Lecture 10

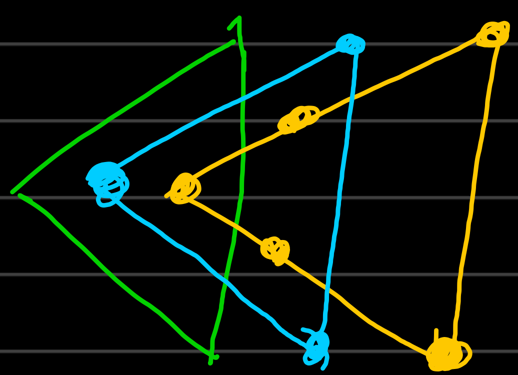
Single Crystal Deformation.

Stacking Faults:

- surface defects. (2D)
- fault in the periodic sequence of stacking of a crystal.

$$\ldots\underbrace{ABCABCABC}_{\text{Ideal FCC Stacking}}\ldots \qquad \underbrace{ABBCABCABCCABC}_{\text{Stacking Fault.}}$$

- Stacking of [111] closed packed planes.



→ Crystal on one side of SF is shifted by a non-lattice translation wrt crystal

* Non-lattice transition.

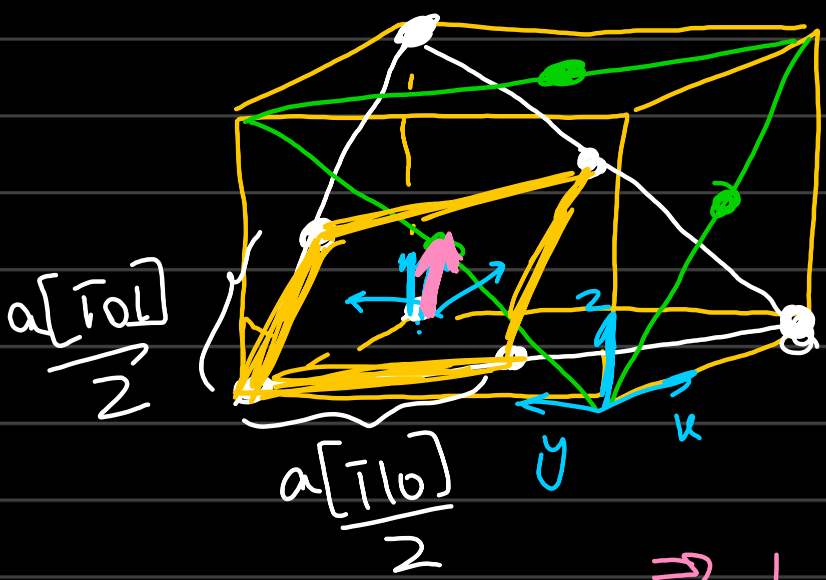
↳ Intrinsic & Extrinsic Stacking Fault:

↓ missing plane

↳ layer inserted

→ Stacking Fault vector

(B translates to C }: ↳ non-lattice translation vector.



Diagonal vector

$= \frac{a[\bar{1}01]}{2} + \frac{a[\bar{1}10]}{2}$

$= \frac{a[\bar{2}11]}{2}$

$\Rightarrow \frac{1}{3} \times \frac{a[\bar{2}11]}{2} = \frac{a[\bar{2}11]}{6}$

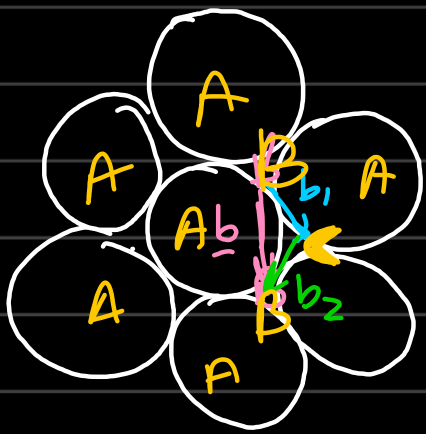
SF vector

Burgers vector of dislocation

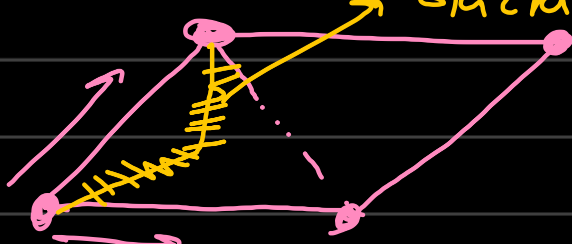
$\Updownarrow$

minimum lattice translation vector.

{Full dislocation} : $b = \frac{a}{2}[10\bar{1}]$



$$\boxed{\underline{b} = \underline{b_1} + \underline{b_2}}$$



stacking Fault vectors.

full lattice translation.

$$\boxed{\frac{a}{2}[\bar{1}01] = \underbrace{\frac{a}{6}[2\bar{1}\bar{1}] + \frac{a}{6}[11\bar{2}]}_{\text{partial dislocations.}}}$$

{Stacking Fault vector}

→ Move from B→C & C→B

↳ Create faults for minimum energy path.

↳ directly B→B is unfavourable.

→ A Stacking Fault is bounded by two partial dislocations $\left\{\frac{a}{6}[2\bar{1}\bar{1}]\right\}$

$$\boxed{\text{Energy of dislocation} = Gb^2}$$

→ movement by creation of stacking faults is more energetically favourable.

