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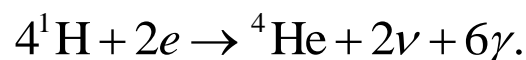
**Problem 55.50 (RHK)**

*We have to calculate (a) the rate at which the Sun is generating neutrinos. Assume that the energy production is entirely by the proton-proton cycle. (b) We have to find the rate with which the solar neutrinos impinge the Earth.*

**Solution:**

(a)

The Sun radiates energy at the rate of  $3.9 \times 10^{26}$  W. In a p-p cycle there is a fusion of four protons and two electrons to form one alpha particle, two neutrinos and six gamma ray photons. That is the p-p nuclear process is



The energy released in the p-p cycle is 26.7 MeV.

Assuming that the energy production is entirely by the proton-proton cycle, we find that the number of such nuclear processes that are taking place in the Sun per second is



$$= \frac{3.9 \times 10^{26} \text{ J s}^{-1}}{26.7 \times 1.6 \times 10^{-13} \text{ J}} = 9.129 \times 10^{37} \text{ p-p cycles per second.}$$

As 2 neutrinos are produced per p-p cycle, the rate at which the Sun is generating neutrinos is

$$= 2 \times 9.129 \times 10^{37} \text{ neutrinos per second}$$

$$= 1.83 \times 10^{38} \text{ neutrinos per second.}$$

(b)

The mean orbital radius of the Earth is  $1.50 \times 10^{11}$  m, and the mean radius of the Earth is  $6.37 \times 10^6$  m. Therefore, the rate with which the solar neutrinos impinge the Earth is

$$= \frac{1.83 \times 10^{38} \times \pi \times (6.37 \times 10^6)^2}{4\pi \times (1.50 \times 10^{11})^2} \text{ neutrinos per second}$$

$$= 8.25 \times 10^{28} \text{ neutrinos per second.}$$