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Evaluation of the Absolute Angle-Dependent Differential Neutron Production Cross Sections by the Reactions $^{3}H(p,n)^{3}He$, $^{1}H(t,n)^{3}He$, $^{2}H(d,n)^{3}He$, $^{3}H(d,n)^{4}He$, and $^{2}H(t,n)^{4}He$ and of the Cross Sections of Their Time-Reversed Counterparts up to 30 MeV and Beyond

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January 2015

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Produced by the IAEA in Austria
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Abstract

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Abstract. The present status is given of the evaluation of the cross sections of neutron producing reactions among the hydrogen isotopes, and of cross sections of nonelastic two-body neutron scattering from the helium isotopes as obtained by detailed-balance calculations. Absolute angle dependent differential cross sections of all reactions are given by their Legendre coefficients at least up to 30 MeV projectile energy, but higher energy data are considered as well. All newly evaluated data are also available in the EXFOR library.

I. INTRODUCTION

Since 1987[1] energy-dependent cross section analysis has been performed supplying the input data for the prediction of absolute neutron production cross section in particular from interactions between the hydrogen isotopes. This effort resulted in a set of codes provided via internet by the Nuclear Data Section of IAEA[2] by which these cross sections can be extracted. In the course of time these energy dependent evaluations were regularly updated and their energy range extended to about 40 MeV[3] (with the most recent update of May 2005). Using detailed balance calculation providing time reversal these cross sections can also be used for the prediction of absolute differential cross sections of nonelastic two-body neutron reactions (done in code TIMREV[2]). Work on these cross sections forced a revision of the ^{3}H(p,n)^{3}He data[4] which is not included in the latest generally available data[3].

II. PROCEDURE

A. Basic (Neutron Producing) Reactions

The backbones of these sets of absolute Legendre coefficients are the highly accurately measured monoenergetic angle dependent absolute differential cross sections of the reactions ^{1}H(t,n)^{3}He, ^{2}H(d,n)^{3}He, ^{3}H(p,n)^{3}He, ^{2}H(t,n)^{4}He, and ^{3}H(d,n)^{4}He, starting in the 1970s at the Ion Beam Facility at LANL, Los Alamos, NM, USA. This facility could provide bunched beams of all three projectile types as needed for the application of the time-of-flight technique, and in addition, using tritium gas as target medium was general procedure.

Three facts contributed to the high accuracy of the data:

1. All the data were measured under as identical conditions as possible:
    - same accelerator and beam line,
    - same experimental geometry,
    - same gas target structure,
    - same gas pressure gauge,
    - same collimator, shield and detector,
    - same instrumentation.

In addition, the beam current was so low (< 40 nA) that beam heating was no issue. Nevertheless, the target was cooled by an air jet, out of habit.

2. The measuring set up was calibrated using three quite independent highly accurate charged particle reference cross sections[5] as outlined before[6].

   These reference cross sections are

   - ^{2}H(d,^{3}He)n at 12.305 MeV with a scale uncertainty of 0.4%,
   - ^{2}H(t,^{4}He)n at 20.000 MeV by way of ^{3}H(d,^{4}He)n at 13.356 MeV with a scale uncertainty of 0.5%, and
   - ^{3}H(p,^{3}He)n at 13.600 MeV with a scale uncertainty of 0.7%.

3. Even if the scale is obtained from very accurate charged particle cross sections, the quality of the angular distributions depends strongly on the knowledge of the energy dependence of the neutron detection efficiency. Consequently much effort was made to establish and improve the neutron detection efficiency curve[7-9].

For practical purposes a reduced form of the Legendre presentation of the center-of-mass cross sections was chosen, namely

$$\frac{\mathrm{d}\sigma(E,\Theta)}{\mathrm{d}\Omega} = \frac{\mathrm{d}\sigma(E,0°)}{\mathrm{d}\Omega} \cdot \sum_i A_i P_i(\cos\Theta) = \sigma_{0,\mathrm{cm}} \cdot \sum_i A_i P_i(\cos\Theta)\,.$$

As the purpose of the Legendre coefficients is the best presentation of the data, their number of digits does not necessarily reflect their uncertainty (no implicit uncertainty can be derived from them).

B. Time Reversed Reactions

As mentioned, some of the nonelastic neutron interactions with the helium isotopes can be viewed at as time reversed to the appropriate neutron production reactions. The code TIMREV of DROSG-2000[2] performs such conversion. Be aware that such a conversion is, near threshold energies, strongly dependent on the atomic masses used in said conversion (see e.g., the near threshold values in Table 3.5). Masses of AME2003[10] are used throughout this code and this report. Exactly speaking, nuclear masses rather than atomic masses are used.

The impact of the nonelastic cross section data on the neutron production data evaluation is minimal as these neutron data can never be as accurate as data dependent on charged particle data. However, inconsistencies might trigger a reevaluation as has happened for ^{3}He(n,p)^{3}H [4] below 6.5 MeV. The impact of this reevaluation is included into the present evaluation.

C. General

The bulk of accurate own data in the energy range from 6 to 17 MeV made reevaluations in this energy a rare event although each new relevant data set was scrutinized for new information. An exception were charged particle data improving the back-angle situation of ^{3}H(d,n)^{4}He between 3 and 7 MeV[11].

