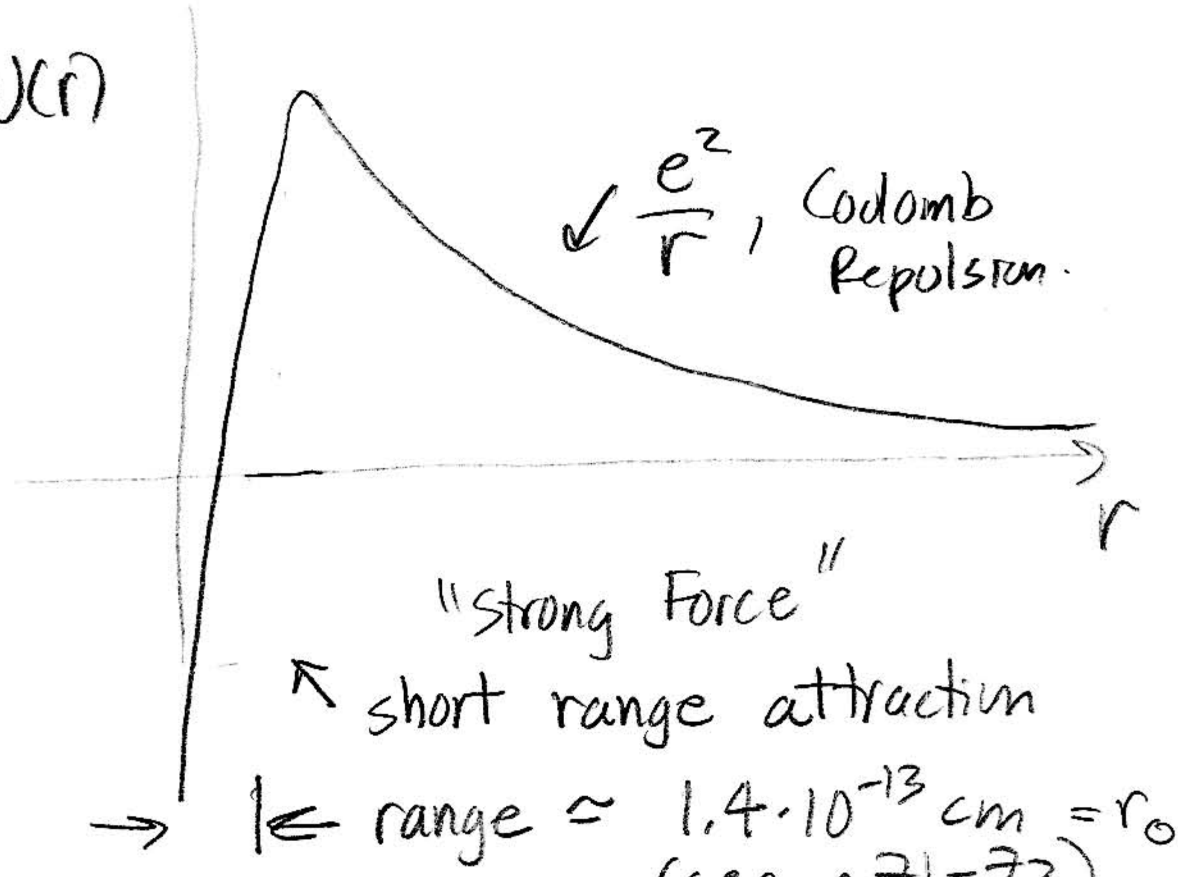


(see p. 71-72)

Nucleons in a nucleus pack themselves with a density of ~

$1/(1.4\cdot 10^{-13}\,cm)^3$ "close packed"

$$A \sim \frac{\frac{4\pi}{3}\cdot r_A^3}{\frac{4\pi}{3}\, r_0^3}$$

$$r_A \sim r_0 \cdot A^{1/3} \sim (1.4\cdot 10^{-13})\, A^{1/3}\ cm$$

$$10^{-13}\ cm = 10^{-15}\ m \equiv fm$$

"femtometer"

or fermi

Energies : Nuclear Levels $\sim 1 \cdot 10^6$ eV

$\sim$ 1 MeV

→ "mirror nuclei" ⟺ replace neutron by proton

$^7_3$Li and $^7_3$Be

↑ 3 protons ↑ 4 protons

$^{11}_5$B $^{11}_6$C

↑ 5 protons ↑ 6 protons

} Figure

Level schemes almost same!

