



Signals and Systems

Fourier Transform and Reciprocal Lattice in Crystallography

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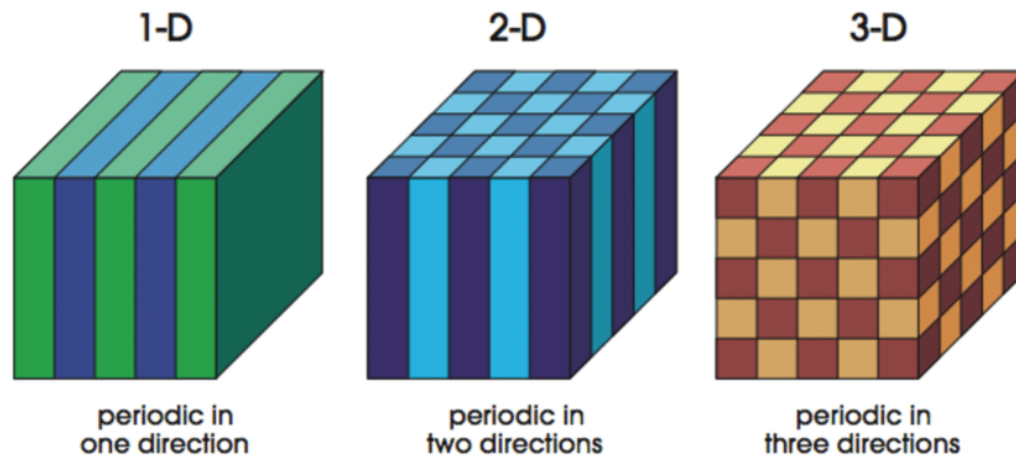
Course Number: 20 14 255

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Introduction to Crystallography

- The study of arrangement of atoms in crystalline solids.
- One of the fundamental properties of a crystal is that its atoms are arranged in a regular three-dimensional array (lattice).



Picture Source: Gao, Weihong. (2016). The Fabrication of Structurally Coloured Textile Materials Using Uniform Spherical Silica Nanoparticles. 10.13140/RG.2.2.25724.54403.

Bravais lattice

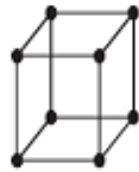
- Named after Auguste Bravais (1850)
- An infinite array of discrete points generated by a set of discrete translation operations described in three dimensional space by:

$$R = n_1 a_1 + n_2 a_2 + n_3 a_3$$

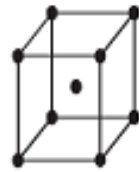
- Refers to the 14 different 3D arrangements of atoms in a crystal.



