

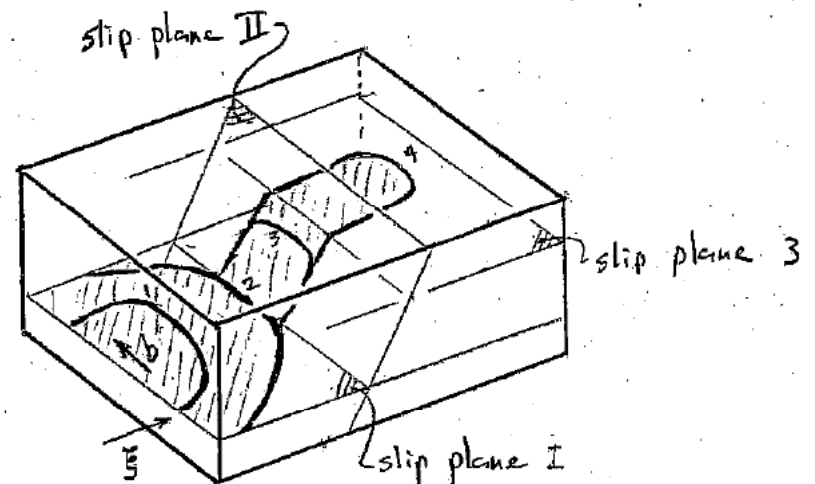
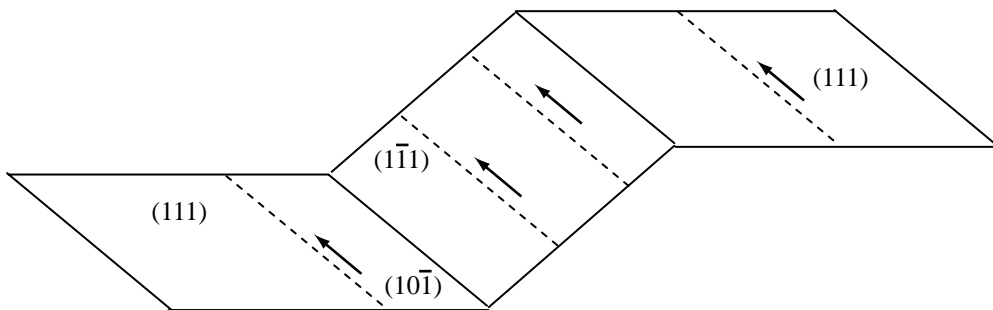


3.40 Sept 30th Lecture Highlights

- Cross-slip
- Applied stress:
 - Stress axis & slip systems
- Dislocation Locking Interactions
 - Intersections
 - Combinations
- Partial Dislocations

Cross-slip

- Overcome an obstacle in primary slip plane
 - Screw dislocation: no uniquely defined slip plane
 - Transfer to intersecting slip plane with same \mathbf{b}
 - Returns to initial slip plane (double cross slip)
 - Conservative: length of dislocation line unchanged



W. Hosford. Mechanical behavior of materials. Cambridge. 2005
Courtesy of Krystyn Van Vliet. Used with permission.
Please also see Fig. 10.8 in Hosford, William F. *Mechanical Behavior of Materials*. New York, NY: Cambridge University Press, 2005.

S Baker. MS&E 402 course notes 2006. Cornell University
Courtesy of Shefford Baker. Used with permission.

