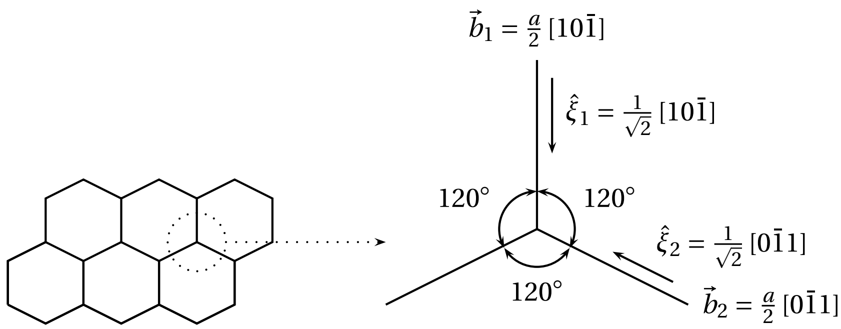
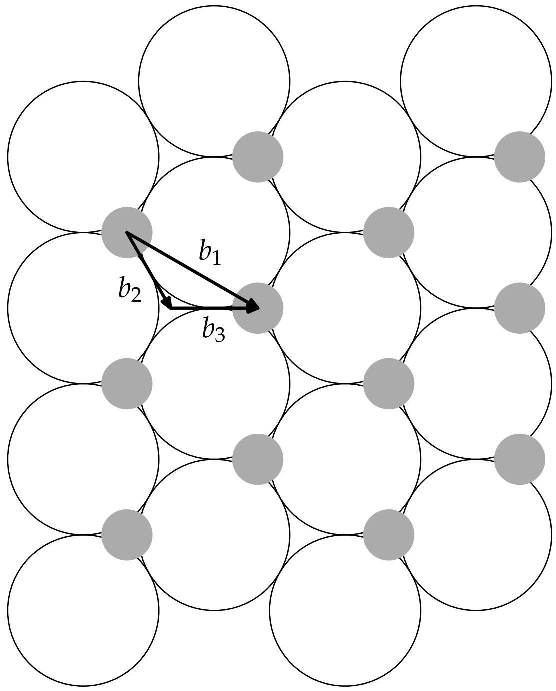
ME 386P-2: Mechanical Behavior of Materials
Dislocations Handout
Date: February 27, 2014

Practice Problem: Consider an array of edge dislocations in an FCC metal forming the hexagonal array shown below. The sense, $\hat{\xi}_i$, and Burgers, $\vec{b}_i$, vectors at one node are given for two dislocations. Calculate the sense and Burgers vectors of the third dislcoation at that node. What type of dislocations are these? In what crystallographic plane do these dislocation lie?



