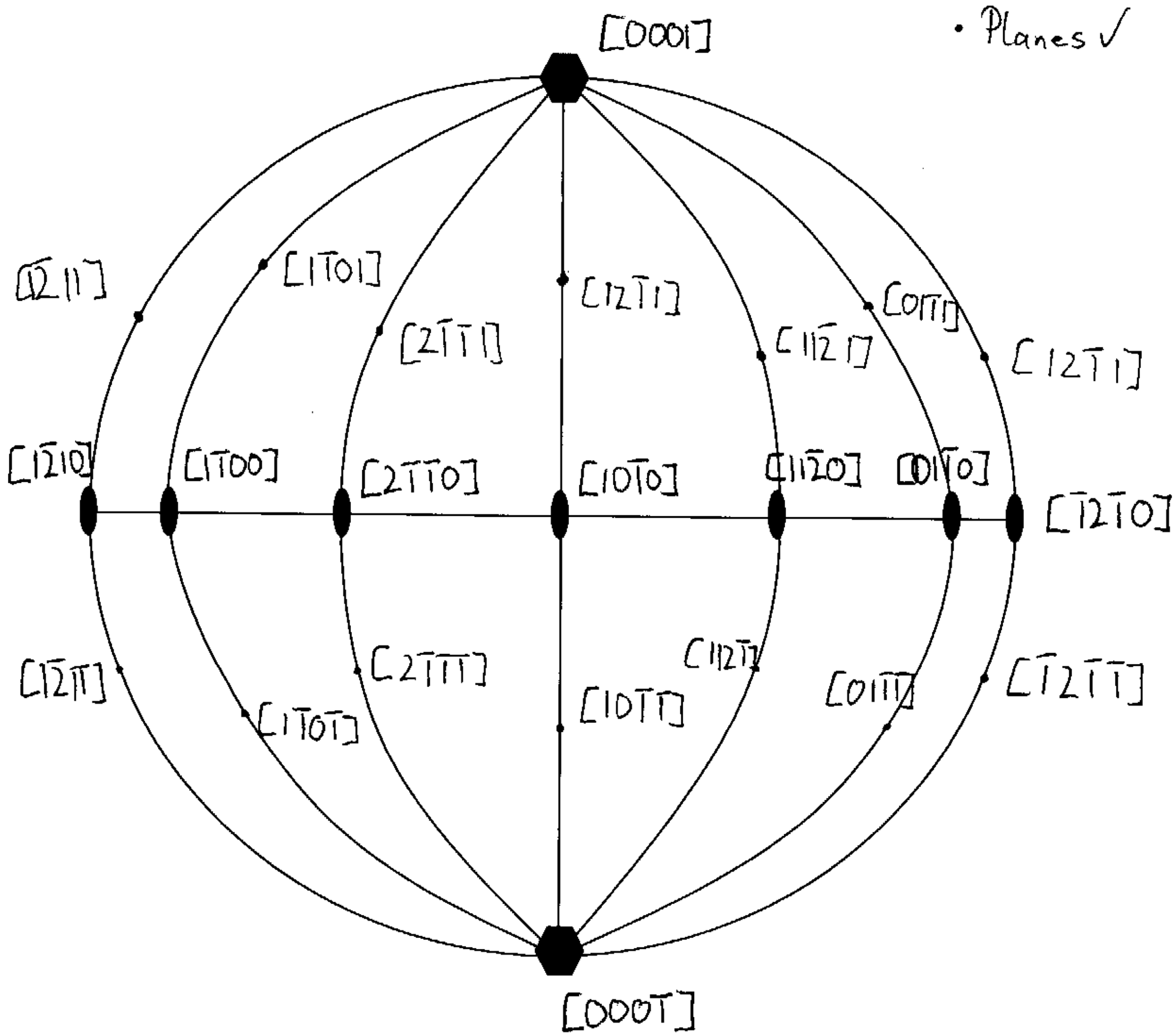
Problem #1:

