

45. (a) Since two neutrinos are produced per proton-proton cycle (see Eq. 44-10 or Fig. 44-11), the rate of neutrino production R_ν satisfies

$$R_\nu = \frac{2P}{Q} = \frac{2(3.9 \times 10^{26} \text{ W})}{(26.7 \text{ MeV})(1.6 \times 10^{-13} \text{ J/MeV})} = 1.8 \times 10^{38} \text{ s}^{-1} .$$

- (b) Let d_{es} be the Earth to Sun distance, and R be the radius of Earth (see Appendix C). Earth represents a small cross section in the “sky” as viewed by a fictitious observer on the Sun. The rate of neutrinos intercepted by that area (very small, relative to the area of the full “sky”) is

$$R_{\nu, \text{Earth}} = R_\nu \left(\frac{\pi R_e^2}{4\pi d_{es}^2} \right) = \frac{(1.8 \times 10^{38} \text{ s}^{-1})}{4} \left(\frac{6.4 \times 10^6 \text{ m}}{1.5 \times 10^{11} \text{ m}} \right)^2 = 8.2 \times 10^{28} \text{ s}^{-1} .$$