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THERMONUCLEAR REACTION RATES

by

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SHERWOOD

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ABSTRACT

This report gives the thermonuclear reaction rates for the DD, DT, D He^3, TT reactions for temperatures 50 ev to 100 kev.

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Thermonuclear reaction rates for the following reactions are given:

$$D + T = He^4 + n + 17.4 \text{ Mev}$$

$$D + D \begin{cases} He^3 + n + 3.3 \text{ Mev} \\ He^3 + p + 4.0 \text{ Mev} \end{cases}$$

$$D + He^3 = He^4 + p + 17.5 \text{ Mev}$$

$$T + T = He^4 + 2n + 11.4 \text{ Mev}$$

Definitions

Reactions/cc/sec = $\frac{1}{2} n_D^2 \overline{\sigma v}$ [n_D = deuterons/cc]

and $n_1 n_2 \overline{\sigma v}$ [reactions between densities n_1, n_2 of species 1 and 2.]

T is defined as $\frac{2}{3}\overline{U}$ where $\overline{U}$ is the mean kinetic energy per particle.

Accuracy

The data presented here were computed mainly from the cross sections of Arnold, Phillips, Sawyer, Stovall and Tuck, Phys. Rev. 93, p. 483 (1954). In this paper, the yields are measured at 90° and use isotropic angular distributions in the center of mass system for (DT), (D, He^3). The resulting probable error in σ is ±6%. For the purposes of this interim report, the $\overline{\sigma v}$ have been rounded to the nearest figure given.

For DD, which is appreciably anisotropic in the center of mass system at the lowest energies observed (~10 kev), the angular distribution

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for DDp > 100 kev, and extrapolated down to lower energies, has been used for both branches. This results in a branching ratio $\sigma_{DDn}/\sigma_{DDp}$ of 0.93 below 20 kev. There is some weak evidence that the angular distributions of the two branches are different, in a sense that would make $\sigma_{DDn}/\sigma_{DDp}$ closer to 1.00. This would increase σ_{DDn} by some 7% and make a similar change in the $\overline{\sigma v}$ of the neutron branch. However, for the purposes of this interim report, $\overline{\sigma v}$ have been rounded off to the nearest figure.

T kev	$\overline{\sigma v}$ TD	$\overline{\sigma v}$ DD_{total}	$\overline{\sigma v}$ D He^3	$\overline{\sigma v}$ TT_{2n}
.05	7×10^{-35}	2×10^{-35}	1×10^{-48}	1×10^{-38}
0.1	3×10^{-30}	4×10^{-31}	3×10^{-41}	2×10^{-33}
0.5	6×10^{-23}	2×10^{-24}	2×10^{-29}	1×10^{-25}
1.0	7×10^{-21}	2×10^{-22}	6×10^{-26}	2×10^{-23}
2.0	3×10^{-19}	5×10^{-21}	2×10^{-23}	1×10^{-21}
5.0	1.4×10^{-17}		1×10^{-20}	6×10^{-20}
10	1.1×10^{-16}	8.6×10^{-19}		5×10^{-19}
20	4.3×10^{-16}	3.6×10^{-18}		
40	7.9×10^{-16}	1.0×10^{-17}		
60	8.7×10^{-16}	1.6×10^{-17}		
80	8.5×10^{-16}	2.3×10^{-17}		
100	8.1×10^{-16}	3.0×10^{-17}		

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