In recent years R-matrix analyses of the ^{4}He and the ^{5}He systems started to provide reliable cross sections up to a few MeV. Thus, such data were used to arrive at the Legendre coefficients as needed. In cooperation with G. M. Hale of LANL the cross sections for ^{3}H(d,n)^{4}He up to 30 MeV were prepared for ENDF-B/VI[12] so that these data are identical there and in the presently valid evaluation. The situation is similar for ^{2}H(d,n)^{3}He up to 40 MeV which was prepared for ENDF-B/VII[13] so that the data there will be identical with those of the presently valid evaluation. As already mentioned, the ^{3}H(p,n)^{3}He evaluation was recently modified[4] below 6.5 MeV using ENDF.B/VII.0 data[14].

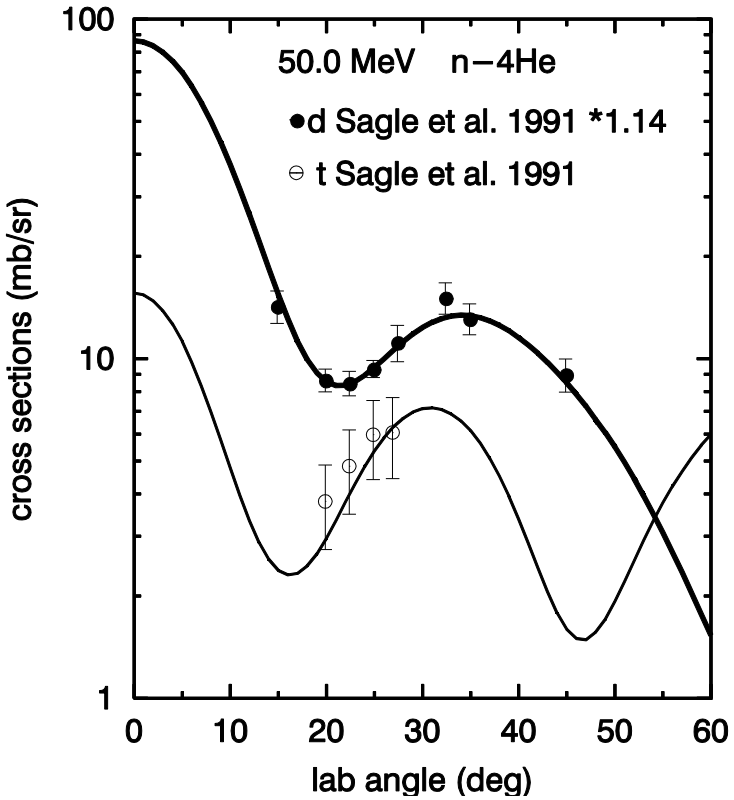

FIG. 1. Absolute angle dependent differential laboratory cross sections of $^{4}He(n,d)^{3}H$ and $^{4}He(n,t)^{2}H$. The curves were obtained by time reversal of the evaluated $^{3}H(d,n)^{4}He$ cross sections, the data points are from Ref. 22.

D. Higher Energy Data

It was fortunate that for both $^{3}H(p,^{3}He)n$[15] and $^{2}H(d,^{3}He)n$ [16]absolute differential cross section data up to 32.8 and 40 MeV, respectively, are available. From both data sets Legendre coefficients could be extracted by means of energy-dependent analyses. The latter is described in Ref.17. The constraint by the integrated cross sections as predicted previously[18] proved very helpful.

The prediction of absolute differential cross sections of $^{3}H(d,n)^{4}He$ at projectile energies above 20 MeV is based on charge symmetry with $^{3}He(d,p)^{4}He$[19] .

The evaluation at higher energies does concentrate on absolute angle dependent cross sections but includes, when possible, excitation functions of the angle-integrated cross section, the 0-degree cross section, and/or the 180-degree cross section. In favorable cases such evaluations extend to a few hundred MeV.

III. RESULTS

The newly evaluated data sets tabulated in this section are also compiled in EXFOR D0756 (for proton and deuteron induced reaction) and V0103 (for neutron induced reaction). They supersede Tables II to IV, VII, X, XIII, XV to XVII of Ref. 6 (compiled in EXFOR D0002.002-007, D0003.002-005, D0004.002-006), Table 1 of Ref.11 (compiled in EXFOR A1180.002-004) and Table V of Ref. 23 (compiled in EXFOR C0009.008).

A. ^{3}H(p,n)^{3}He reactions

TABLE 1.1. Kinematic data.

Reaction (units)	^{3}H(p,n)^{3}He (MeV)	^{1}H(t,n)^{3}He (MeV)	^{3}He(n,p)^{3}H (MeV)
Q-value	-0.763803	-0.763803	+0.763803
E_{thr} [a]	1.019044	3.05073	0
$E_{thrp+d+n}$ [b]	8.3544	25.0108	n/a
$E_{thr2p+2n}$ [c]	11.3278	33.9123	n/a
E_{dbl} [d]	<1.147327	no upper value	n/a
E_{n}(0deg) [e]	>0.064	>0.574	n/a
E_{n}(0deg) [f]	<7.585	<17.64	n/a
$E_{projmin}$ [g]	1.0191	3.051	0.001
$E_{projmax}$ [h]	32.80(318.)	98.19(940.8)	31.786(317.)

