

HW 2.1  $\Delta U = N_{ph} \cdot \langle E_{ph} \rangle$

A)  $N_{ph} = \alpha \gamma 2\pi \quad (2.29)$

$E = \hbar \omega, \quad \omega_c = \frac{3\gamma^3 c}{2\rho} \quad (2.25)$

$E_{ph} = \frac{\hbar 3\gamma^3 c}{2\rho}$

$\Delta U = \alpha \gamma 2\pi \left( \frac{\hbar 3\gamma^3 c}{2\rho} \right) = \frac{3\alpha \gamma^4 c \hbar \pi}{\rho}$

$U = \frac{4\pi}{3} \alpha \beta^3 \gamma^4 \frac{\hbar c}{\rho}$

$\gamma \gg 1 \Rightarrow \beta \approx 1$

$U = \frac{4}{3} \pi \alpha \gamma^4 \frac{\hbar c}{\rho}$

B)  $M_p = 938 \text{ MeV} \quad M_e = 0.511 \text{ MeV}$

$\gamma_p = \left( \frac{7e^{12}}{938e^6} \right) \approx 7.5e^3$

$\gamma_e = \left( \frac{7e^{12}}{0.511e^6} \right) \approx 1.37e^7$

$E \propto \gamma^4$

$\gamma_p^4 \approx 3.2e^{15}$

$\gamma_e^4 \approx 3.5e^{28}$

$\sim 10^{13}$  more energy/power radiated by electrons