- Symmetries ✓
- Labels ✓
- Planes ✓



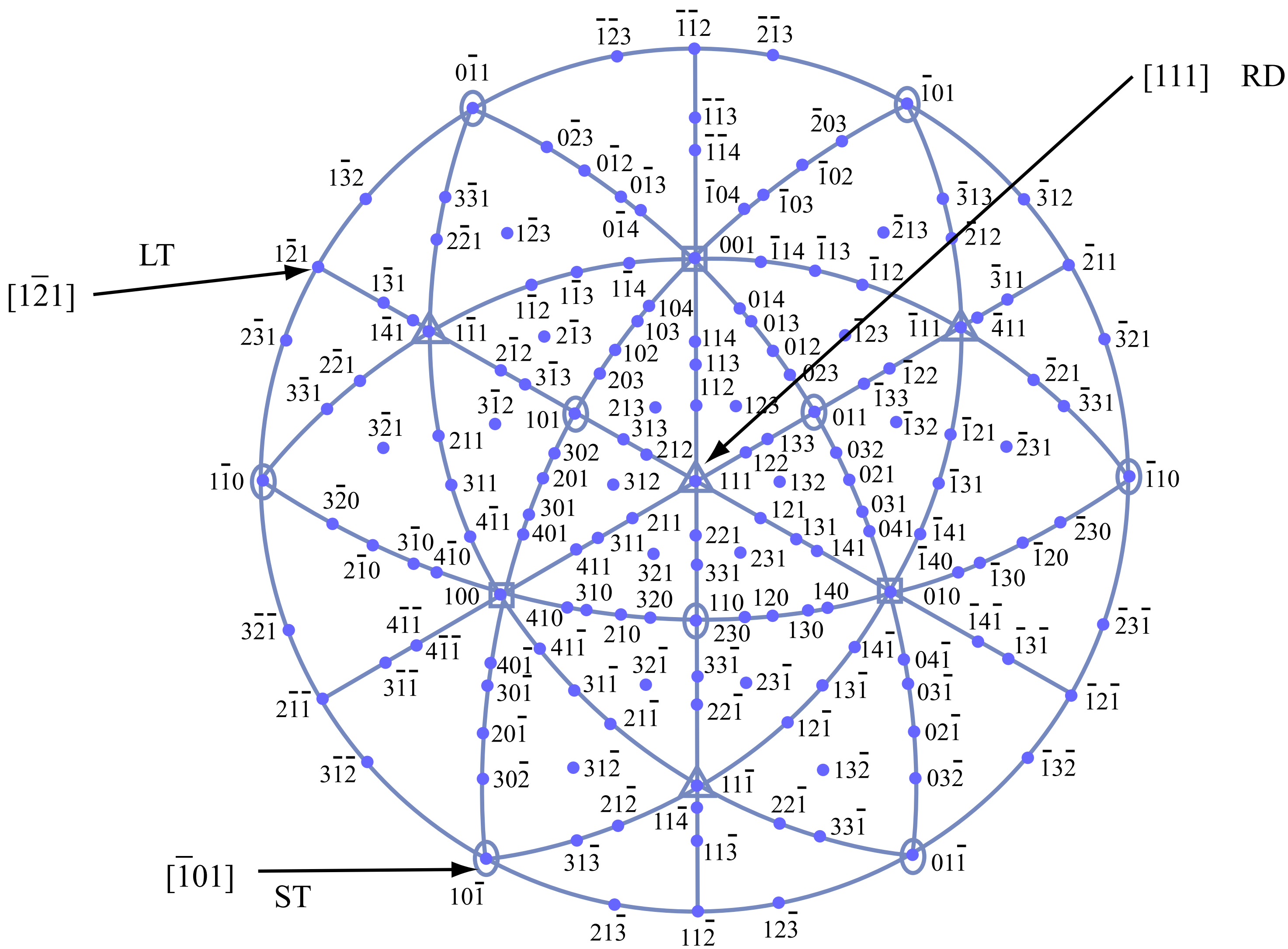
Problem #2:

$$\begin{pmatrix}1\\1\\1\end{pmatrix} \times \begin{pmatrix}\bar{1}\\0\\1\end{pmatrix} = \begin{pmatrix}1\\\bar{2}\\1\end{pmatrix}$$