[a] Energy threshold of two-body reaction.
[b] Energy threshold of three-body reaction.
[c] Energy threshold of four-body reaction.
[d] Upper energy threshold of double valued angles.
[e] Minimum monoenergetic neutron energy at zero degree.
[f] Maximum monoenergetic neutron energy at zero degree.
[g] Minimum projectile energy covered by the evaluation.
[h] Maximum projectile energy covered by the evaluation; values in parenthesis are for excitation function(s), only.

TABLE 1.2. Legendre coefficients of the absolute differential cross sections of $^{3}H(p,n)^{3}He$.

E_p (MeV)	$\sigma_{0,cm}$ (mb/sr)	A_0	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}
1.019054	0.0208	1.0000										
1.019055	0.0657	1.0000										
1.019064	0.2071	1.0000										
1.0191	0.454	1.0000										
1.019154	0.6483	1.0000										
1.0192	0.824	1.0000										
1.019254	0.9113	1.0000										
1.01935	1.135	1.0000										
1.019454	1.24	1.0000										
1.0195	1.33	1.0000										
1.019654	1.517	1.0000										
1.019854	1.747	0.9995	0.0005									
1.020	1.8674	0.9989	0.0010	0.0001								
1.024	4.005	0.9990	0.0004	0.0006								
1.029	5.593	0.9992	-0.0010	0.0018								
1.03	5.88	0.9994	-0.0017	0.0023								
1.040	7.607	1.0043	-0.0088	0.0046								
1.05	8.768	1.0082	-0.0161	0.0079								
1.060	9.629	1.0130	-0.0233	0.0104	-0.0001							
1.069	10.24	1.0171	-0.0305	0.0135	-0.0001							
1.07	10.306	1.0177	-0.0313	0.0138	-0.0002							
1.080	10.86	1.0225	-0.0398	0.0175	-0.0002							
1.09	11.324	1.0273	-0.0485	0.0215	-0.0003							

1.100	11.72	1.0321	-0.0577	0.0259	-0.0004			
1.119	12.37	1.0406	-0.0748	0.0348	-0.0006			
1.150	13.15	1.0550	-0.1063	0.0523	-0.0010			
1.200	14.36	1.0735	-0.1570	0.0853	-0.0018			
1.25	15.50	1.0890	-0.2055	0.1193	-0.0028			
1.30	16.68	1.1052	-0.2543	0.1529	-0.0038			
1.35	17.90	1.1207	-0.3028	0.1871	-0.0050			
1.40	18.97	1.1358	-0.3508	0.2208	-0.0058			
1.45	19.99	1.1511	-0.3985	0.2540	-0.0066			
1.50	20.93	1.1672	-0.4480	0.2886	-0.0078			
1.55	21.56	1.1832	-0.4979	0.3252	-0.0105			
1.60	22.17	1.1985	-0.5455	0.3615	-0.0145			
1.65	22.59	1.2106	-0.5866	0.3952	-0.0202	0.0010		
1.70	23.00	1.2229	-0.6252	0.4265	-0.0263	0.0022		
1.80	23.80	1.2396	-0.6918	0.4868	-0.0376	0.0046	-0.0017	
1.900	25.23	1.2281	-0.7285	0.5460	-0.0481	0.0068	-0.0043	
2.000	27.77	1.1789	-0.7280	0.6023	-0.0556	0.0086	-0.0062	
2.100	31.22	1.1149	-0.7035	0.6470	-0.0613	0.0098	-0.0069	
2.200	34.82	1.0515	-0.6725	0.6817	-0.0648	0.0107	-0.0074	0.0008
2.300	38.85	0.9860	-0.6365	0.7129	-0.0680	0.0114	-0.0075	0.0017
2.400	43.30	0.9300	-0.6032	0.7370	-0.0704	0.0119	-0.0076	0.0022
2.500	47.38	0.8877	-0.5812	0.7603	-0.0745	0.0125	-0.0076	0.0028
2.600	50.47	0.8494	-0.5597	0.7795	-0.0779	0.0131	-0.0076	0.0032
2.700	52.92	0.8254	-0.5469	0.7948	-0.0828	0.0137	-0.0077	0.0035
2.800	54.58	0.8067	-0.5348	0.8060	-0.0885	0.0145	-0.0078	0.0038
2.900	55.44	0.7920	-0.5250	0.8160	-0.0949	0.0157	-0.0079	0.0042

