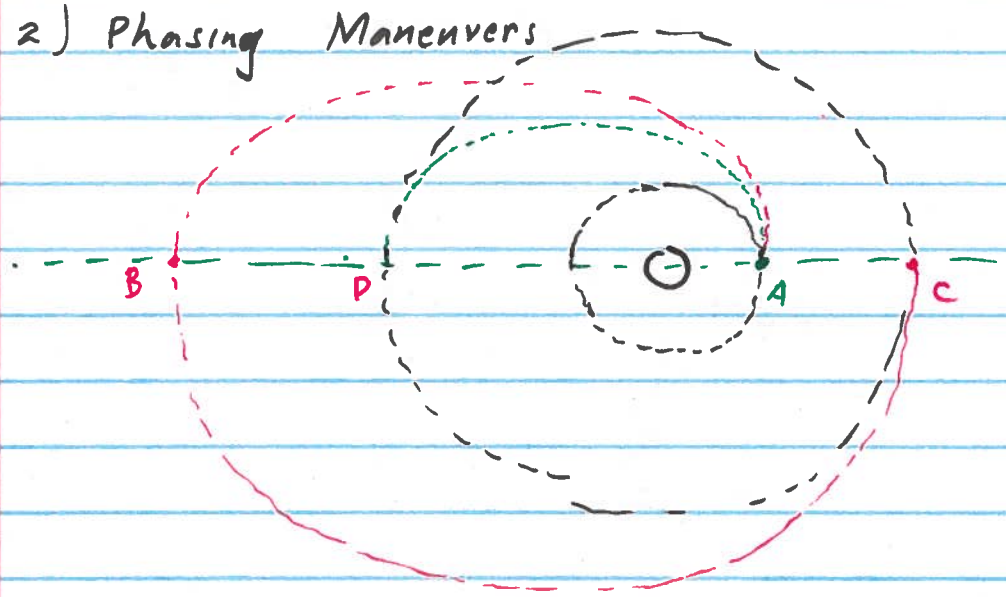
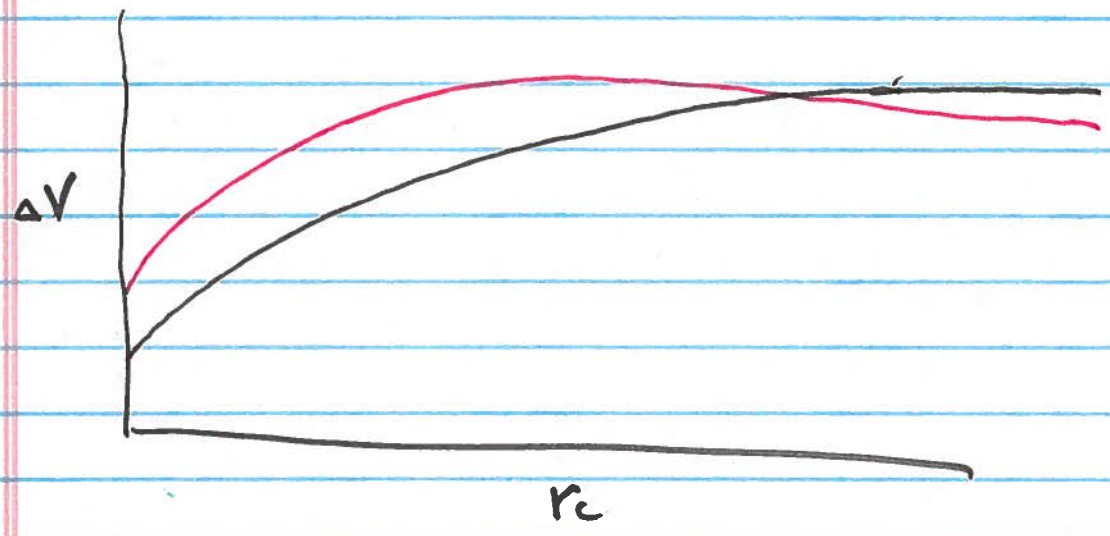
1) Bi-Elliptic transfers