→ Strong force, not electrostatics

Quarks :

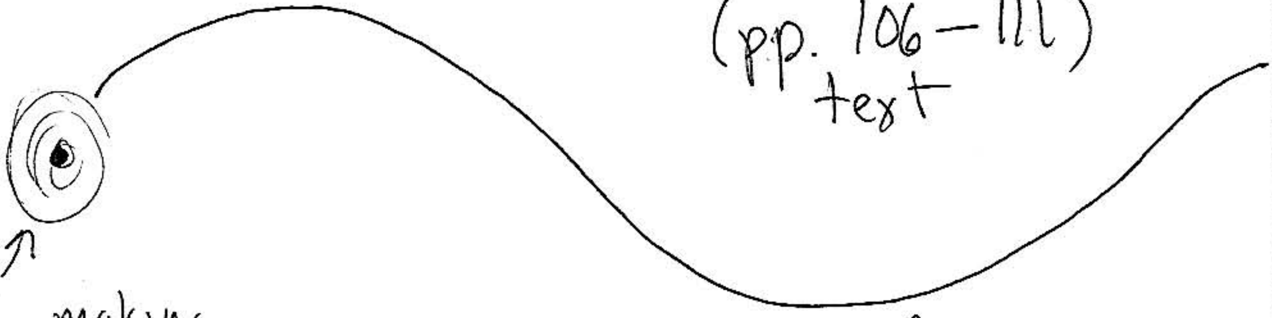
$q \quad \bar{q}$ ← antiquark

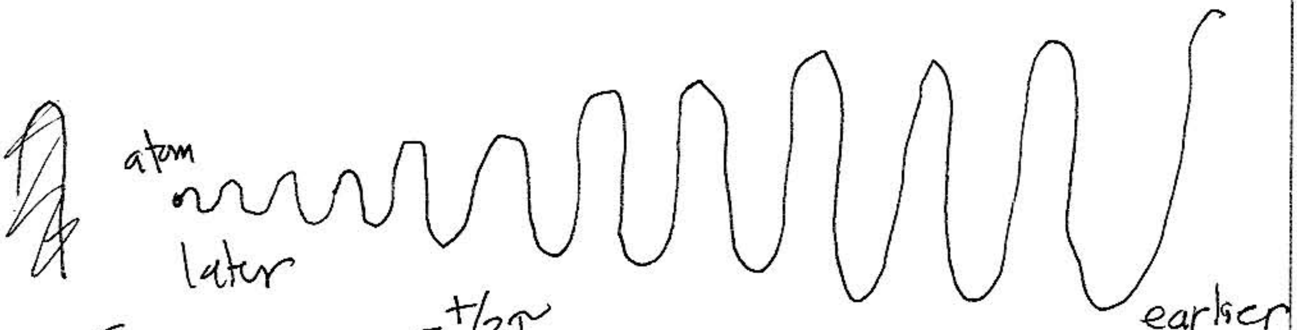
Typical γ's are 100's of MeV.

