Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science (Third Year)
Subject: Physics

Paper Code: PYD103

Paper Title: Solid State Physics

Unit-1: Crystal Structure

Module Name: Brillouin Zones

Module No: 09

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Notes

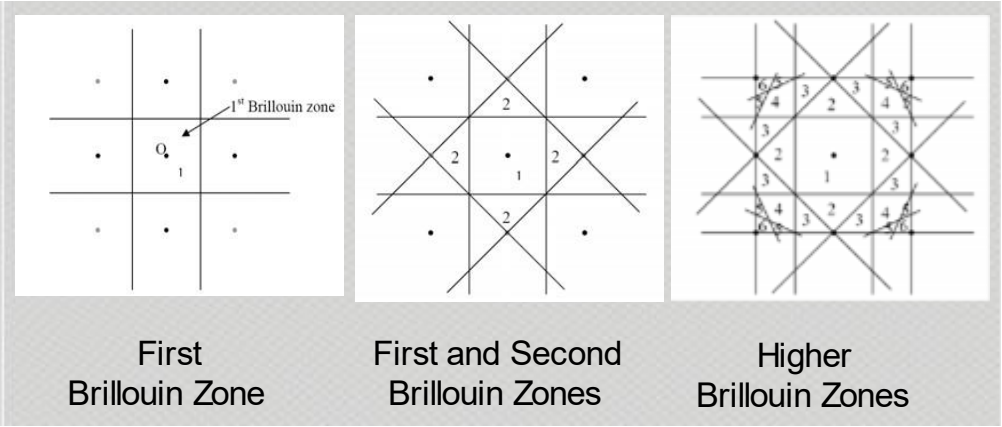
Concept of Brillouin Zones:

- The First Brillouin Zone (BZ) is defined as the **Wigner-Seitz primitive cell** in the reciprocal lattice. It gives a geometric interpretation of the diffraction condition, in terms of the reciprocal lattice.
- The Brillouin construction exhibits all **wave vectors *k*** that can be **Bragg reflected** by the crystal.
- The constructions divide the reciprocal space into fragments, out of which **The First Brillouin Zone i**s of the greatest importance.

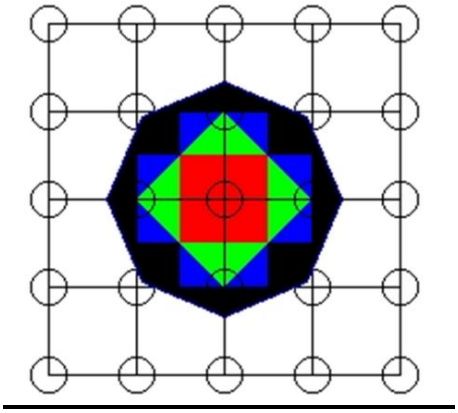
Construction of Brillouin Zones:

- Determine all the perpendicular bisecting lines in 2-D reciprocal lattice, the area enclosed by those perpendicular bisecting lines give rise to the Brillouin Zones.
- Determine all the perpendicular bisecting planes in 3-D reciprocal lattice, the volume enclosed by those perpendicular bisecting planes give rise to the Brillouin Zones.

Brillouin Zones: Square Lattice



First Four Brillouin Zones: Square Lattice

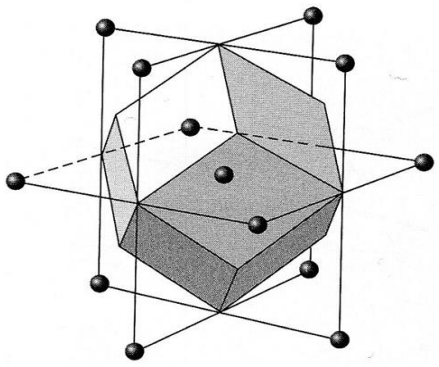


Brillouin Zones of simple cubic lattice:

The reciprocal lattice of a simple cubic lattice is itself a simple cubic lattice, of lattice constant $\frac{2\pi}{a}$. The six planes bound a cube of edge $\frac{2\pi}{a}$ and of volume $\left(\frac{2\pi}{a}\right)^3$; this cube is the first Brillouin zone of simple cubic crystal lattice.

Brillouin Zones of body centered cubic lattice:

First Brillouin zone of body centered cubic lattice is a Rhombic dodecahedron (polyhedron with 12 flat faces), as shown in the figure given below.



Brillouin Zones of face centered cubic lattice:

First Brillouin zone of face centered cubic lattice is a truncated octahedron, as shown in the figure given below.