B. Sc. (Physics)
Part III (Solid State Physics)
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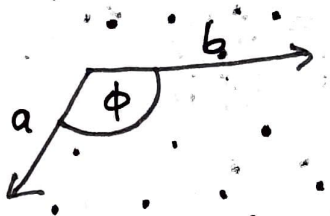
"BRAVAIS LATTICE"

There is no natural restriction on lengths a, b of translation vectors. An unlimited number of lattices is possible. But the requirement that a lattice should invariant under a rotation operation $\frac{2\pi}{n}$ where $n = 1, 2, 3 - - -$ or under the mirror operation places restriction on the primitive translation vectors a, b. These lattices thus obtained are special type of lattice called Bravais lattice. There are five in two dimensions:-

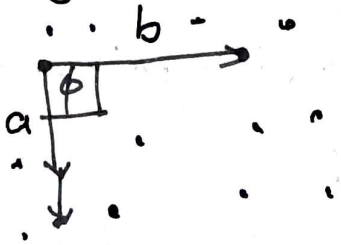
(1) Oblique lattice:-



$|a| \neq |b|$

The oblique lattice is invariant under rotation of π and 2π about any lattice points.

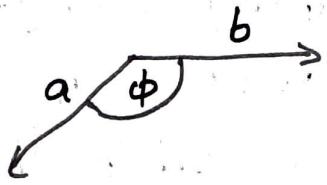
(2) Square lattice



$|a| = |b|$

$\phi = 90^\circ$.

(3) Hexagonal lattice



$|a| = |b|$, $\phi = 120^\circ$

This lattice remains invariant under a rotation of $2\pi/6$ about an axis through a lattice print and normal to the plane.

(iv). Rectangular lattice:- The primitive translation vectors a, b in terms of unit vectors in cartesian co-ordinate can be expressed as

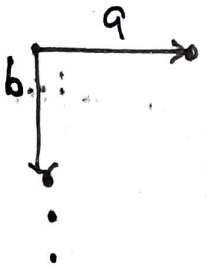
$$\left.\begin{aligned} a &= i a_x + j a_y \\ b &= i b_x + j b_y \end{aligned}\right\} \quad \text{---(1)}$$

If the primitive vectors are mirrored in x axis, then a, b are transformed into new vectors a' and b'.

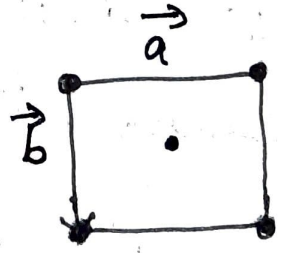
$$\left.\begin{aligned} \therefore a' &= i a_x - j a_y \\ b' &= i b_x - j b_y \end{aligned}\right\} \quad \text{---(2)}$$

If the lattice is invariant under reflection then a' and b' must be lattice vectors.

$$\left.\begin{aligned} \therefore a &= j a \\ b &= j b \end{aligned}\right\} \quad \text{---(3)}$$



(v) Centred rectangular lattice:-



$$b' = a - b$$

$$\therefore b'_x = a_x - b_x = b_x$$

$$b'_y = a_y - b_y = -b_y$$ these eqn can have soln provided $a_y = 0$, $a_x = 2b_x$.

We have the possible choice of primitive translation vectors given by $a = ia$, $b = \frac{ia}{2} + jb_y$.

$\therefore$ For this lattice $|a| \neq |b|$, $\phi = 90^\circ$.