2) Phasing Maneuvers





$$v_p = \sqrt{\frac{2\mu r_A}{r_p(r_p+r_A)}} \qquad v_A = \sqrt{\frac{2\mu r_p}{r_A(r_p+r_A)}}$$

$$\Delta V = \Delta V_p + \Delta V_A$$

$$\Delta V_p = \sqrt{\frac{2\mu r_A}{r_p(r_p+r_A)}} - \sqrt{\frac{\mu}{r_p}}$$

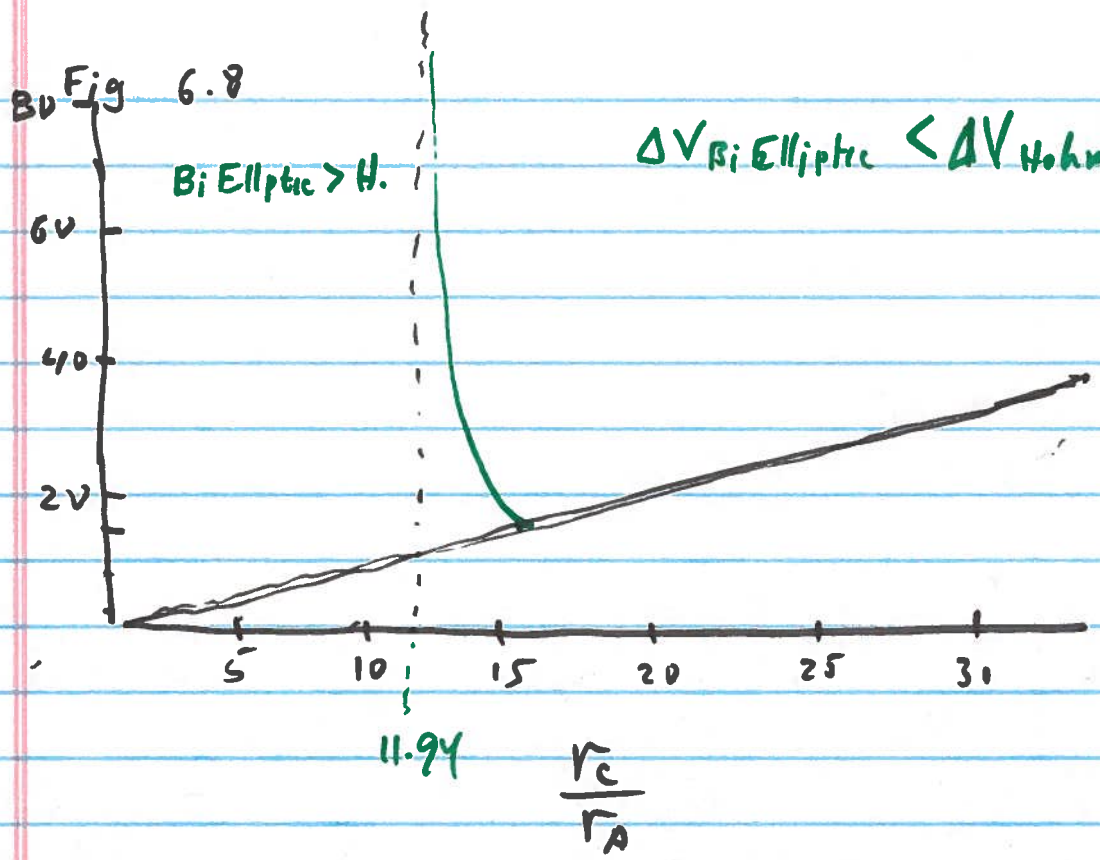
$$\Delta V_A = \sqrt{\frac{\mu}{r_A}} - \sqrt{\frac{2\mu r_p}{r_A(r_p+r_A)}}$$

