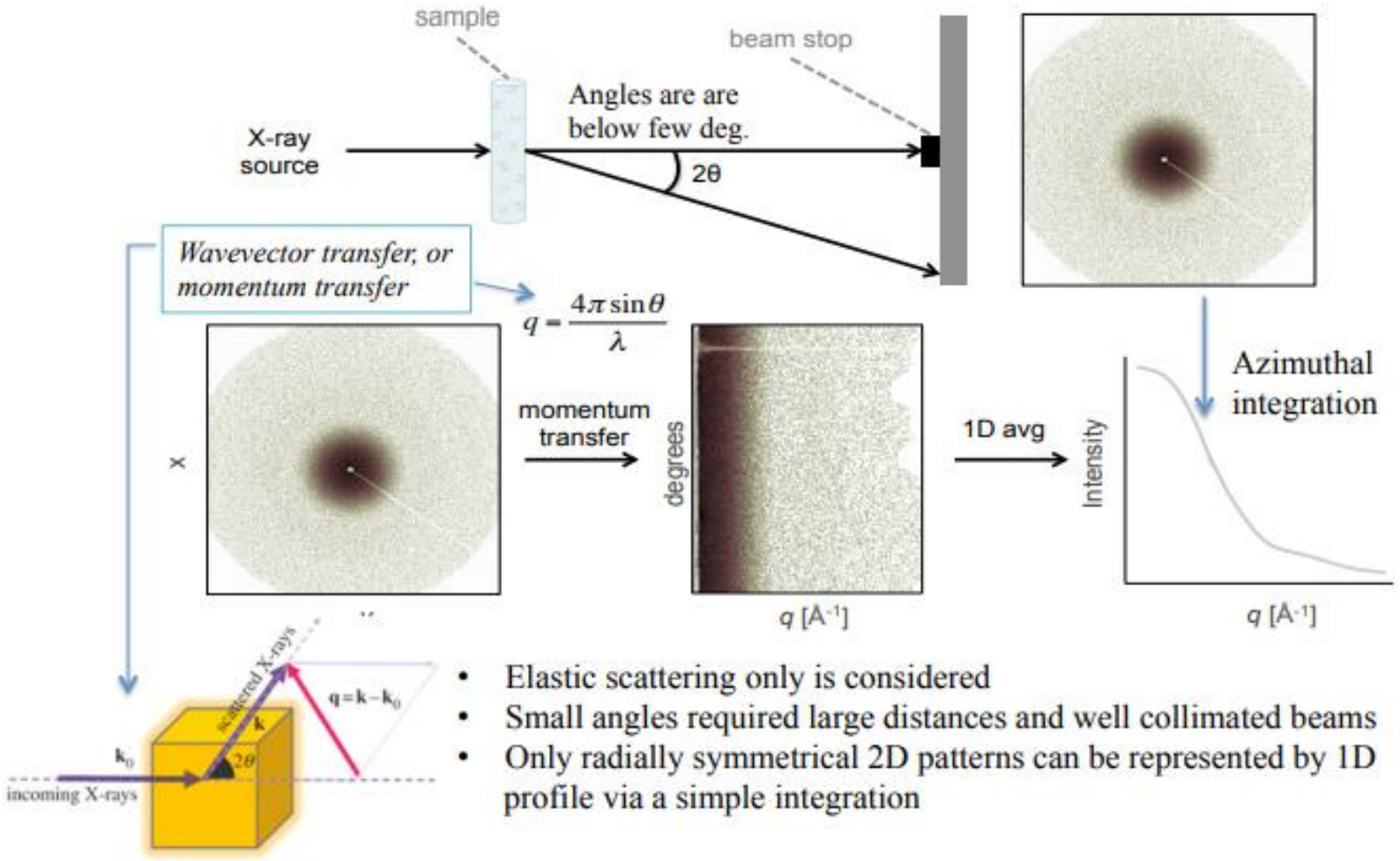
Point collimated SAXS

Line collimated SAXS

- Point-collimation instruments have pinholes that shape the X-ray beam to a small circular or elliptical spot that illuminates the sample. The scattered intensity is small and therefore the measurement time is in the order of hours or days in case of very weak scatterers.
- Line-collimation instruments confine the beam only in one dimension so that the beam profile is a long but narrow line. The illuminated sample volume is much larger compared to point-collimation and the scattered intensity at the same flux density is proportionally larger

