PH-105 Assignment Sheet - 2 (Quantum Mechanics)

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45. **A charged pi-meson has a rest energy of 140 MeV and a lifetime of 26 ns, while a rho-meson has a rest energy of 765 MeV and a lifetime of $4.4 \times 10^{-24} s$. In each case find the absolute and fractional uncertainty in energy. Use the following uncertainty principle for this problem $\Delta E \Delta t \geq \hbar/2$.**

Solution :
By the use of uncertainty principle, we approximate ΔE as follows:

$$\Delta E \approx \frac{\hbar/2}{\Delta t}$$

where Δt is the lifetime of the particle.

(a) For the pi-meson

$$\text{Absolute uncertainty in energy} = \Delta E \approx \frac{5.273 \times 10^{-35}}{2.6 \times 10^{-8}} = 2.028 \times 10^{-27} J = 1.268 \times 10^{-14} MeV$$

$$\text{Fractional uncertainty in energy } = \frac{\Delta E}{E} = \frac{1.268 \times 10^{-14} MeV}{140 MeV} = 9.057 \times 10^{-17}$$

(b) For the rho-meson

$$\text{Absolute uncertainty in energy} = \Delta E \approx \frac{5.273 \times 10^{-35}}{4.4 \times 10^{-24}} = 1.198 \times 10^{-11} J = 74.89 MeV$$

$$\text{Fractional uncertainty in energy } = \frac{\Delta E}{E} = \frac{74.89 MeV}{765 MeV} = 0.098$$