Level 2 Stars

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Problem Set S.4

(1) What is the name of the main nuclear-fusion chain that occurs at the centre of the Sun? What direct observational evidence provides strong support for nuclear fusion as the power source of the Sun?

[2 marks]

(2) On the basis of the conservation laws for nuclear reactions, which of the following sets of products can result from a collision between a deuteron ($^{2}H_{1}$) and a $^{4}He_{2}$ nucleus?

[3 marks]

(i) $^{3}He_{2} + {}^{1}H_{1}$ (ii) $^{6}He_{2} + e^{+} + \nu$

(iii) $^{6}Li_{3} + e^{-} + \bar{\nu}$ (iv) $^{6}Li_{3} + \gamma$

(v) $^{6}Be_{4} + \gamma$ (vi) $^{6}Be_{4} + e^{-} + \bar{\nu}$

(3) Estimate the number of PPI reaction chains per second required to produce the luminosity of the sun, assuming that all of the energy released in this chain is due to thermal processes. Assuming that 2 neutrinos are released for each PPI reaction chain, estimate the number of neutrinos per square metre per second at the Earth.

[5 marks]

[$L_{\odot}$ = 3.84 x 10^{26} W; $1eV = 1.602 \times 10^{-19} J$; AU = 1.50 x 10^{11} m]