$$\delta\text{GPE} = -\frac{GM_r dm}{r}$$

$$dm = (4\pi r^2 dr)\,\rho$$

$$M_r = \frac{4}{3}\pi r^3\,\rho$$

$$\text{GPE} = \int_0^R -\frac{16\pi^2}{3}\,G\rho^2 r^4 dr$$

$$\text{GPE} = -\frac{16}{15}\,\pi^2 G\rho^2 R^5$$

$$\text{GPE} = -\frac{3}{5}\,\frac{GM^2}{R}$$

$$T_{\text{crit}} \sim \frac{2}{3}\frac{Z_1 Z_2 e^2}{kr}$$

$$T_{\text{crit}} \sim \frac{4}{3}\,\frac{\mu_m Z_1^2 Z_2^2 e^4}{kh^2}$$

$$\mu_m \equiv \frac{1}{\frac{1}{m_1}+\frac{1}{m_2}} = \frac{m_1\,m_2}{m_1+m_2}$$

$$\epsilon_{pp} \sim 1\,\rho X^2\left(\frac{T}{10^6\,\text{K}}\right)^4 \qquad \frac{\text{J}}{\text{s}}/\text{kg}/\frac{\text{kg}}{\text{m}^3}$$

$$\epsilon_{CNO} \sim 8\times 10^{-19}\;\rho X X_{\text{CNO}}\left(\frac{T}{10^6\,\text{K}}\right)^{19.9} \qquad \frac{\text{J}}{\text{s}}/\text{kg}/\frac{\text{kg}}{\text{m}^3}$$

$$\epsilon_{3\alpha} \sim 5\times 10^7\;\rho^2 Y^2\left(\frac{T}{10^8\,\text{K}}\right)^{41} \qquad \frac{\text{J}}{\text{s}}/\text{kg}/\left(\frac{\text{kg}}{\text{m}^3}\right)^2$$

$$dL = \epsilon\,dm$$

$$dL = \epsilon\,(4\pi r^2 dr)\,\rho$$

$$\frac{dL}{dr} = 4\pi r^2\rho\,\epsilon$$

$$dm = 4\pi r^2 dr\,\rho$$