Effects of Stress

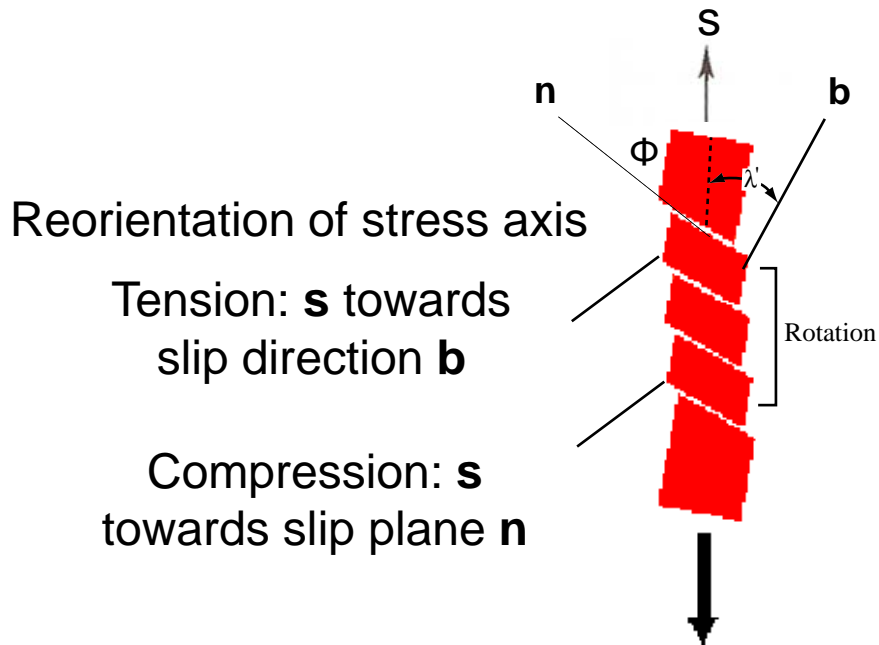
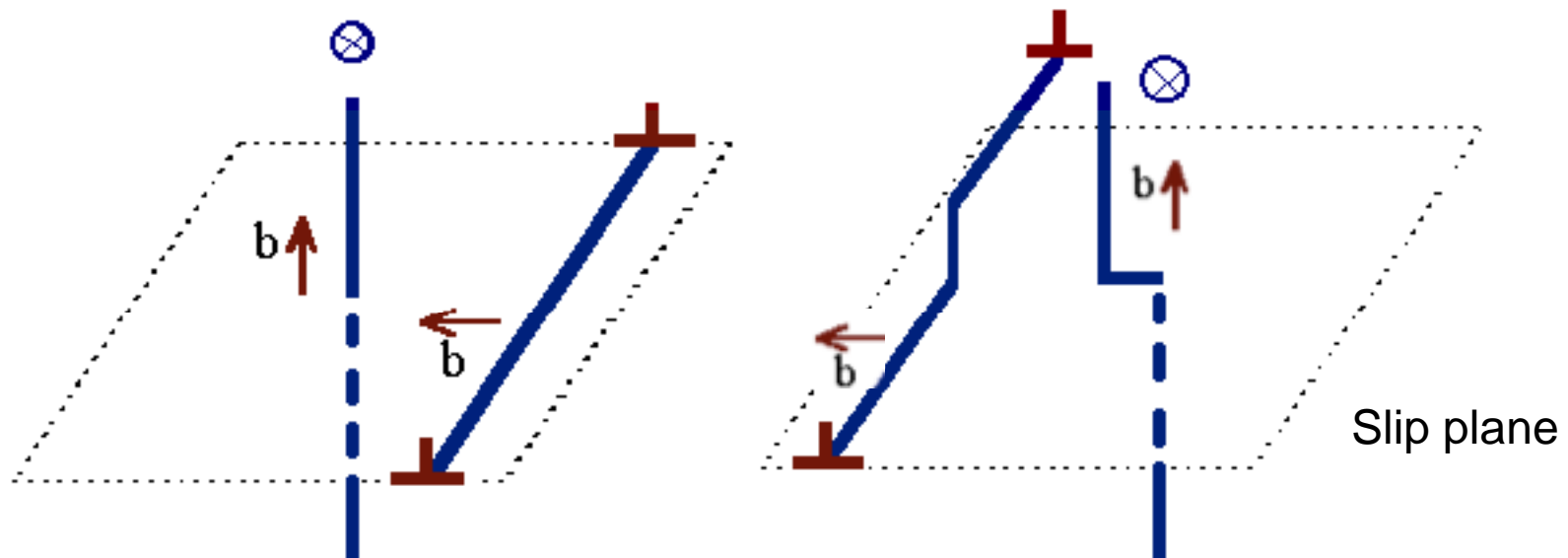


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Please see Fig. 5.31 in Reed-Hill and Abbaschian,
Physical Metallurgy Principles. Boston, MA: PWS Publishing, 1994.