The 14 Crystal (Bravais) lattice



Simple cubic



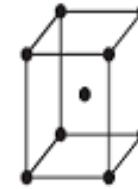
Body-centered cubic



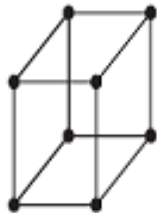
Face-centered cubic



Simple tetragonal



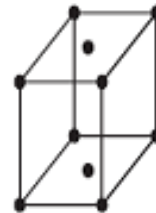
Body-centered tetragonal



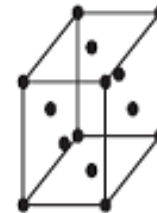
Simple orthorhombic



Body-centered orthorhombic



Base-centered orthorhombic



Face-centered orthorhombic



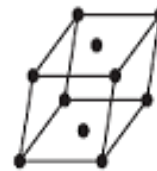
Rhomboidal



Hexagonal



Simple monoclinic

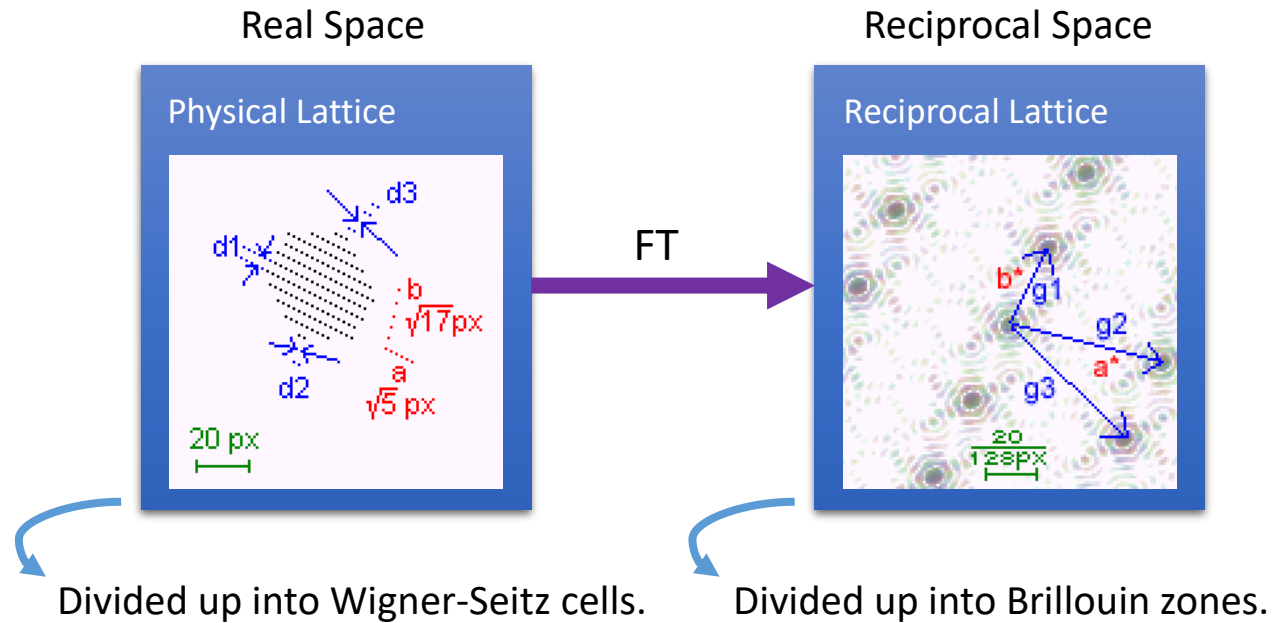


Base-centered monoclinic

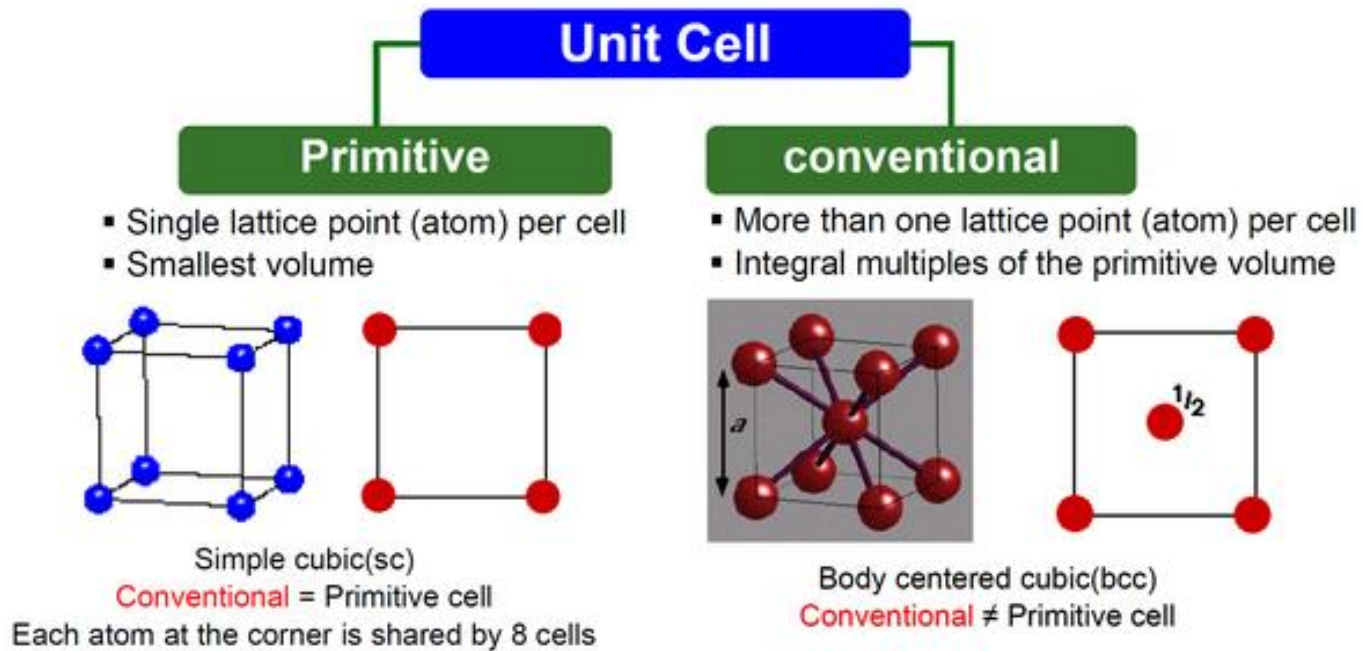


Triclinic

How does Fourier transform applies?