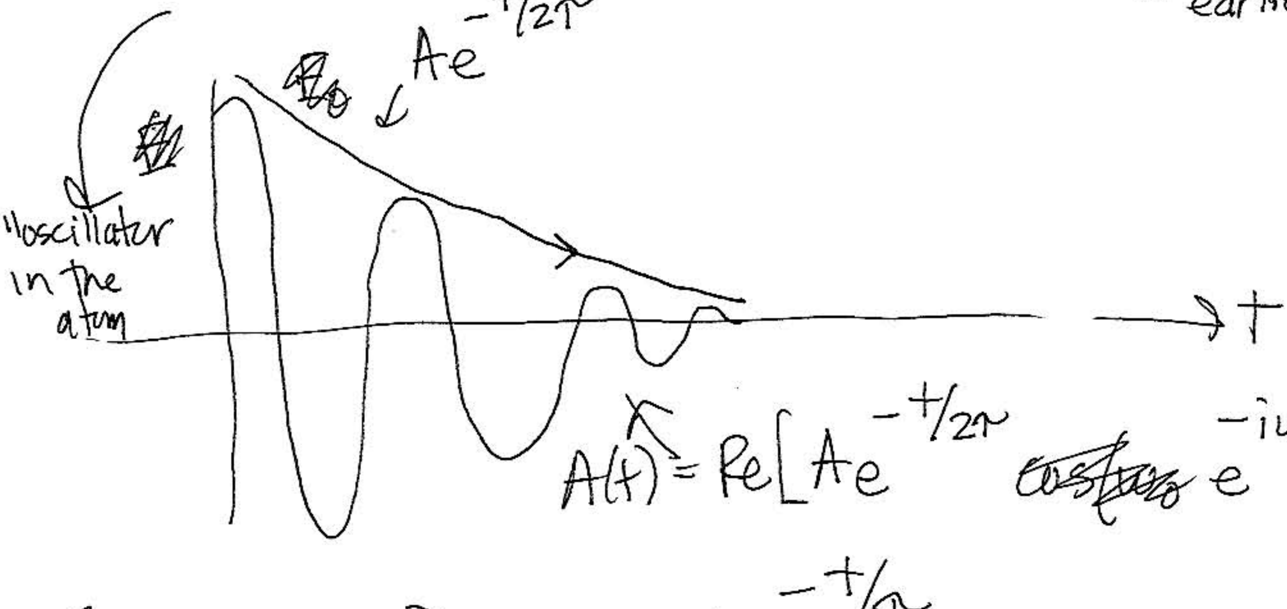
(Figure)

Finite Widths of Levels

(pp. 106–111 text)







$$A(t) = \mathrm{Re}\left[A e^{-t/2\tau} \cancel{\cos\omega_0 t}\; e^{-i\omega_0 t}\right]$$

$$\langle \text{Intensity} \rangle \propto A e^{-t/\tau}$$

$\tau \rightarrow$ lifetime

Simple Decay $A(t)$

satisfies: $$\frac{dA}{dt} + \left(i\omega_0 + \frac{1}{2\tau}\right)A = 0$$

damping, caused by loss of energy.

In this case: from physics of radiation itself)

(complex).

Imagine driving the system with an applied "force"

$$\underbrace{\frac{dA}{dt} + \left(i\omega_0 + \frac{1}{2\tau}\right)A}_{\text{steady state}} = \underbrace{Fe^{-i\omega t}}_{\text{really real part}}$$