Changes Schmid factors:
Activates new slip systems

FCC $\langle 110 \rangle \{111\}$ slip system
Tension applied

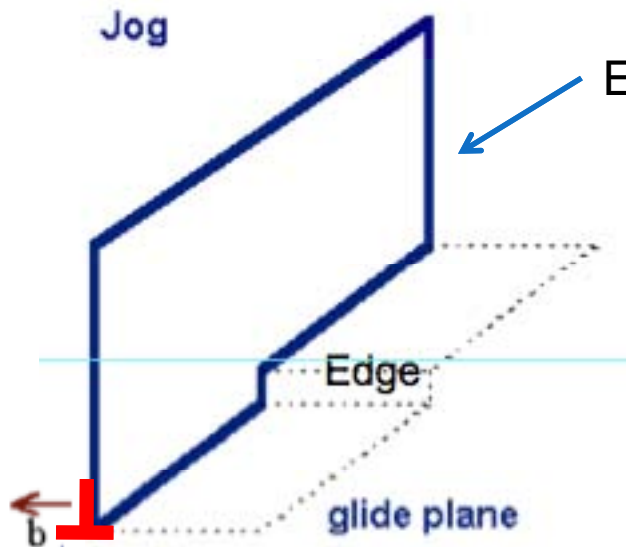
Dislocation Intersections



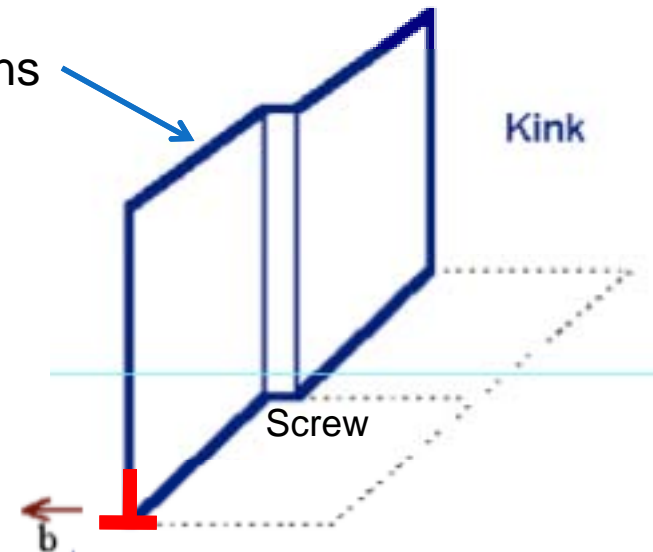
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- Dislocation acquires a step
 - Equal in direction and magnitude to intersecting dislocations burgers vector
 - Exception: $\mathbf{b} \parallel$ dislocation line: Nothing happens
 - May have different character and glide plane than original dislocation

Steps in Dislocations



Step normal to slip plane
Changes glide plane
Pinning point (glissile)

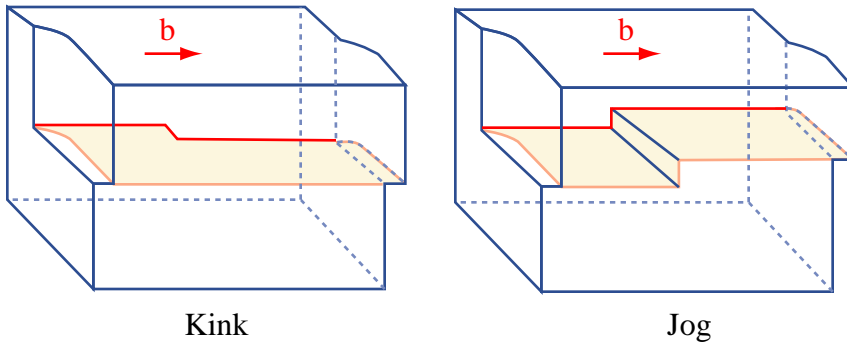


Step in slip plane
Constant glide plane
Mobile (sessile)