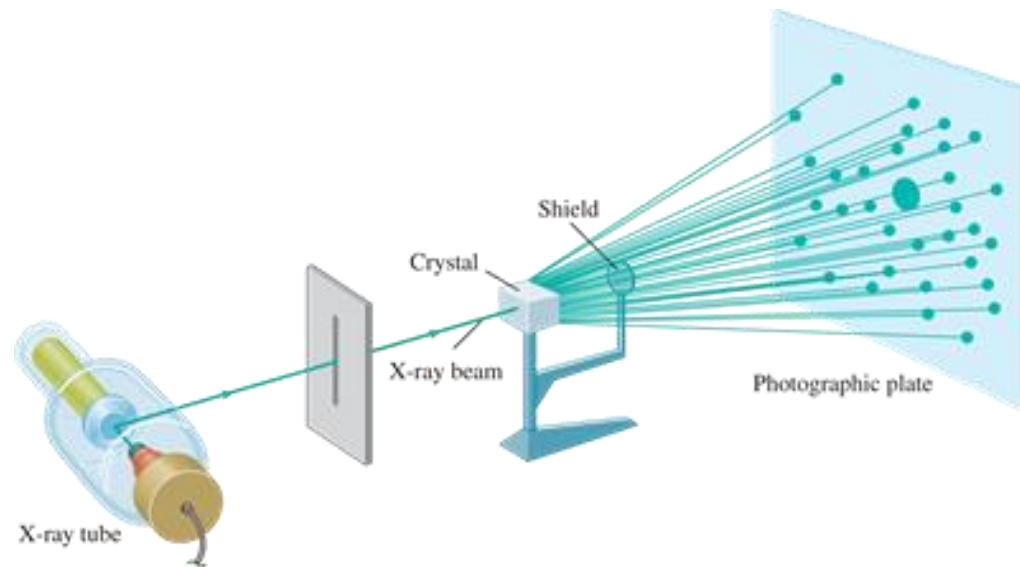


Primitive Cell

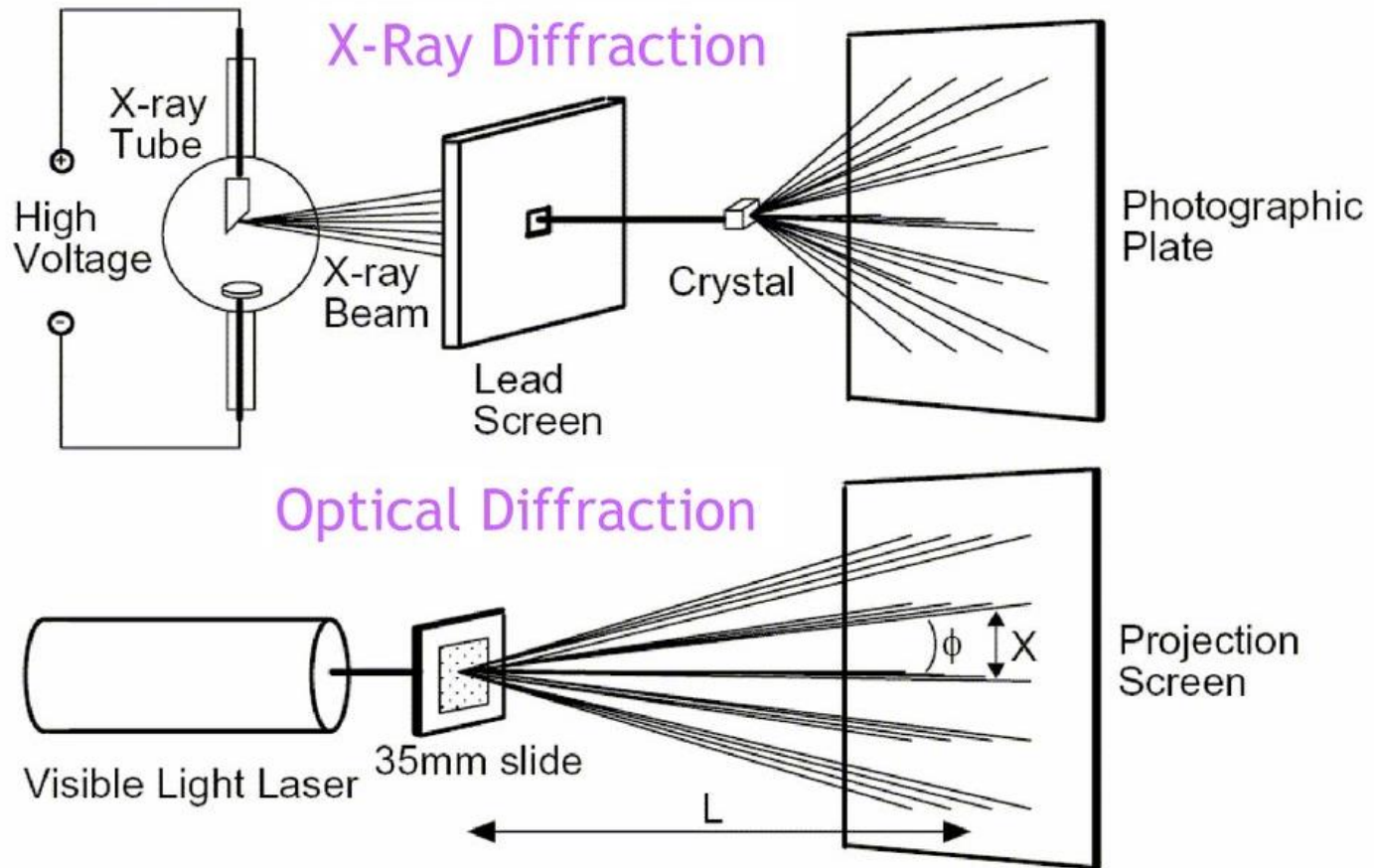


Reciprocal Lattice

- Fourier transform of a physical lattice (usually Bravais lattice).
- Present in reciprocal space (known as momentum space and K-space).
