

856.

Problem 54.81 (RHK)

An intermediate state in a particular nuclear reaction decays within 1.2×10^{-22} s of its formation. (a) We have to find the uncertainty ΔE in our knowledge of this intermediate state. (b) We have to answer whether this state can be called a compound nucleus.

Solution:

(a)

An intermediate state in a particular nuclear reaction decays within 1.2×10^{-22} s of its formation.

From the Heisenberg's uncertainty principle we can estimate the uncertainty ΔE in our knowledge of this intermediate state.

We have

$$\Delta E \Delta t = \frac{h}{2\pi},$$

or



$$\begin{aligned}\Delta E &= \frac{h}{2\pi\Delta t} = \frac{6.63 \times 10^{-34} \text{ J s}}{2\pi \times 1.2 \times 10^{-22} \text{ s}} \\ &= 8.79 \times 10^{-12} \text{ J} = \frac{8.79 \times 10^{-12}}{1.6 \times 10^{-13}} \text{ MeV} \\ &= 54.9 \text{ MeV}.\end{aligned}$$

(b)

The decay time is of the order of nuclear reaction that is the time taken for interaction to take place at the speed of light between nuclei separated by distance of the order of their radii. Therefore, the intermediate state is not a compound nuclear state.