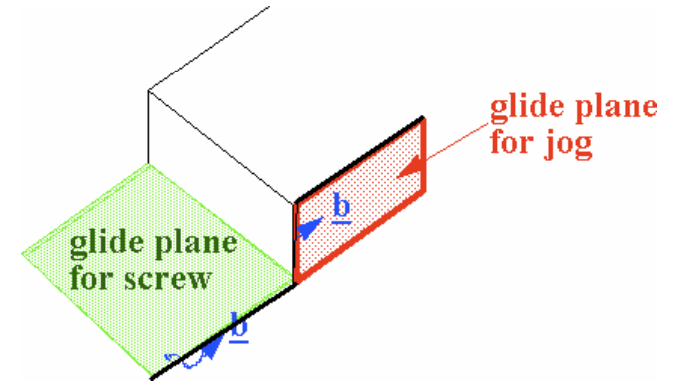
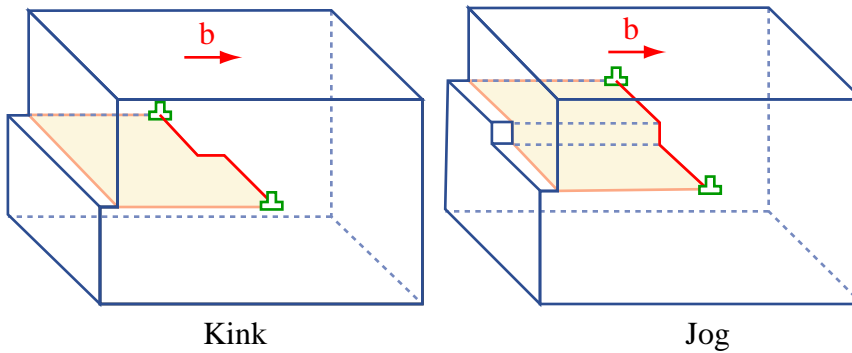
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Steps in Dislocations- Visual

Screw Dislocation:



Edge Dislocation:



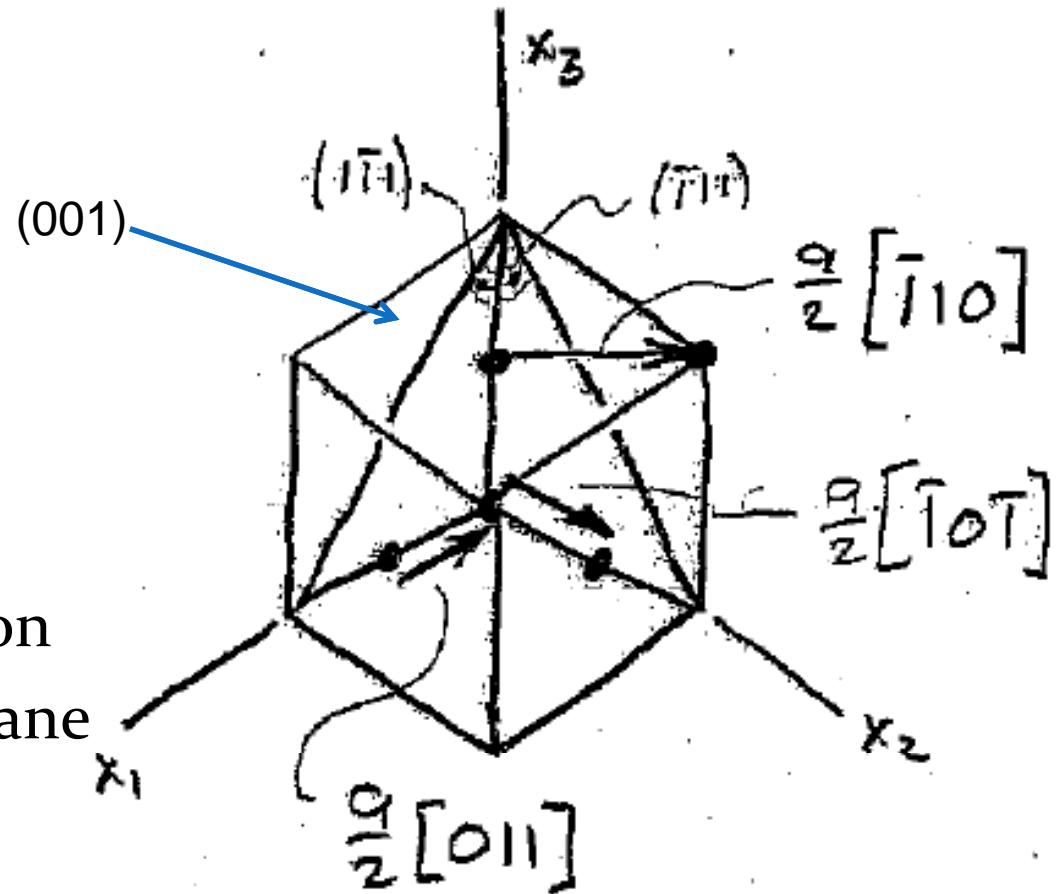
Courtesy of A. M. Donald. Used with permission.