- Used in theory of diffraction, e.g. X-ray diffraction.

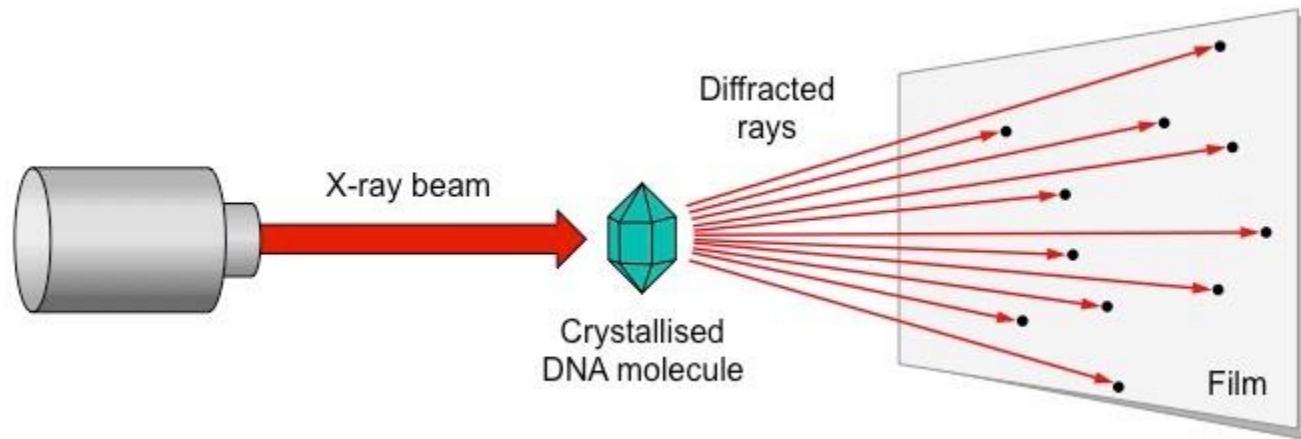


Theory of Diffraction



Rosalind Franklin Idea

- What happens if we had a crystallised DNA molecule?