3.000	56.01	0.7806	-0.5195	0.8269	-0.1015	0.0170	-0.0079	0.0045			
3.100	56.44	0.7706	-0.5158	0.8390	-0.1088	0.0183	-0.0081	0.0049			
3.200	56.48	0.7624	-0.5138	0.8515	-0.1168	0.0198	-0.0084	0.0053			
3.400	55.54	0.7551	-0.5175	0.8767	-0.1355	0.0240	-0.0090	0.0062			
3.600	53.53	0.7556	-0.5281	0.9042	-0.1584	0.0295	-0.0098	0.0070			
3.800	51.18	0.7618	-0.5418	0.9336	-0.1868	0.0359	-0.0108	0.0080			
4.000	48.18	0.7709	-0.5571	0.9633	-0.2178	0.0435	-0.0119	0.0090			
4.500	40.95	0.8123	-0.5998	1.0241	-0.3024	0.0691	-0.0153	0.0120			
5.000	34.77	0.8616	-0.6520	1.0866	-0.3958	0.1047	-0.0197	0.0155	-0.0009		
5.500	29.69	0.9170	-0.7163	1.1700	-0.5122	0.1499	-0.0256	0.0196	-0.0024		
6.000	25.33	0.9750	-0.7761	1.2513	-0.6454	0.2078	-0.0329	0.0246	-0.0043		
6.500	21.64	1.0404	-0.8455	1.3330	-0.7904	0.2809	-0.0423	0.0305	-0.0066		
7.000	18.69	1.1117	-0.9068	1.3914	-0.9372	0.3673	-0.0550	0.0373	-0.0089		
7.500	16.64	1.1745	-0.9374	1.4040	-1.0607	0.4580	-0.0706	0.0440	-0.0117		
8.000	15.30	1.2045	-0.9294	1.3542	-1.1202	0.5423	-0.0871	0.0500	-0.0144		
8.500	14.54	1.1931	-0.8758	1.2566	-1.1144	0.6035	-0.1017	0.0547	-0.0160		
9.000	14.29	1.1555	-0.7892	1.1221	-1.0631	0.6473	-0.1135	0.0571	-0.0162		
9.500	14.53	1.0955	-0.6851	0.9790	-0.9722	0.6587	-0.1200	0.0581	-0.0141		
10.000	14.91	1.0338	-0.5834	0.8480	-0.8807	0.6559	-0.1213	0.0584	-0.0108		
11.000	16.15	0.8780	-0.4057	0.6399	-0.6787	0.6245	-0.1090	0.0557	-0.0046		
11.500	16.96	0.8025	-0.3301	0.5593	-0.5827	0.6001	-0.1023	0.0552	-0.0020		
12.000	17.85	0.7328	-0.2624	0.4940	-0.4948	0.5708	-0.0956	0.0548	0.0005		
13.000	19.73	0.6131	-0.1527	0.4052	-0.3520	0.5084	-0.0809	0.0526	0.0049	0.0014	
13.600	20.815	0.5554	-0.0998	0.3660	-0.2857	0.4765	-0.0729	0.0515	0.0069	0.0028	-0.0008
14.000	21.50	0.5219	-0.0684	0.3437	-0.2478	0.4571	-0.0677	0.0510	0.0081	0.0039	-0.0018
15.000	23.02	0.4530	-0.0036	0.3023	-0.1725	0.4117	-0.0543	0.0504	0.0108	0.0069	-0.0047

16.000	24.38	0.3983	0.0445	0.2761	-0.1151	0.3710	-0.0423	0.0505	0.0133	0.0095	-0.0058	
18.000	26.20	0.3230	0.1100	0.2470	-0.0340	0.3110	-0.0240	0.0520	0.0150	0.0110	-0.0110	
21.0	28.06	0.2489	0.1644	0.2276	0.0453	0.2458	-0.0003	0.0550	0.0172	0.0145	-0.0137	-0.0046
24.0	31.06	0.1890	0.1816	0.2149	0.1032	0.2046	0.0254	0.0583	0.0198	0.0124	-0.0079	-0.0013
27.0	32.56	0.1513	0.1789	0.2084	0.1431	0.1919	0.0444	0.0600	0.0210	0.0079	-0.0054	-0.0015
30.0	33.79	0.1220	0.1700	0.2050	0.1665	0.1880	0.0650	0.0612	0.0210	0.0050	-0.0022	-0.0016
32.8	34.7	0.1018	0.1600	0.2000	0.1815	0.1905	0.0829	0.0622	0.0201	0.0022	0.0004	-0.0016

TABLE 1.3. Selection of higher energy $^{3}H(p,n)^{3}He$ cross sections.

E_p (MeV)	$\sigma_{0,cm}$ (mb/sr)
40.	28.3
45.	27.4
50.	26.4
56.8	25.2
60.	24.6
80.	21.5
100.	19.0
120.	17.1
160.	14.3
200.	12.3
318.	8.9

TABLE 1.4. Legendre coefficients of the absolute differential cross sections of $^{3}He(n,p)^{3}H$ obtained by detailed balance calculation. The last column gives the angle-integrated (n,p) cross section.