Lomer Lock: Combination

- 2 Dislocations on primary slip planes combine

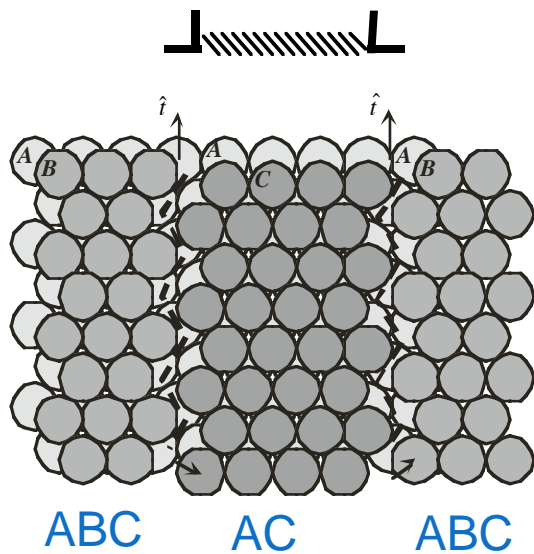
$$\frac{a^2}{2} + \frac{a^2}{2} > \frac{a^2}{2}$$

- new dislocation:
 - **b** primary slip direction
 - **n** non-primary slip plane
- Dislocation becomes immobile “locked”



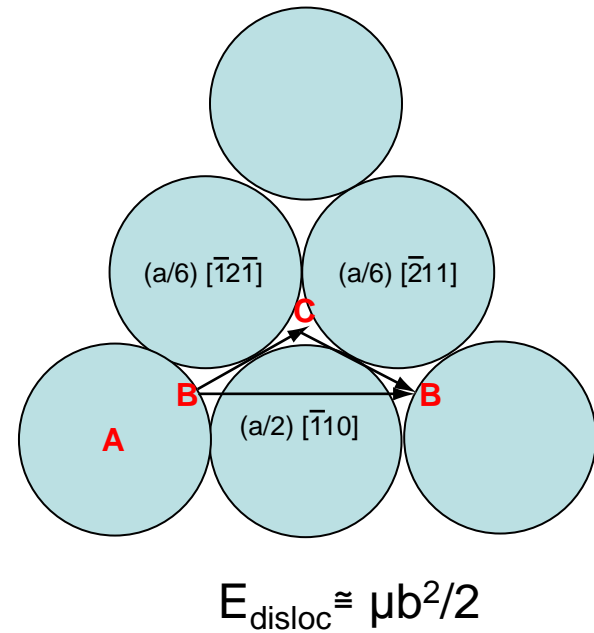
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Partial Dislocations



