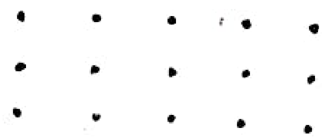
Reciprocal Lattice :-

Every crystal is associated with 2 type of lattices :-
i) direct lattice
ii) Reciprocal lattice

Need of Reciprocal lattice :-

In direct lattice, lattice points r arranged according to their position.

In Reciprocal lattice, lattice points are arranged according to their wave vector ($\vec{k}$) or momentum ($\hbar k$).



Hence direct lattice is defined in Position space.
Reciprocal " " " " Momentum space or fourier space.

They are inversely related i.e. position & mom. are conjugate of each other.

→ direct lattice has the unit of length.
→ Reciprocal " " " " $[\text{length}]^{-1}$

Wave vector is no. of waves per unit wave length. It tells, in which dirn wave is propogating i.e.

$$\boxed{K = \frac{2\pi}{\lambda}}$$

✓ Potn Energy in position space.
✓ K.E. in Mom. space.

Total Energy is Conserved. i.e. K.E & P.E. are inversely related. { K.E ↓ as much P.E ↑ }

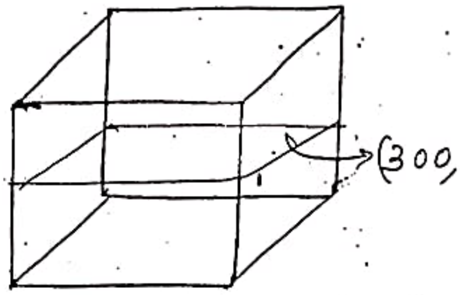
If e^- is completely free then its will have K.E. only.

Resons for need of Reci. Lattice :-

- It is difficult to visualize the crystal plane as order of the plane increases.

As $hkl \uparrow$, $d_{hkl} \downarrow$

e.g. (3,0 0) plane → difficult to visulize.



In Reciprocal lattice, each plane is represented by its normal.

& length of the normal is inversely proportional to interplaner spacing.

⇒ So smaller the " " , larger is the length of the normal.

⇒ Plane near in direct lattice will be far away in reci. lattice.

⇒ Every physical property of crystal is pereodic.

To calculate e^- concentration (e^- conc. follow pereodic prop

A func^n is given $n(r) = n(r+a)$

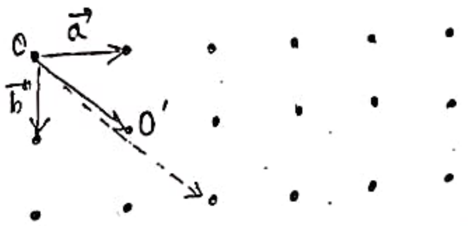
To calculate e^- conc., we need to expand this func^n 4 to expand pereodic func^n, we need fourier series. 4 fourier series is the concept of fourier space or reci space.

* Every physical property of crystal is pereodic like e^- ~~And~~ concentration & magnetic moment.

* Fourier transform of direct lattic is reciprocal lattice.

& Inverse " " " Reci. " " direct "

In 2 dim. direct lattice, there are 2 vectors $\vec{a}$ & $\vec{b}$.



To move from O to O', we use Translation Vector.

It is called Lattice Translation

The vector joining 2 Lattice ~~points~~ vectors called Lattice Translation vectors.

$$\vec{T} = \vec{a} + \vec{b}$$

In general $\boxed{\vec{T} = n_1\vec{a} + n_2\vec{b} + n_3\vec{c}}$

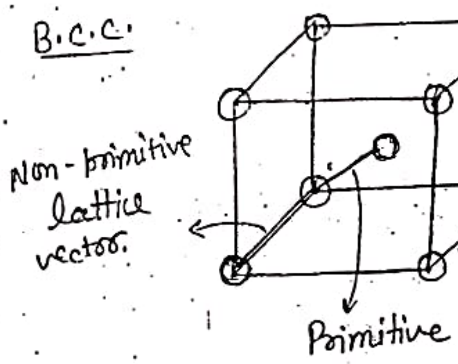
It is defining in direct lattice only.

where, a, b, c are Primitive direct lattice vector.

bcoz they are joining nearest lattice (points), vectors.

If they join far lattice points then these vectors will be non-primitive.

B.C.C.



B.C.C. is 1 basis structure.

lattice parameter → joining IInd near neighbour.

Here, lattice vector connect non-nearest lattice points. so Non-primiti

In Reciprocal lattice, $\vec{A}, \vec{B}, \vec{C}$ are the primitive Reciprocal lattice vectors.

$$\boxed{\begin{aligned} \vec{A} &= \frac{2\pi(\vec{b}\times\vec{c})}{\vec{a}\cdot(\vec{b}\times\vec{c})} \\ \vec{B} &= \frac{2\pi(\vec{c}\times\vec{a})}{\vec{a}\cdot(\vec{b}\times\vec{c})} \\ \vec{C} &= \frac{2\pi(\vec{a}\times\vec{b})}{\vec{a}\cdot(\vec{b}\times\vec{c})} \end{aligned}}$$

Reciprocal lattice vector $\boxed{\vec{G} = h\vec{A} + k\vec{B} + l\vec{C}}$

- $\boxed{e^{iG\cdot T} = 1}$
- $\boxed{\vec{G}\cdot\vec{T} = 2\pi n}$, $n \rightarrow$ some integer
  $n = 0, 1, 2, \cdots$