E_n (MeV)	$\sigma_{0,cm}$ (mb/sr)	A_0	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}	σ_{np} (mb)
0.1	138.4	1.0406	-0.0748	0.0348	-0.0006								1809.
0.2	90.3	1.0795	-0.1756	0.0983	-0.0022								1223.
0.3	75.4	1.1112	-0.2728	0.1659	-0.0043								1052.
0.4	68.6	1.1415	-0.3688	0.2334	-0.0061								984.
0.5	64.3	1.1732	-0.4668	0.3023	-0.0087								949.
0.6	60.3	1.2032	-0.5616	0.3746	-0.0165	0.0003							911.
0.7	56.8	1.2269	-0.6390	0.4381	-0.0285	0.0026	-0.0001						876.
0.8	54.6	1.2400	-0.7013	0.4980	-0.0396	0.0050	-0.0021						850.
0.9	54.6	1.2211	-0.7310	0.5572	-0.0497	0.0072	-0.0048						838.
1.0	57.3	1.1671	-0.7245	0.6117	-0.0568	0.0089	-0.0064						840.
1.2	65.7	1.0392	-0.6661	0.6880	-0.0655	0.0109	-0.0075	0.0010					857.
1.4	76.2	0.9216	-0.5986	0.7414	-0.0711	0.0120	-0.0076	0.0023					882.
1.6	83.4	0.8439	-0.5567	0.7826	-0.0787	0.0132	-0.0076	0.0033					884.
1.8	85.8	0.8036	-0.5326	0.8079	-0.0897	0.0147	-0.0078	0.0039					866.
2.0	84.6	0.7787	-0.5188	0.8291	-0.1028	0.0172	-0.0079	0.0045					828.
2.5	76.5	0.7546	-0.5232	0.8926	-0.1484	0.0271	-0.0094	0.0067					726.
3.0	64.1	0.7719	-0.5585	0.9659	-0.2207	0.0443	-0.0120	0.0091					622.
3.5	52.5	0.8140	-0.6015	1.0262	-0.3056	0.0702	-0.0154	0.0121					537.
4.0	43.4	0.8635	-0.6542	1.0893	-0.3995	0.1062	-0.0199	0.0156	-0.0010				470.
4.5	36.2	0.9190	-0.7186	1.1731	-0.5168	0.1518	-0.0258	0.0198	-0.0025				418.
5.0	30.3	0.9772	-0.7784	1.2542	-0.6504	0.2102	-0.0332	0.0248	-0.0044				372.

5.5	25.5	1.0429	-0.8480	1.3357	-0.7957	0.2838	-0.0427	0.0307	-0.0067				334.
6.0	21.8	1.1143	-0.9085	1.3928	-0.9422	0.3705	-0.0555	0.0376	-0.0090				305.
6.5	19.2	1.1762	-0.9378	1.4033	-1.0641	0.4612	-0.0712	0.0442	-0.0118				283.
7.0	17.5	1.2048	-0.9283	1.3515	-1.1210	0.5449	-0.0876	0.0502	-0.0145				265.
7.5	16.5	1.1922	-0.8733	1.2525	-1.1134	0.6054	-0.1022	0.0548	-0.0160				247.
8.0	16.1	1.1537	-0.7858	1.1171	-1.0605	0.6483	-0.1138	0.0572	-0.0162				233.
9.0	16.6	1.0315	-0.5800	0.8438	-0.8775	0.6557	-0.1212	0.0584	-0.0107				215.
10.0	17.8	0.8753	-0.4030	0.6369	-0.6753	0.6237	-0.1088	0.0557	-0.0045				196.
11.0	19.5	0.7306	-0.2603	0.4921	-0.4920	0.5698	-0.0954	0.0548	0.0006				179.
12.0	21.4	0.6114	-0.1511	0.4040	-0.3500	0.5074	-0.0807	0.0526	0.0050	0.0014			165.
13.0	23.2	0.5206	-0.0672	0.3428	-0.2463	0.4563	-0.0675	0.0510	0.0082	0.0040	-0.0019		152.
14.0	24.7	0.4520	-0.0027	0.3017	-0.1714	0.4110	-0.0541	0.0504	0.0108	0.0070	-0.0047		140.
15.0	26.0	0.3975	0.0452	0.2758	-0.1143	0.3704	-0.0421	0.0505	0.0133	0.0095	-0.0058		130.
16.0	27.1	0.3555	0.0814	0.2585	-0.0695	0.3379	-0.0323	0.0511	0.0145	0.0104	-0.0081		121.
18.0	28.3	0.2955	0.1332	0.2385	-0.0037	0.2873	-0.0163	0.0529	0.0155	0.0121	-0.0133	-0.0017	105.
20.0	29.5	0.2486	0.1646	0.2275	0.0456	0.2455	-0.0002	0.0550	0.0172	0.0145	-0.0137	-0.0046	92.1
22.0	31.5	0.2061	0.1791	0.2184	0.0862	0.2146	0.0178	0.0573	0.0190	0.0137	-0.0097	-0.0025	81.6
24.0	33.1	0.1745	0.1821	0.2119	0.1185	0.1982	0.0322	0.0590	0.0204	0.0109	-0.0068	-0.0009	72.5
25.0	33.5	0.1623	0.1810	0.2098	0.1318	0.1945	0.0382	0.0596	0.0207	0.0093	-0.0061	-0.0011	68.3
26.0	33.8	0.1512	0.1789	0.2084	0.1432	0.1918	0.0445	0.0600	0.0210	0.0079	-0.0054	-0.0015	64.2
28.0	34.6	0.1307	0.1734	0.2062	0.1603	0.1885	0.0582	0.0608	0.0210	0.0059	-0.0033	-0.0017	56.8
30.0	35.3	0.1140	0.1666	0.2034	0.1723	0.1883	0.0717	0.0616	0.0208	0.0041	-0.0012	-0.0016	50.6
31.0	35.6	0.1070	0.1630	0.2015	0.1776	0.1894	0.0781	0.0619	0.0204	0.0030	-0.0003	-0.0016	47.8
31.5	35.7	0.1037	0.1611	0.2006	0.1801	0.1901	0.0811	0.0621	0.0202	0.0025	0.0002	-0.0016	46.5