Partial dislocation

Single dislocation →
2 partials & stacking fault

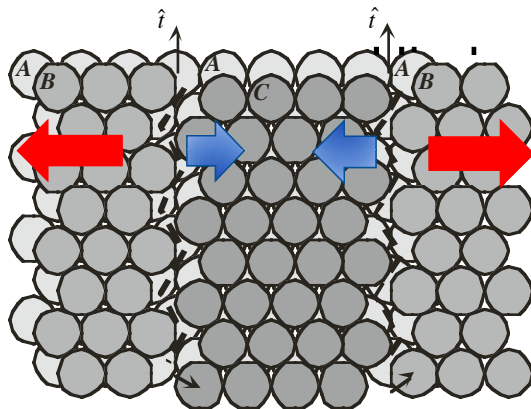


$$\frac{E_{\text{partials}}}{E_{\text{Perfect}}} = \frac{\frac{a^2}{6} + \frac{a^2}{6}}{\frac{a^2}{2}} = \frac{2}{3}$$

Partial Dislocations

Dislocations repel

Stacking fault resists



Partial dislocation

$$\gamma_{SF} \Delta x \propto \frac{\mu b^2}{\gamma_{SF}}$$

$$\gamma_{SF} = b \tau$$

$$\tau = \frac{\mu b}{2\pi\Delta x} (\text{screw}) \frac{\mu b}{2\pi(1-\nu)\Delta x} (\text{edge})$$

- Stacking Fault Energy γ_{SF} (mJ/m²)
- Ag: 22 Cu: 78 Ni: 128
- Low γ_{SF} = large separation
- Hinders partial recombination
 - Limits cross-slip
 - Easier work hardening

Courtesy of Sam Allen and Krystyn Van Vliet. Used with permission.
Please also see Fig. 9.25 in Hosford, William F. *Mechanical Behavior of Materials*.
New York, NY: Cambridge University Press, 2005.

A. Putnis. Introduction to mineral sciences. Cambridge Univ. Press. 1992

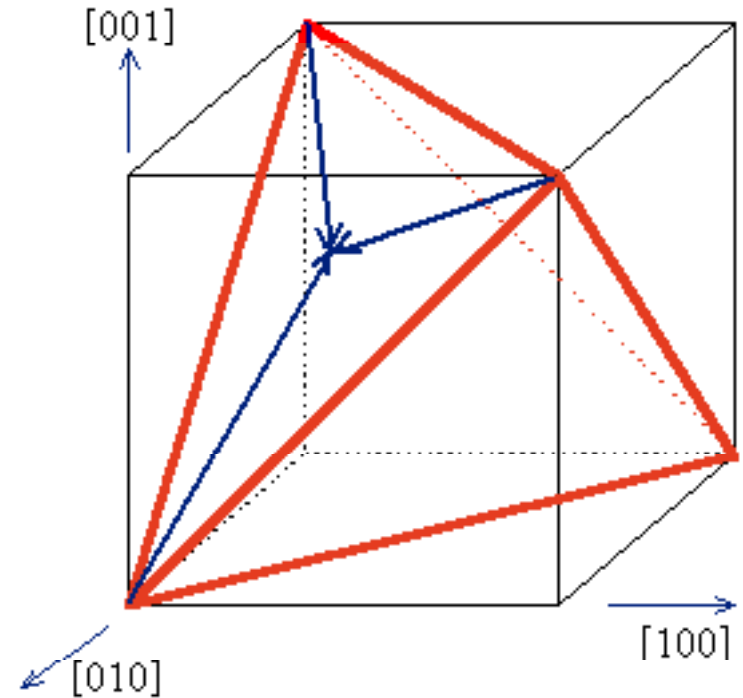
L. E. Murr, Interfacial Phenomena in Metals and Alloys(Addison Wesley, Reading MA, 1975).

Thompson's Tetrahedron

- Notation for all slip planes, directions, and partials.