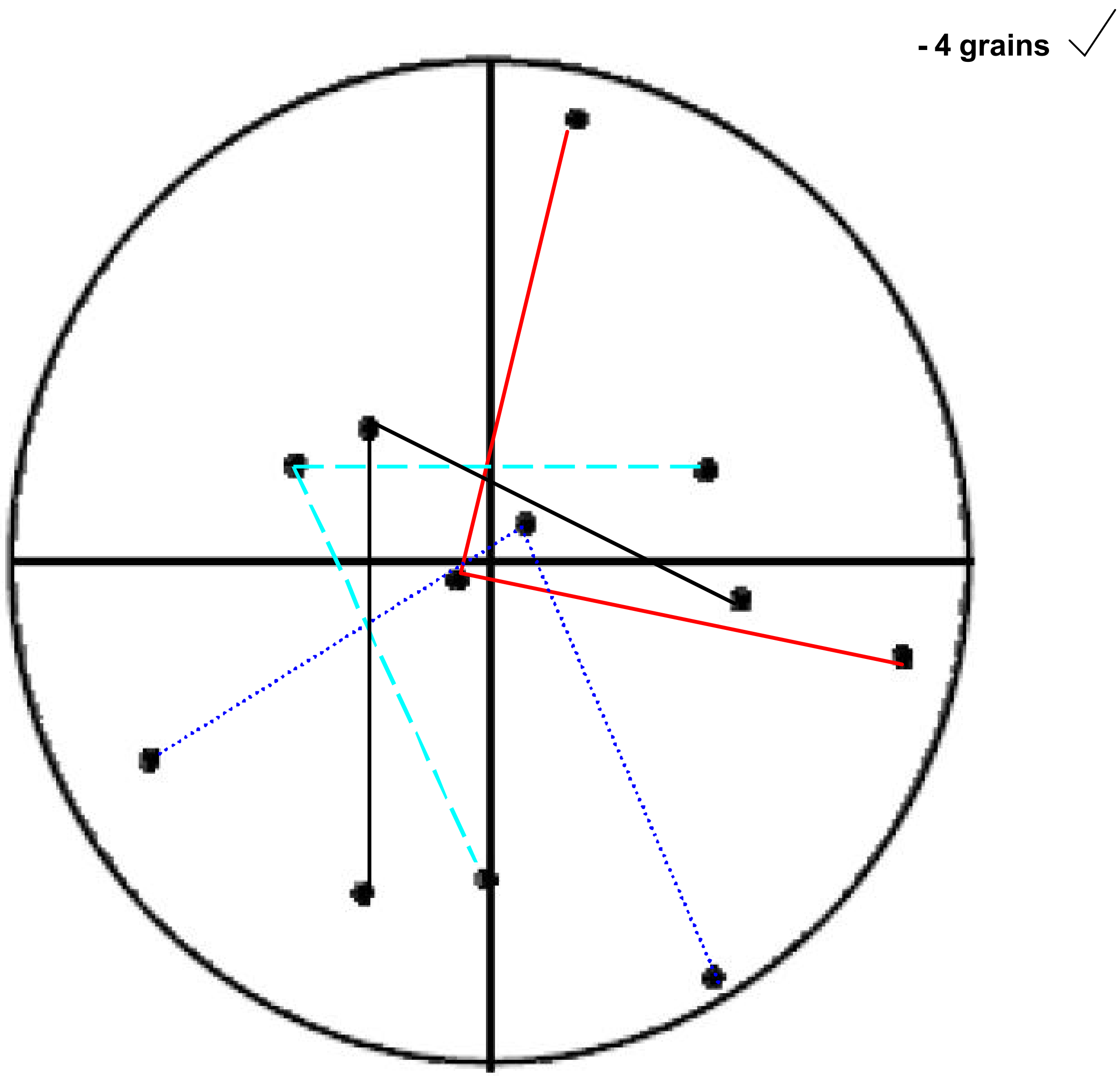
-Cross prod.

-Results for LT

-Directions in proj.