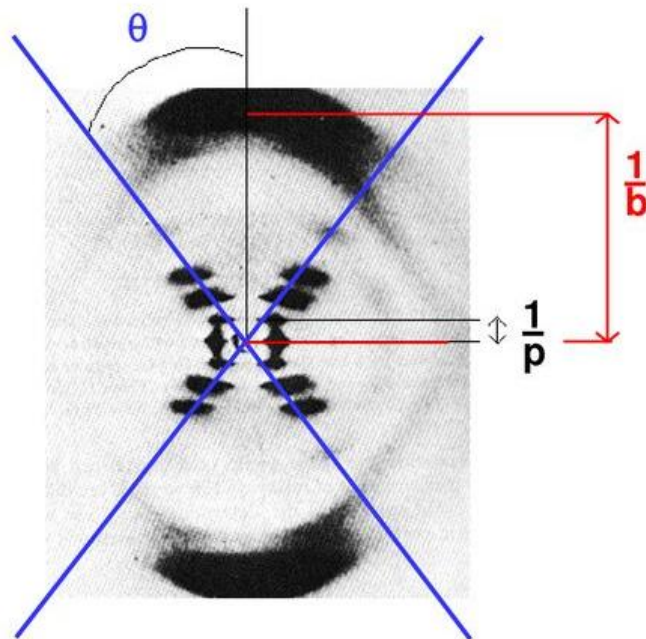


Rosalind Franklin Idea (cont.)



X-Ray Diffraction of DNA

Diffraction pattern

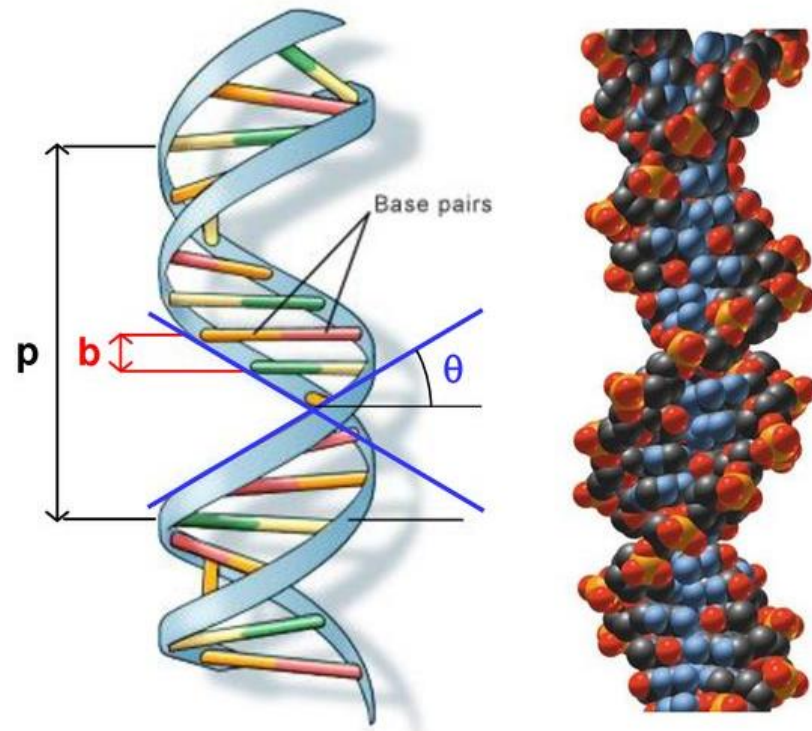


p = period of one turn

b = base spacing

θ = slope of the helix

The double helix of DNA



The END!