Example: FCC

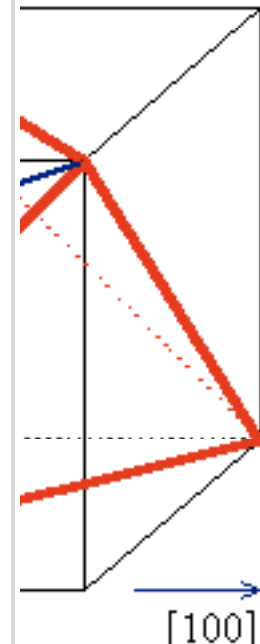
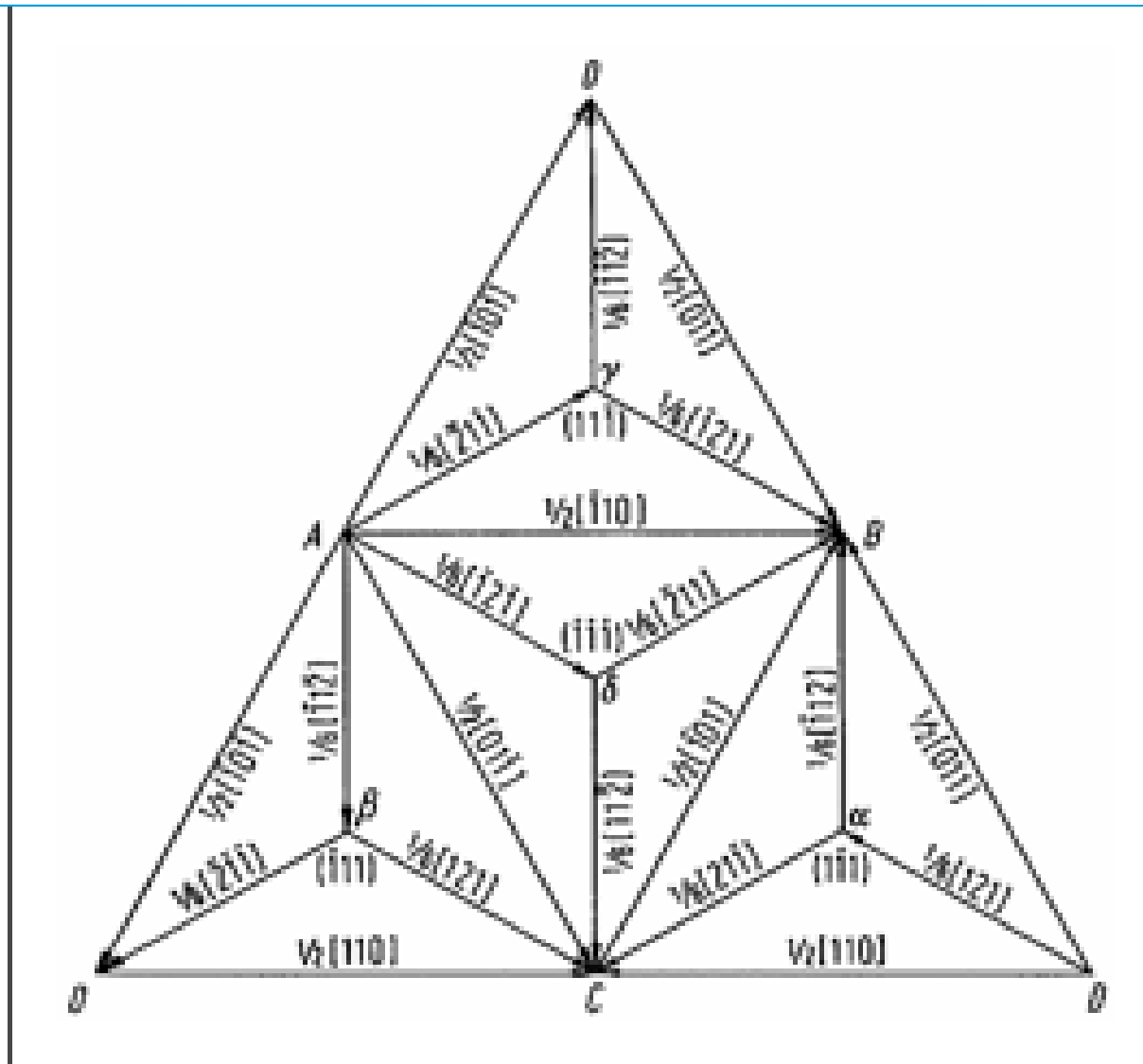
- Triangles are slip planes
 - $\{111\}$
- Edges are slip directions
 - $\langle 110 \rangle$
- Blue arrows:
 - Partial dislocations



