poster project

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1 Proton-Proton Chain Reaction

Initially two protons will undergo fusion to form deuterium. One of the protons will experience beta plus decay.[1]

$$p + p \rightarrow^2_1 D + e^+ + v_e \tag{1}$$

the resultant positron will annihilate with an electron into two gamma rays and the complete equation can be seen.

$$p + p + e^- \rightarrow^2_1 D + v_e + 1.442MeV \tag{2}$$

This reaction is quite slow due to the fact is it started by weak nuclear forces. On average a proton stays in the core of the sun for $1x10^9$ years. Due to the time taken it has so far experimentally impossible to calculate the cross section[3].

A fast reaction is now initiated by the strong nuclear force

$$^2_1D +^1_1 H \rightarrow^3_2 He + \gamma + 5.493MeV \tag{3}$$

In our sun deuterium only exists for approximately one second before fusing with a proton[1]. The overall reaction is

$$4^1H^+ + 2e^- \rightarrow^4 He^{2+} + 2v_e \tag{4}$$

This releases 26.73 MeV of energy, not accounting for what is lost to nuetrinos[3].

1.1 P-P I Chain

The first vranch of the p-p chain prodcues 83.3 percent of ^4He. the equation for the p-pI branch is as follows:

$$^3_2He +^3_2 He \rightarrow {}^4_2He + 2^1_1H + 12.859MeV \tag{5}$$

This branch is dominant between temperatures of 10-18MK[2].

1.2 P-P II Chain

This branch is dominant with temperatures between 14-23MK[1]. This section includes the following three reactions:

$$^3_2He +^4_2 He \rightarrow {}^7_4Be + \gamma + 1.59MeV \tag{6}$$

$$^7_4Be +^1_1 H \rightarrow^8_5 B + \gamma \tag{7}$$

$$^8_5B \rightarrow^8_4 Be + e^+ + v_e \tag{8}$$

$$^8_4Be \rightarrow 2^4_2He \tag{9}$$

References

[1] Eric G Adelberger et al. “Solar fusion cross sections. II. The p p chain and CNO cycles”. In: *Reviews of Modern Physics* 83.1 (2011), p. 195.

[2] Christian Iliadis. *Nuclear physics of stars*. John Wiley & Sons, 2015.

[3] Anthony C Phillips. *The physics of stars*. John Wiley & Sons, 2013.