31.786	35.8	0.1018	0.1600	0.2000	0.1815	0.1905	0.0829	0.0622	0.0201	0.0022	0.0004	-0.0016	45.8

B. $^{2}H(d,n)^{3}He$ reactions

TABLE 2.1. Kinematic data.

Reaction (unit)	$^{2}H(d,n)^{3}He$ (MeV)	$^{3}He(n,d)^{2}H$ (MeV)
Q-value	+3.268864	-3.268864
E_{thr} [a]	n/a	4.364386
$E_{thrd+p+n}$ [b]	4.45045	n/a
$E_{thr2p+2n}$ [c]	8.90354	n/a
$E_{n}(0deg)$ [d]	>2.449	n/a
$E_{n}(0deg)$ [e]	<7.706	n/a
$E_{projmin}$ [f]	0.02	4.38
$E_{projmax}$ [g]	39.80(85.)	30.945(61.2)

[a] Energy threshold of two-body reaction.
[b] Energy threshold of three-body reaction.
[c] Energy threshold of four-body reaction.
[d] Minimum monoenergetic neutron energy at zero degree.
[e] Maximum monoenergetic neutron energy at zero degree.
[f] Minimum projectile energy covered by the evaluation.
[g] Maximum projectile energy covered by the evaluation; values in parenthesis are for excitation function(s), only.

TABLE 2.2. Legendre coefficients of the absolute differential cross sections of $^{2}H(d,n)^{3}He$. (Due to the angular symmetry all odd coefficients are zero.)

E_d (MeV)	$\sigma_{0,cm}$ (mb/sr)	A_0	A_2	A_4	A_6	A_8	A_{10}	A_{12}	A_{14}	A_{16}
0.0018	3.5e-10	.83542	0.16437	0.00021						
0.00206	2.14e-9	.83465	0.16513	0.00022						
0.00227	6.7e-9	.83414	0.16563	0.00023						
0.0030	1.13e-7	.83201	0.16773	0.00026						
0.0040	1.35e-6	.82911	0.17060	0.00029						
0.0055	1.75e-5	.82512	0.17453	0.00035						
0.0070	9.3e-5	.82130	0.17829	0.00041						
0.0100	8.619e-4	0.81449	0.18499	0.00052						
0.0120	2.37e-3	0.81009	0.18932	0.00059						
0.0140	5.28e-3	0.80552	0.19381	0.00067						
0.0160	0.0101	0.80107	0.19819	0.00074						
0.0166	0.0122	0.79961	0.19963	0.00076						
0.0170	0.0136	0.79873	0.20049	0.00078						
0.0180	0.0177	0.79663	0.20255	0.00082						
0.0190	0.0225	0.79442	0.20473	0.00085						
0.0200	0.0278	0.79257	0.20654	0.00089						
0.0250	0.0651	0.78261	0.21630	0.00109						
0.0300	0.121	0.77329	0.22542	0.00129						
0.0400	0.282	0.75608	0.24220	0.00172						
0.0500	0.497	0.73775	0.26000	0.00225						
0.0600	0.749	0.72315	0.27400	0.00285						
0.0700	1.024	0.71050	0.28600	0.00350						
0.0800	1.316	0.69785	0.29800	0.00415						

0.0900	1.615	0.68755	0.30750	0.00495			
0.1000	1.918	0.67780	0.31640	0.00580			
0.1099	2.222	0.66836	0.32498	0.00666			
0.1169	2.438	0.66227	0.33047	0.00726			
0.150	3.427	0.63839	0.35120	0.01040	0.00001		
0.200	4.856	0.60818	0.37631	0.01550	0.00001		
0.250	6.172	0.58478	0.39370	0.02150	0.00002		
0.300	7.403	0.56397	0.40800	0.02800	0.00003		
0.350	8.528	0.54697	0.41799	0.03500	0.00004		
0.400	9.575	0.53163	0.42632	0.04200	0.00005		
0.450	10.535	0.51843	0.43250	0.04900	0.00007		
0.500	11.435	0.50600	0.43690	0.05700	0.00009	0.00001	
0.550	12.297	0.49357	0.44029	0.06600	0.00012	0.00001	
0.600	13.081	0.48294	0.44290	0.07400	0.00015	0.00001	
0.650	13.808	0.47320	0.44460	0.08200	0.00019	0.00001	
0.700	14.502	0.46361	0.44590	0.09024	0.00023	0.00002	
0.750	15.142	0.45495	0.44680	0.09796	0.00027	0.00002	
0.800	15.727	0.44720	0.44666	0.10580	0.00032	0.00002	
0.850	16.304	0.43910	0.44567	0.11480	0.00040	0.00003	
0.900	16.850	0.43138	0.44416	0.12390	0.00053	0.00003	
0.950	17.350	0.42440	0.44180	0.13300	0.00077	0.00003	
1.000	17.822	0.41779	0.43920	0.14177	0.00120	0.00004	
1.100	18.709	0.40503	0.43369	0.15832	0.00290	0.00005	0.00001
1.200	19.589	0.39270	0.42795	0.17398	0.00530	0.00006	0.00001
1.300	20.478	0.38099	0.42195	0.18898	0.00800	0.00007	0.00001
1.400	21.363	0.37000	0.41595	0.20298	0.01096	0.00009	0.00002