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Thompson's Tetrahedron

- Exam
- Triang
- $\{111\}$
- Edges
- $\langle 110 \rangle$
- Blue a
- Par



http://www.tf.uni-kiel.de/matwis/amat/def_en/kap_5/illustr/i5_4_5.html

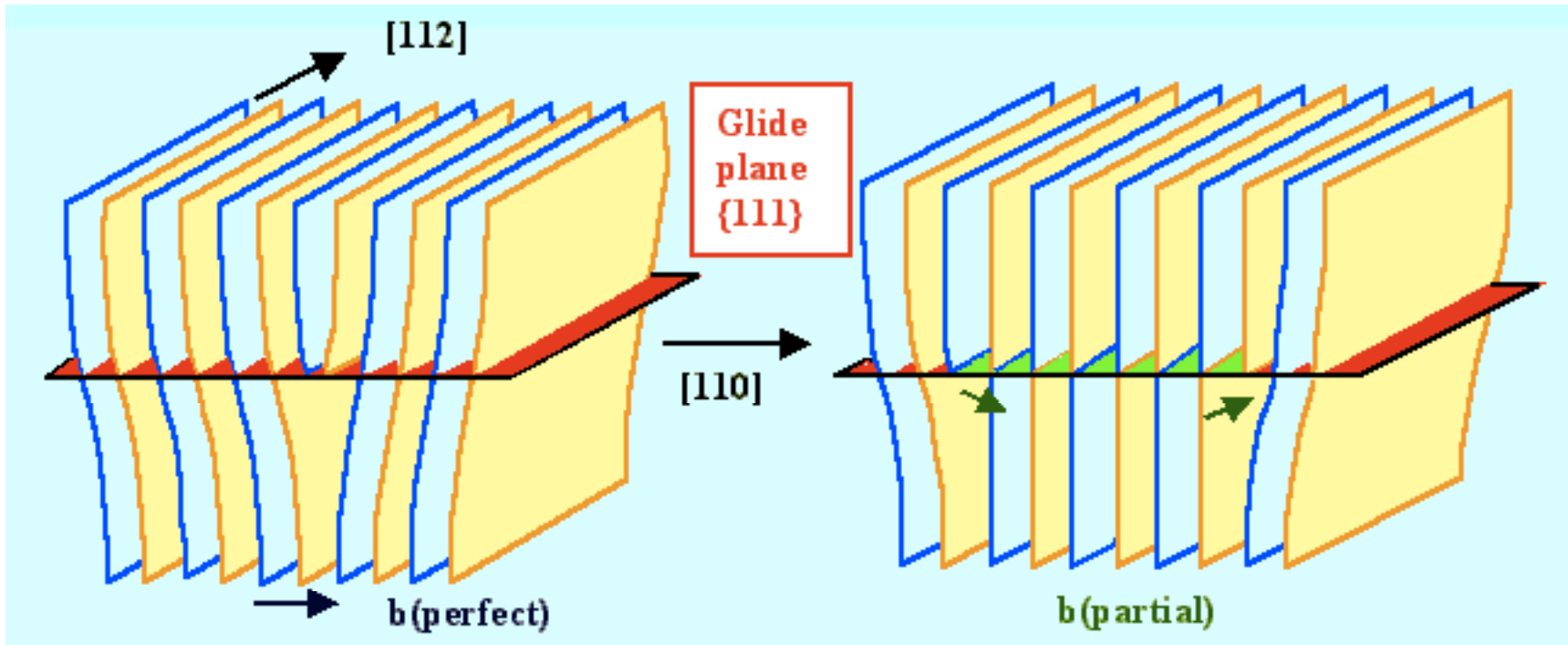
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Questions?

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Please see Cham, Jorge. "[Unemployment vs. Graduate Stipends.](#)"

Piled Higher & Deeper, August 21, 2009.



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View from below
Glide plane

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Please see Fig. 5.8b in Hull, D., and D. J. Bacon.

Introduction to Dislocations. Boston, MA: Butterworth-Heinemann, 2001.

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3.40J / 22.71J / 3.14 Physical Metallurgy
Fall 2009

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