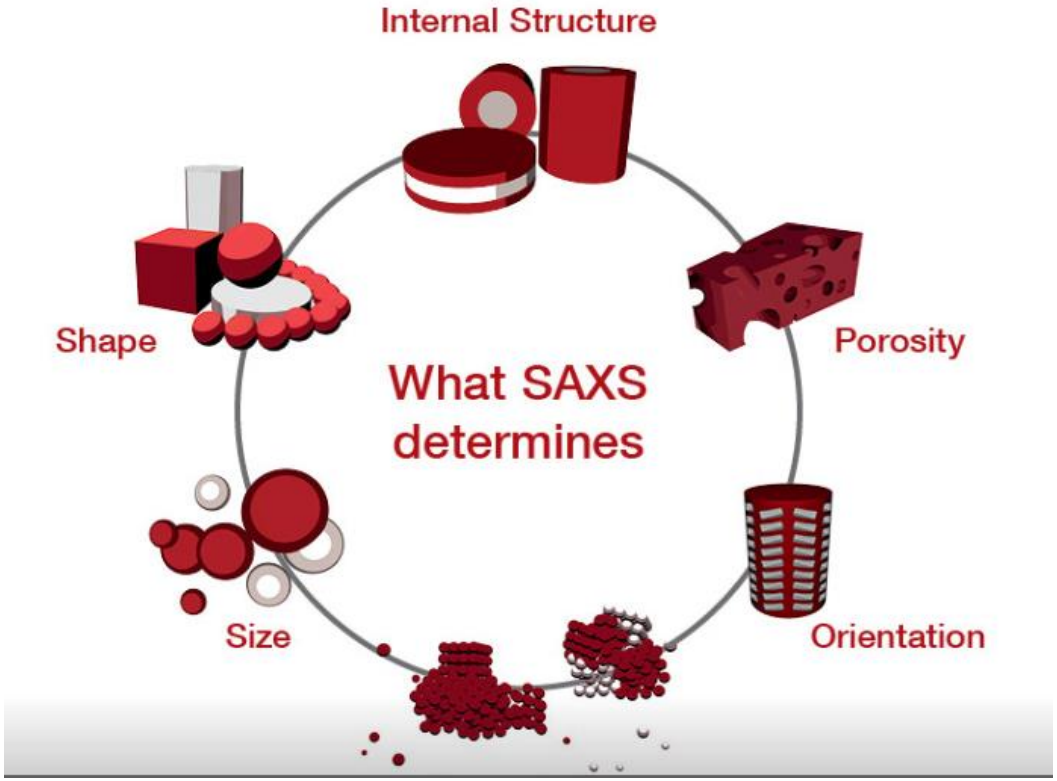


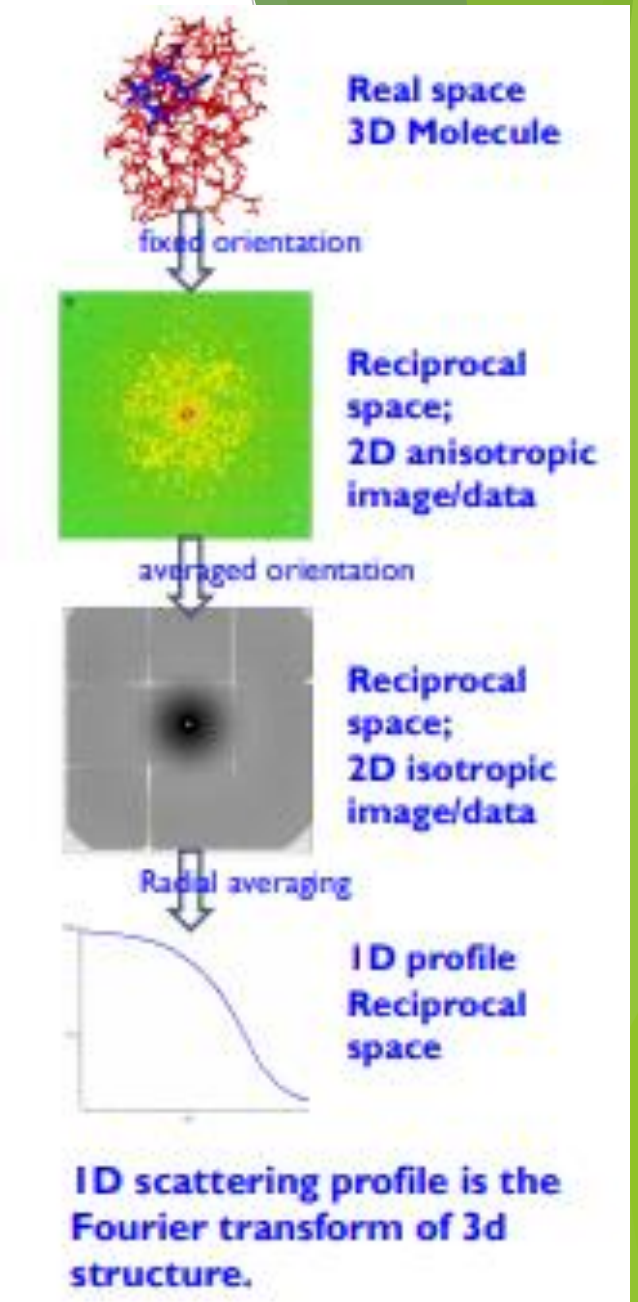
SAXS experiments :



- Elastic scattering only is considered
- Small angles required large distances and well collimated beams
- Only radially symmetrical 2D patterns can be represented by 1D profile via a simple integration

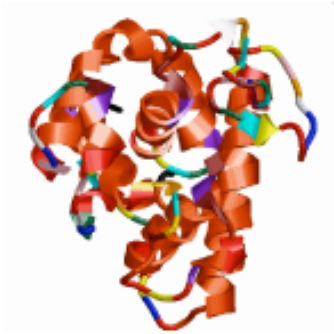
Application of SAXS :





- Shape
- Size
- Internal structure
- Crystallinity
- Porosity
- Orientation

SAXS Applications:



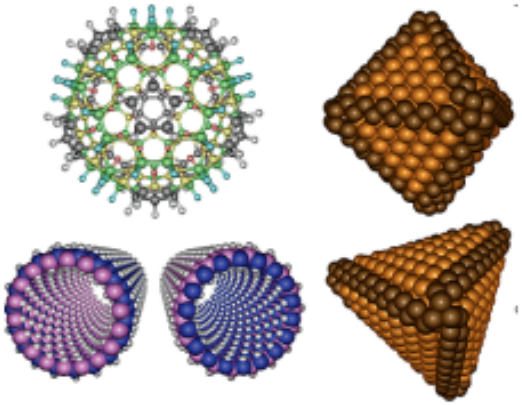
LIQUID

Protein; Pharmaceuticals.

SOLID

Powder; Liquid Crystal;

Nano Materials; Polymer; Fiber.



Thank you