1.500	22.223	0.35995	0.40980	0.21612	0.01400	0.00011	0.00002			
1.600	23.039	0.35069	0.40391	0.22826	0.01699	0.00013	0.00002			
1.700	23.845	0.34174	0.39803	0.23996	0.02009	0.00015	0.00003			
1.800	24.606	0.33363	0.39240	0.25061	0.02316	0.00017	0.00003			
1.900	25.363	0.32565	0.38725	0.26045	0.02640	0.00020	0.00004	0.00001		
2.000	26.095	0.31779	0.38189	0.26970	0.03035	0.00022	0.00004	0.00001		
2.100	26.787	0.31060	0.37672	0.27857	0.03380	0.00025	0.00005	0.00001		
2.200	27.388	0.30427	0.37160	0.28668	0.03709	0.00029	0.00006	0.00001		
2.300	27.971	0.29815	0.36668	0.29426	0.04050	0.00033	0.00007	0.00001		
2.400	28.540	0.29221	0.36208	0.30136	0.04390	0.00037	0.00007	0.00001		
2.500	29.078	0.28670	0.35754	0.30796	0.04730	0.00041	0.00008	0.00001		
2.600	29.597	0.28145	0.35324	0.31407	0.05068	0.00045	0.00009	0.00002		
2.700	30.107	0.27634	0.34907	0.32013	0.05385	0.00049	0.00010	0.00002		
2.800	30.611	0.27132	0.34500	0.32600	0.05701	0.00054	0.00011	0.00002		
2.900	31.099	0.26650	0.34135	0.33150	0.05991	0.00060	0.00012	0.00002		
3.000	31.575	0.26178	0.33753	0.33670	0.06316	0.00067	0.00013	0.00002		
3.200	32.482	0.25300	0.33050	0.34620	0.06932	0.00080	0.00015	0.00003		
3.400	33.383	0.24462	0.32393	0.35402	0.07619	0.00103	0.00018	0.00003		
3.600	34.221	0.23712	0.31763	0.36025	0.08280	0.00195	0.00021	0.00004		
3.800	35.097	0.22975	0.31166	0.36538	0.08893	0.00398	0.00024	0.00005	0.00001	
4.000	35.912	0.22312	0.30582	0.36955	0.09480	0.00636	0.00028	0.00006	0.00001	
4.500	37.579	0.20989	0.29279	0.37525	0.10892	0.01250	0.00050	0.00013	0.00002	
5.000	39.128	0.19843	0.28139	0.37810	0.12218	0.01810	0.00137	0.00037	0.00006	
5.500	40.534	0.18855	0.27070	0.37850	0.13431	0.02364	0.00343	0.00073	0.00013	
6.000	41.771	0.18010	0.26137	0.37688	0.14591	0.02902	0.00530	0.00112	0.00029	0.00001
6.500	42.934	0.17248	0.25353	0.37341	0.15679	0.03465	0.00712	0.00147	0.00053	0.00002

