# Day – 2

☆ Basic def$^n$ of lattice
☆ Symmetry in crystal structure } mathematical framework

→ Development of materials and processes

- Stone-age man used stones on earth's surface, made spears and other weapons
- Chalcolithic age – Copper used (mining to below earth's surface
- Harappan / Mohenjo Daro – Bronze (alloy)
  - Cu + Sn
  - not naturally found.
- Indians used wootz steel for war weapons.

Observing the shift in paradigm.

→ Structure-property relation:

Recall that structure affects property.

- Starting point – Perfect crystal structure
  - ↓
  - Crystalline materials
- Amorphous – No shape (solid solidified

form of liquid)
Eg: glass

- Standardized description :

  Symmetry, mathematical description

- Crystal :

→ Definite structure
→ Repeating pattern of atoms
→ Non-uniformity at a location.

- Lattice / Space Lattice :

Atoms or molecules that decorate a lattice.
But what is a lattice?

A definite framework of atoms that repeats itself in all directions is called lattice.

Translational symmetry: If lattices is 'moved' in equal units of distance in a linear way such that we can't say whether lattice has moved or not is called translational symmetry. [Invariant under Translation]

- Einstein summation convention:

$$t = v_i a_i = v_1 a_1 + v_2 a_2 + v_3 a_3$$

$$??? = \varepsilon_{ijk} p_i \varepsilon_j r_k$$

$$??? = b_i v_i a_i$$

Random scalar

Summation to be done

$$\tau = \{t / t = u_i \vec{a}_i,\ u_i \in Z\}$$

$\vec{a}_i$ → lattice vectors

$t$ → translation vector.

Volume of unit cell $= [\vec{a}_1\ \vec{a}_2\ \vec{a}_3]$

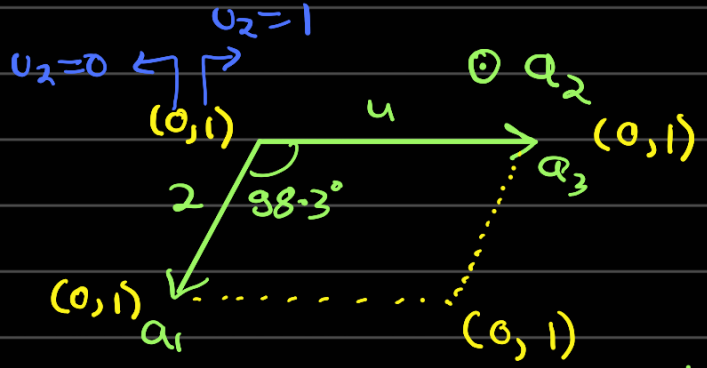
$= (\vec{a}_1 \times \vec{a}_2) \cdot \vec{a}_3$

☆ Problem:

Parameter coordinates: $(2, 3, 4, 90, 98.3, 90)$

$\downarrow$ $\downarrow$ $\downarrow$ $\downarrow$ $\downarrow$ $\downarrow$

$a_1$ $a_2$ $a_3$ $\alpha_3$ $\alpha_2$ $\alpha_1$




$\vec{a}_1 = 2\hat{i}$

$\vec{a}_2 = 3\cos 98.3^\circ \hat{i} + 3\sin 98.3^\circ \hat{j}$

$\vec{a}_3 = 4\hat{k}$

$\therefore V = [\vec{a}_1\ \vec{a}_2\ \vec{a}_3]$

$= 24 \sin 98^\circ$

$\simeq 23.766$

☆ Symmetry: Defined by symmetry elements/ operators.

(i) Translational

(ii) Rotational

(iii) Reflectional } Roto-reflectional

(iv) Inversional → either of them

Roto-inversional