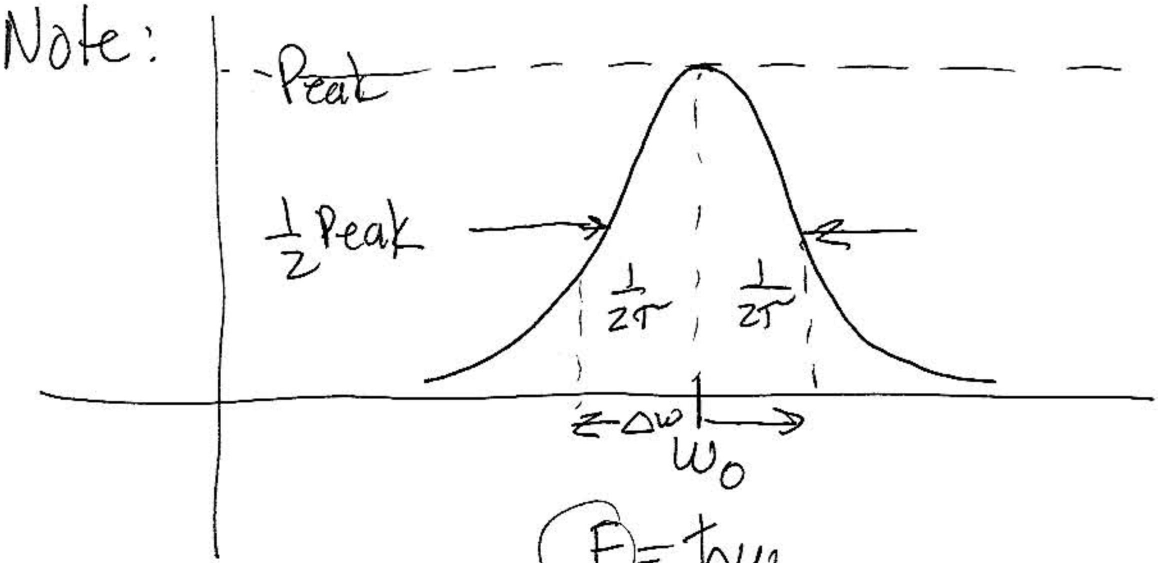
$$A = A_0 e^{i\omega t}$$

$$A_0 = \frac{iFe^{-i\omega t}}{(\omega-\omega_0) + \frac{i}{2\tau}}$$

$$I \propto |A_0|^2 \propto \frac{1}{|(\omega-\omega_0) + i/2\tau|^2}$$

$$I(\omega) = I(\omega_0) \cdot \frac{(1/2\tau)^2}{(\omega-\omega_0)^2 + (1/2\tau)^2}$$

Note:



$$E = \hbar\omega_0$$

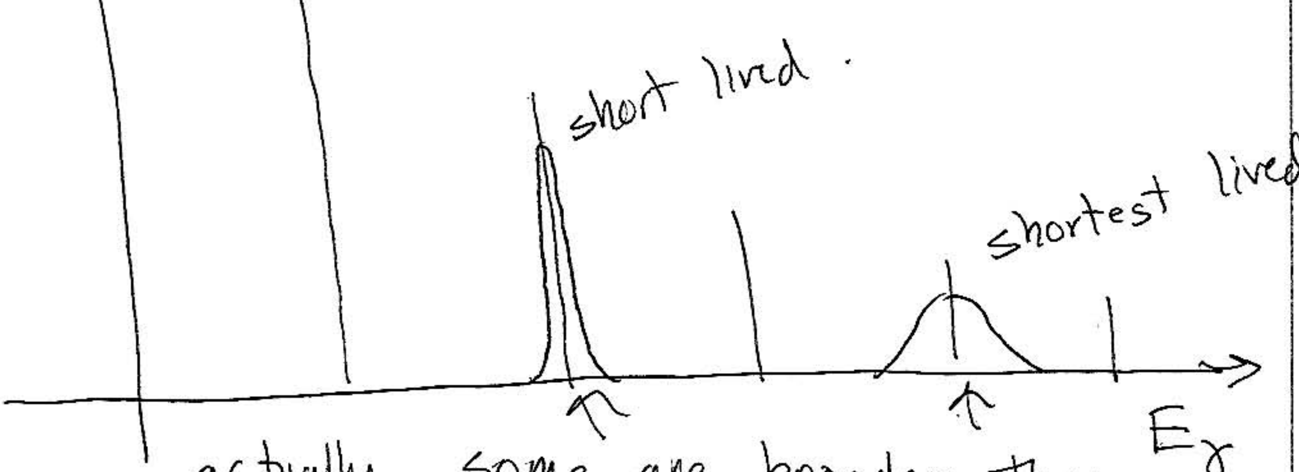
of level

$$\boxed{\Delta\omega = \frac{1}{\tau}}$$ ← rather general

$$\Delta E = \hbar\Delta\omega = \frac{\hbar}{\tau}$$

Your energy is "blurry", by $\propto \frac{1}{\text{your lifetime}}$.

line spectrum



actually, some are broader than others