Problem #3:



Problem #4:

$$\tau = \frac{\mu b}{2\pi r} \qquad r = \frac{\mu b}{2\pi \tau} \qquad \tau_{crit} = 2\ MPa$$

	Al	Au
μ/GPa	25	27
b/nm	0.283	0.288

$$\Rightarrow Al: r_{crit} = \frac{25 \cdot 10^{9}\ N/m^2 \cdot 0.283 \cdot 10^{-9}\ m}{2\pi \cdot 2 \cdot 10^{6}\ N/m^2} = 0.56\ \mu m = 1.98 \cdot 10^{3} b$$

$$\Rightarrow Au: r_{crit} = \frac{27 \cdot 10^{9}\ N/m^2 \cdot 0.288 \cdot 10^{-9}\ m}{2\pi \cdot 2 \cdot 10^{6}\ N/m^2} = 0.62\ \mu m = 2.15 \cdot 10^{3} b$$

$$r_{crit,Au} > r_{crit,Al}$$

- equation ✓
- find properties ✓
- calculate r_{crit} and conclusion ✓

Problem #5:

a) - no change in distance since stress field is the same
- parallel screws ⇝ repel ⇝ 2nd screw moves in same direction
- antiparallel attract ⇝ 2nd screw moves in opposite direction ⇝ annihilation

b)

$$\tau_{xy} = \frac{\mu b x}{2\pi(1-\nu)} \frac{(x^2 - y^2)}{(x^2+y^2)^2}$$

$y = 0$ same plane

$$\tau_{xy} = \frac{\mu b x \, x^2}{2\pi(1-\nu) x^4} = \frac{\mu b}{2\pi(1-\nu)x} \rightsquigarrow x = \frac{\mu b}{2\pi(1-\nu)\tau_{xy}}$$

	Al	Au
μ/GPa	25	27
b/nm	0.283	0.288
ν	0.35	0.42

$$\Rightarrow \text{Al}: x = \frac{25 \cdot 10^9 \, N/m^2 \cdot 0.283 \cdot 10^{-9} m}{2\pi(1-0.35) \cdot 2 \cdot 10^6 \, N/m^2} = 6.1 \cdot 10^3 b = 1.7 \mu m$$

$$\Rightarrow \text{Au}: x = \frac{27 \cdot 10^9 \, N/m^2 \cdot 0.288 \cdot 10^{-9} m}{2\pi(1-0.42) \cdot 2 \cdot 10^6 \, N/m^2} = 6.6 \cdot 10^3 b = 1.9 \mu m$$

$x \approx 3-4 \, r_{crit}$ ⇒ edge bigger stress field than screw

c) edge and screw have complimentary stress fields ⇝ edge not moved by screw

- discussion of effects in a) ✓
- comparison screw edge ✓
- complimentary stress fields ✓

Problem #6:

- Decompose $\vec{b}$ into screw and edge as a function of the rotation angle of the loop

$$\vec{b} = \vec{b}_{screw} + \vec{b}_{edge}$$

$$\Rightarrow b_{\parallel} = |\vec{b}| \cos\theta \ \hat{=} \text{ screw}$$

$$b_{\perp} = |\vec{b}| \sin\theta \ \hat{=} \text{ edge}$$

- $d\epsilon_{screw} = \mu |\vec{b}_{screw}|^2 \, dL \Rightarrow d\epsilon_{screw} = \mu (|\vec{b}|\cos\theta)^2 \, r \, d\theta$

  ($dL = r\,d\theta$)

$$\epsilon_{screw} = \int_0^{2\pi} \mu b^2 \cos^2\theta \, r\,d\theta = \mu b^2 r \int_0^{2\pi} \cos^2\theta \, d\theta$$

$$= \mu b^2 r \left[\frac{x}{2} + \frac{\sin 2x}{4} \right]_0^{2\pi} = \mu b^2 r \pi \qquad \left[\frac{N/m^2 \cdot m^2 \cdot m}{1} = Nm = J \right] \checkmark$$

$$\epsilon_{edge} = \ldots = \frac{\mu b^2 r}{1-\nu} \cdot \pi$$

- $\epsilon_{tot} = \epsilon_{edge} + \epsilon_{screw} = \pi \mu b^2 r \frac{2-\nu}{1-\nu}$

→ Decomposition of $\vec{b}$ ✓
- Integral + Equations ✓
- total Energy of screw ✓

3.40J / 22.71J / 3.14 Physical Metallurgy
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