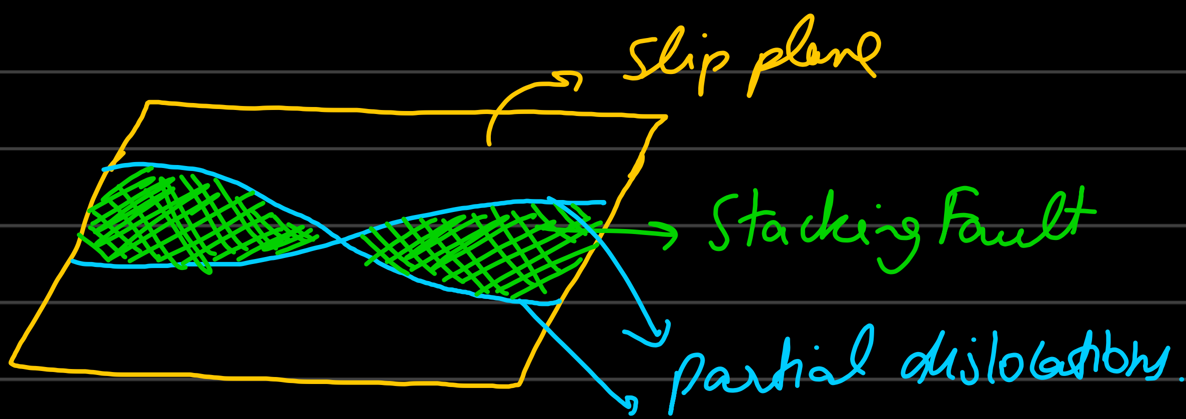
In FCC : $\underline{b} = \frac{a}{2}[1\bar{1}0]$ $\quad |b| = \frac{a}{\sqrt{2}}$

$$E_{FCC} = Gb^2 = \frac{Ga^2}{2}$$

Energy of partial dislocation:

$$E_{fcc} = 2G\left(\frac{1}{6}a[\bar{2}11]\right)^2 = \frac{Ga^2}{3}$$

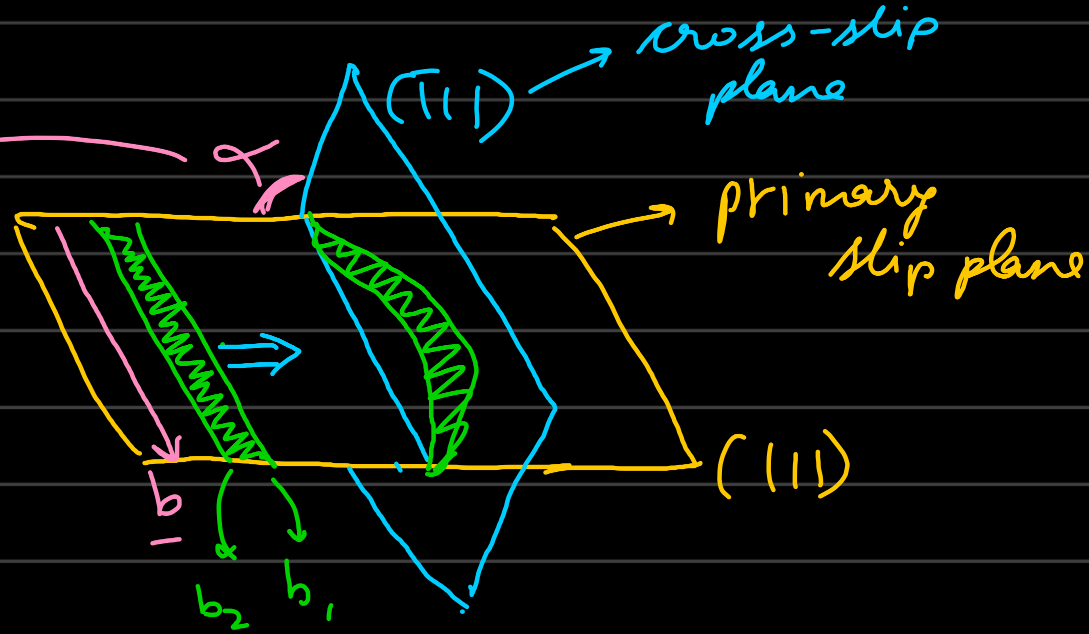
$$\underbrace{\frac{Ga^2}{3} < \frac{Ga^2}{2}}$$



→ A perfect dislocation would prefer to split into two partial dislocation.

$\cos^{-1}\left(\frac{1}{3}\right)$

$\hookrightarrow 70.\_^{\circ}$



↳ leading partial dislocation.

↳ The partial dislocation lines are favourable to move onto the cross-slip plane.

* $\underbrace{\langle 11\bar{2}\rangle, \langle 1\bar{1}0\rangle, \langle 111\rangle}$

mutually ⊥lr to each other.

→ angle b/w two partials = 120° $(\underset{\sim}{b_1}, \underset{\sim}{b_2})$

stacking fault moves on slip planes.

→ very st. fault lines observed in microstructure. {sharp features}

→ intersecting fault lines. (angle ≃ 71°)

→ observed in TEM imaging {transmission electron microscopy}