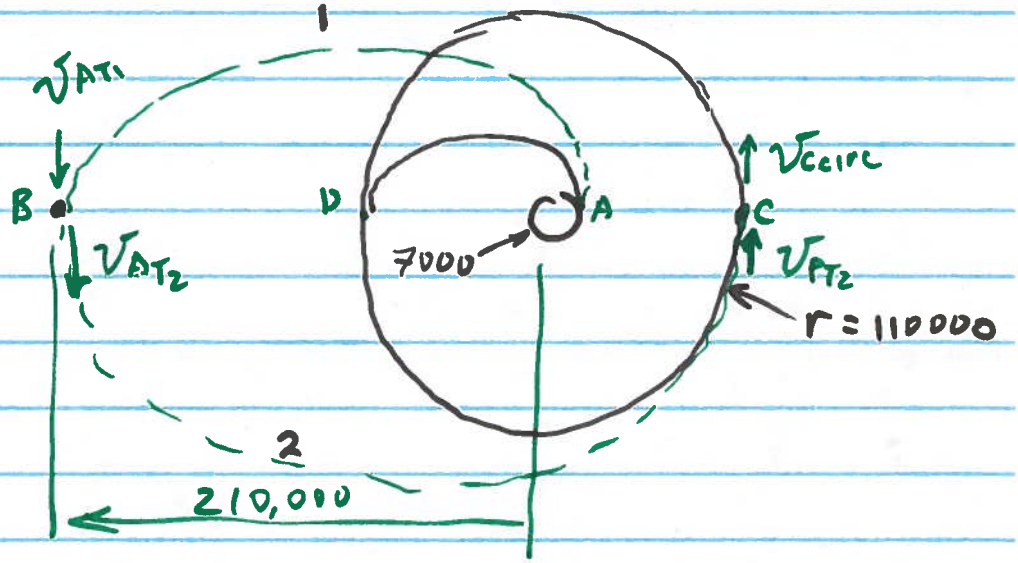
$$\Delta V_p = \sqrt{\frac{\mu}{r_p}}\left(\sqrt{\frac{2r_A}{r_p+r_A}} - 1\right)$$

$$\Delta V_A = \sqrt{\frac{\mu}{r_A}}\left(1 - \sqrt{\frac{2r_p}{r_p+r_A}}\right)$$

$$\Rightarrow \Delta V_{TOTAL_H} = \sqrt{\frac{\mu}{r_A}}\left[\frac{1}{\sqrt{\alpha}} - \frac{\sqrt{2}(1-\alpha)}{\sqrt{\alpha(1+\alpha)}} - 1\right]$$

$$\alpha = \frac{r_A}{r_p} = \frac{r_{\text{outer}}}{r_{\text{INNER}}}$$





$r_p = 7000$

$r_A = 110000$

Hohmann (A → D)

@ A $\quad \Delta V_p = \sqrt{\frac{\mu}{r_p}} \left\{ \sqrt{\frac{2 r_A}{r_p + r_A}} - 1 \right\} = 2.802 \ Km/s$

@ D $\quad \Delta V_A = \sqrt{\frac{\mu}{r_A}} \left\{ 1 - \sqrt{\frac{2 r_p}{r_p + r_A}} \right\} = 1.245 \ Km/s$

$\Delta V_{Total} = 2.802 + 1.245 = 4.047 \ Km/s$

Hohmann $\quad \tau = \pi \sqrt{\frac{(r_p + r_A)^3}{8\mu}} = 70407 \ SEC$

~ 0.815 DAYS

Bi-Elliptic:

@ A $\quad \Delta V_{@A} = v_{P_{T_1}} - v_{A_{circ}}$

@ B $\quad \Delta V_{@B} = v_{A_{T_2}} - v_{A_{T_1}}$

@ C $\quad \Delta V_{@C} = |v_{P_{T_2}}| - |v_{C_{circ}}|$

@ A $\quad \sqrt{\frac{\mu}{r_P}} \left\{ \sqrt{\frac{2 r_A}{r_P + r_A}} - 1 \right\}$ $\quad r_P = 7000$, $r_A = 210{,}000$

$= 2.9521 \ \text{km/s}$

@ B $\quad \sqrt{\frac{2\mu r_{P_{T_2}}}{r_{A_{T_2}}(r_{P_{T_2}} + r_{A_{T_2}})}} - \sqrt{\frac{2\mu r_{P_{T_1}}}{r_{A_{T_1}}(r_{P_{T_1}} + r_{A_{T_1}})}} = 0.7924 \ \text{km/s}$

$r_{P_{T_1}} = 7000$, $r_{A_{T_1}} = 210000$

$r_{P_{T_2}} = 110{,}000$, $r_{A_{T_2}} = 210000$

@ C $\quad \sqrt{\frac{\mu}{r_{P_{T_2}}}} \left\{ \sqrt{\frac{2 r_{A_{T_2}}}{r_{P_{T_2}} + r_{A_{T_2}}}} - 1 \right\}$ $\quad r_{A_{T_2}} = 210{,}000$, $r_{P_{T_2}} = 110000$

$= 0.2772 \ \text{km/s}$

ΔV_{Total} Bi Ell $= |\Delta v_{@A}| + |\Delta V_{@B}| + |\Delta V_{@C}|$

$= 2.9521 + 0.7924 + 0.2772$

$= 4.0217 \ \text{km/s}$ $\qquad$ 4.047