Edge Dislocation in an FCC Lattice

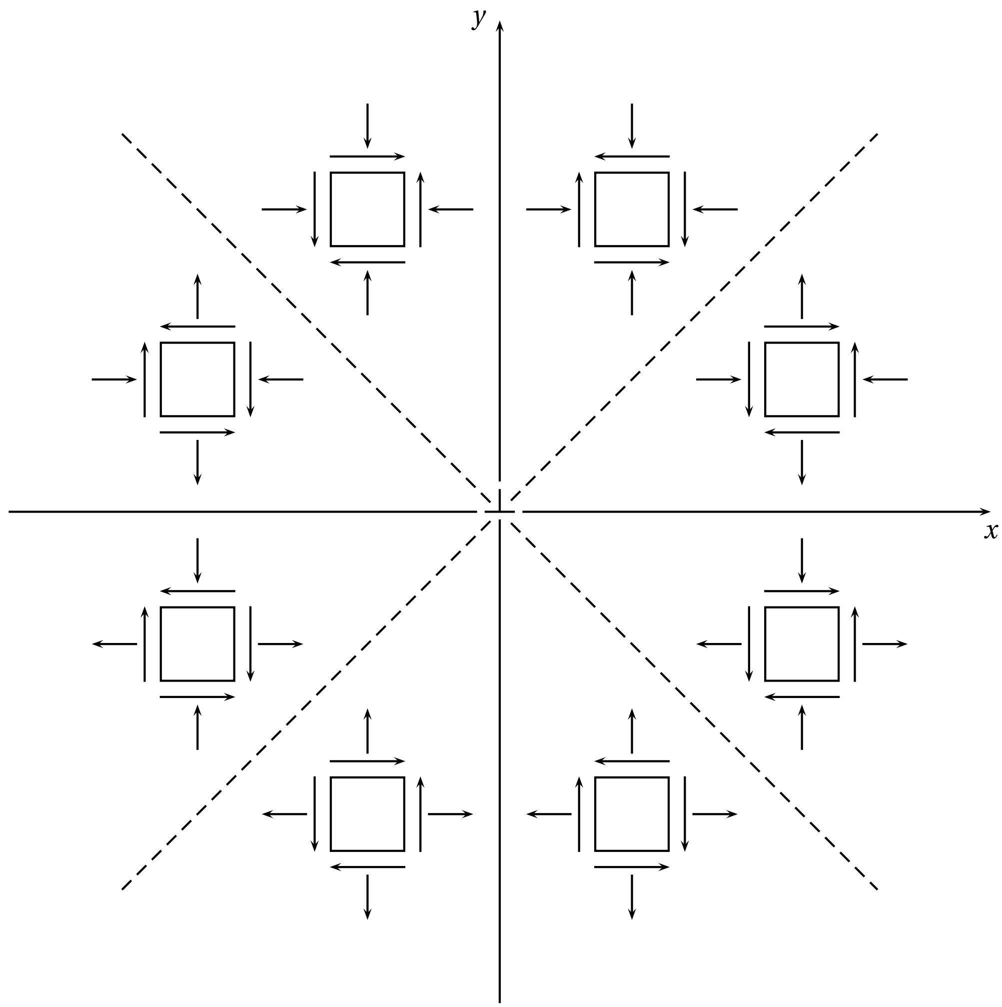
$$b_1 = b_2 + b_3$$



$$\begin{aligned} b_1 &= \frac{a}{2}[\bar{1}01] \\ b_2 &= \frac{a}{6}[\bar{2}11] \\ b_3 &= \frac{a}{6}[\bar{1}\bar{1}2] \end{aligned}$$

Will the full dislocation b_1 decompose into two partial dislocations, b_2 and b_3? Use Frank's rule to answer this question. What are the ramifications of the full dislocation potentially decomposing into partial dislocations?

Stress Field about an Edge Dislcoation



In polar coordinates:

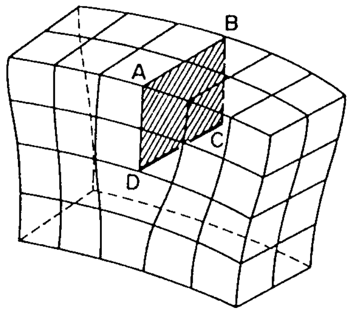
$$\sigma_{rr} = \sigma_{\theta\theta} = -\frac{Gb}{2\pi(1-\nu)}\frac{\sin\theta}{r}$$
$$\sigma_{r\theta} = \frac{Gb}{2\pi(1-\nu)}\frac{\cos\theta}{r}$$

In Cartesian coordinates:

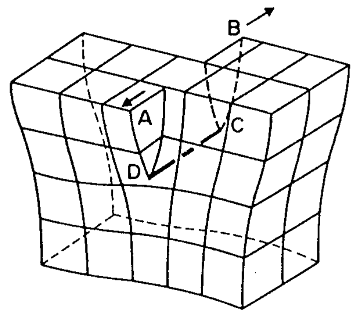
$$\sigma_{xx} = -\frac{Gb}{2\pi(1-\nu)}\frac{y(3x^2+y^2)}{(x^2+y^2)^2}$$
$$\sigma_{yy} = \frac{Gb}{2\pi(1-\nu)}\frac{y(x^2-y^2)}{(x^2+y^2)^2}$$
$$\tau_{xy} = \frac{Gb}{2\pi(1-\nu)}\frac{x(x^2-y^2)}{(x^2+y^2)^2}$$
$$\sigma_{zz} = \nu(\sigma_{xx}+\sigma_{yy})$$

and $\tau_{xz} = \tau_{yz} = 0$.

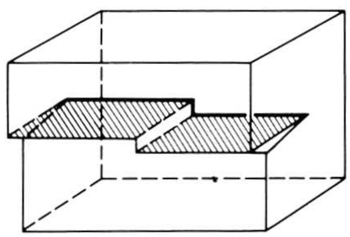
Examples: D. Hull and D. J. Bacon, *Introduction to Dislocations*, Fourth Edition (Butterworth-Heinemann, Oxford) 2001.



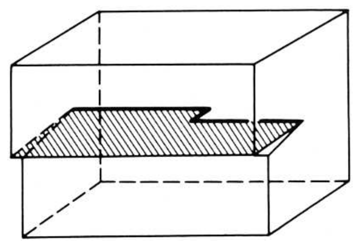
Edge dislocation



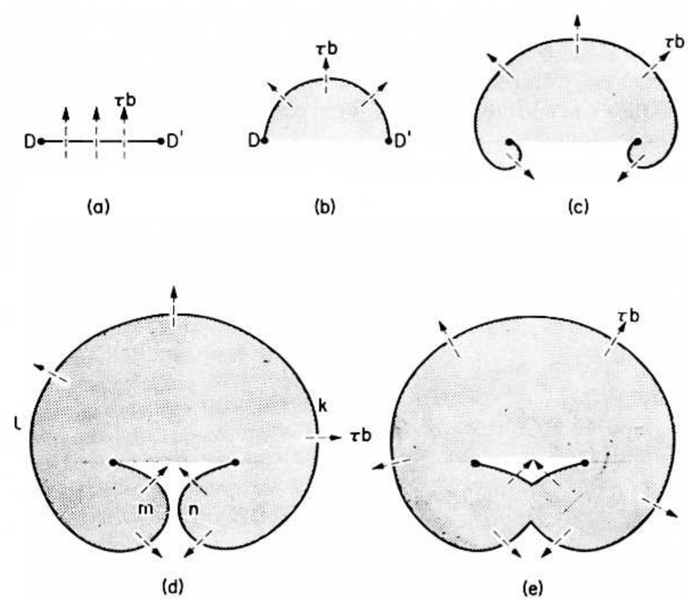
Screw dislocation



Jog in a screw dislocation



Kink in a screw dislocation



A Frank-Read dislocation source