TOTAL CROSS SECTION OF THE T + T REACTION IN THE 60 — 1140 keV *ENERGY RANGE*

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The total cross section for the T + T reaction was measured in the energy range 60 — 1140 keV. A thin gas target was used. In the energy range investigated the cross section rises monotonically from 10 mb at 60 keV to 82 mb at 1140 keV.

THE reactions

$$T + t \rightarrow \alpha + n + n + 11.33\,\mathrm{MeV},$$
$$T + t \rightarrow He^5 + n + (11.33\,\mathrm{MeV} - \varepsilon),$$
$$He^5 \rightarrow He^4 + n + \varepsilon$$

have been investigated by two groups of workers.

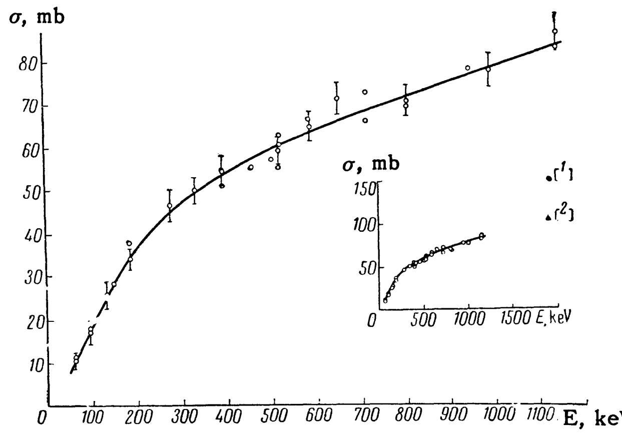
Agnew et al.[1] measured the differential cross section at 0° over the energy range 40 to 2220 keV. The neutrons were detected by a "long counter." After measuring the angular distribution of the neutrons at 1316 keV, the authors concluded that the total cross section could be obtained approximately from their differential cross section by multiplying the latter by 10.

In the second investigation, Jarmie and Allen,[2] measured the differential cross section at 30° in the laboratory frame of reference, for energies in the range 0.95 to 2.1 MeV, and the total cross section at 1.9 MeV ($\sigma = 106 \pm 6$ mb). The total cross section was obtained at this energy by measuring the α particle spectrum at 30, 60, 90 and 120°. The total cross section at 1.9 MeV quoted in [1] (150 ± 15 mb) is about 30% greater than the result obtained by Jarmie and Allen.[2] This discrepancy was one of the reasons why we undertook a measurement of the total cross section for the T + T reaction over the energy range 60 to 1140 keV.

The cross sections were measured on the electrostatic accelerator at the Joint Institute for Nuclear Research. A thin gas target was used, the tritium concentration being 65 — 93% and the pressure 50 — 60 mm Hg. The tritium concentration was measured with an ionization chamber calibrated with pure tritium.

Neutrons from the reaction were counted integrally. The geometry and counting apparatus have been described in an earlier paper on the He^3 + T reaction.[3] The results were corrected for contamination of the gas sample by deuterium and for DH^+ ions in the beam; these contribute to the observed neutron yield through the T (d, n) He^4 and D (t, n) He^4 reactions. The magnitude of the contribution was obtained by measuring nα coincidences. The number of nα coincidences was related to the number of deuterium atoms in the target through a calibration run in which the target was filled with deuterium to a concentration of $98.9 \pm 0.2\%$. In calculating the cross sections, the following effects were taken into account: 1) the T + T reaction produces two neutrons per interaction, while the T (d, n) He^4 and D (t, n) He^4 reactions produce only one neutron per interaction; 2) a Ra-α-Be source, the T + T reaction, the T + d reaction, and the D + t reaction will all differ in the fraction of emitted neutrons which leave the tank; 3) neutrons from these sources will be absorbed differently by the oxygen in $KMnO_4$[3]. Details of the experimental method and of the various corrections applied are given in [4].

Our results for the cross section of the reaction T + T are shown in the figure. The cross section as a function of energy may be represented by the formula $\sigma = (a + b \log E_{keV}) \times 10^{-27}\,\mathrm{cm}^2$, where



The cross section of the T +T reaction as a function of triton energy E.

$a = (-91.2 \pm 2.5)$ and $b = (55.8 \pm 1)$ according to a least-squares analysis. The total cross section for the T + T reaction rises monotonically from 10 mb at 60 keV to 82 mb at 1140 keV. The relative standard error of the experimental points shown in the figure amounts to 20 to 16% in the 60 — 100 keV energy range, 12 to 6.5% in the 133 — 392 keV range, and 6.5 to 5.1% in the 392 — 1140 keV range.

The results obtained by Jarmie and Allen[2] at 1.9 MeV are also shown on the figure. An extrapolation of our curve passes through the point representing their measurement. The total cross sections obtained from the differential cross sections of Agnew et al.[1] by multiplying the latter by 10 lie 25 to 27% above our results at energies near 1 MeV.

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[2] N. Jarmie and R. C. Allen, Phys. Rev. **111**, 1121 (1958).

[3] Li, Osetinskii, Sodnom, Govorov, Sizov, and Salatskii, JETP **39**, 225 (1960), Soviet Phys. JETP **12**, 163 (1961).

[4] Govorov, Li, Osetinskii, Salatskii, and Sizov, Preprint R-764, Joint Institute for Nuclear Research (1960).

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60