7.000	43.847	0.16625	0.24675	0.36891	0.16660	0.03990	0.00876	0.00187	0.00093	0.00003
7.500	44.665	0.16065	0.24105	0.36438	0.17531	0.04470	0.01022	0.00228	0.00137	0.00004
8.000	45.361	0.15571	0.23638	0.35942	0.18330	0.04900	0.01163	0.00270	0.00180	0.00006
8.500	45.919	0.15141	0.23216	0.35439	0.19061	0.05300	0.01291	0.00314	0.00230	0.00008
9.000	46.283	0.14787	0.22837	0.34902	0.19740	0.05663	0.01420	0.00360	0.00280	0.00010
9.500	46.454	0.14502	0.22526	0.34385	0.20319	0.05992	0.01531	0.00404	0.00327	0.00013
10.000	46.523	0.14254	0.22239	0.33827	0.2090	0.06292	0.01650	0.00451	0.00371	0.00016
11.000	46.394	0.13850	0.21740	0.32737	0.21910	0.06856	0.01895	0.00538	0.00447	0.00027
12.000	45.996	0.13536	0.21321	0.31644	0.22784	0.07382	0.02145	0.00619	0.00517	0.00052
13.000	45.520	0.13253	0.20952	0.30562	0.23572	0.07900	0.02373	0.00697	0.00575	0.00116
14.000	44.971	0.12998	0.20638	0.29473	0.24233	0.08407	0.02614	0.00778	0.00632	0.00227
15.000	44.416	0.12752	0.20362	0.28424	0.24817	0.08913	0.02855	0.00860	0.00680	0.00337
16.000	43.820	0.12524	0.20100	0.27460	0.25350	0.09400	0.03081	0.00938	0.00722	0.00425
17.000	43.184	0.12314	0.19868	0.26531	0.25840	0.09860	0.03314	0.01017	0.00757	0.00499
18.000	42.562	0.12106	0.19630	0.25680	0.26279	0.10301	0.03554	0.01100	0.00792	0.00558
19.000	41.839	0.11933	0.19447	0.24842	0.26683	0.10722	0.03791	0.01174	0.00817	0.00591
20.000	41.171	0.11750	0.19240	0.24100	0.27009	0.11150	0.04040	0.01250	0.00840	0.00620
22.000	39.911	0.11380	0.18830	0.22870	0.27500	0.11950	0.04540	0.01410	0.00890	0.00630
24.000	38.597	0.11048	0.18457	0.21989	0.27870	0.12547	0.04982	0.01567	0.00942	0.00598
26.000	37.368	0.10714	0.18176	0.21147	0.28097	0.13177	0.05440	0.01735	0.00975	0.00539
28.000	36.083	0.10417	0.17842	0.20462	0.28233	0.13800	0.05841	0.01894	0.01021	0.00490
30.000	34.976	0.10090	0.17540	0.19890	0.28260	0.14370	0.06270	0.02080	0.01060	0.00440
32.000	33.847	0.09789	0.17212	0.19276	0.28232	0.15003	0.06709	0.02279	0.01101	0.00399
34.000	32.669	0.09522	0.16962	0.18744	0.28104	0.15595	0.07090	0.02489	0.01129	0.00365
36.000	31.594	0.09244	0.16691	0.18201	0.27909	0.16229	0.07518	0.02721	0.01156	0.00332
38.000	30.596	0.08962	0.16408	0.17670	0.27681	0.16837	0.07978	0.02974	0.01187	0.00303

40.000	29.577	0.08704	0.16210	0.17259	0.27436	0.17296	0.08369	0.03236	0.01213	0.00277

TABLE 2.3. Selection of higher energy $^{2}H(d,n)^{3}He$ cross sections. The second column gives the angle-integrated (d,n) cross section.

E_d (MeV)	$\sigma_{d,n}$ (mb)	$\sigma_{0,cm}$ (mb/sr)
45.	27.632	24.9
50.	23.601	22.1
55.	20.158	19.275
60.	17.217	16.69
65.	14.705	14.45
70.	12.560	12.51
75.	10.727	10.83
80.	9.162	9.375
85.	7.826	8.117
90.	6.684	7.027
95.	5.709	6.084
100.	4.876	5.267
120.	2.595	
140.	1.381	
160.	0.735	
180.	0.391	
200.	0.208	

TABLE 2.4. Legendre coefficients of the absolute differential cross sections of $^{3}He(n,d)^{2}H$ obtained by detailed balance calculation.. The last column gives the angle-integrated (n,d) cross section.

E_n (MeV)	$\sigma_{0,cm}$ (mb/sr)	A_0	A_2	A_4	A_6	A_8	A_{10}	A_{12}	A_{14}	A_{16}	σ_{nd} (mb)
4.4	0.0070	0.7323	0.2652	0.0025							0.064
4.5	0.223	0.6066	0.3775	0.0159							1.70
4.6	0.658	0.5461	0.4185	0.0354							4.52
4.7	1.23	0.5054	0.4371	0.0574	0.0001						7.78
4.8	1.88	0.4727	0.4447	0.0824	0.0002						11.2
4.9	2.58	0.4469	0.4466	0.1062	0.0003						14.5
5.0	3.30	0.4242	0.4417	0.1333	0.0008						17.6
5.2	4.82	0.3866	0.4249	0.1818	0.0066	0.0001					23.4
5.4	6.50	0.3553	0.4068	0.2223	0.0155	0.0001					29.0
5.6	8.25	0.3297	0.3898	0.2556	0.0247	0.0002					34.2
5.8	10.0	0.3074	0.3742	0.2826	0.0354	0.0003	0.0001				38.8
6.0	11.8	0.2894	0.3598	0.3047	0.0456	0.0004	0.0001				42.7
6.5	16.0	0.2531	0.3306	0.3461	0.0692	0.0008	0.0002				50.8
7.0	20.1	0.2248	0.3074	0.3685	0.0932	0.0057	0.0003	0.0001			56.8
7.5	23.9	0.2053	0.2883	0.3766	0.1142	0.0147	0.0007	0.0002			61.6
8.0	27.5	0.1896	0.2719	0.3785	0.1330	0.0230	0.0032	0.0007	0.0001		65.4
8.5	30.7	0.1770	0.2582	0.3757	0.1502	0.0312	0.0060	0.0013	0.0004		68.4
9.0	33.7	0.1670	0.2475	0.3694	0.1655	0.0393	0.0086	0.0018	0.0009		70.7
9.5	36.3	0.1587	0.2392	0.3625	0.1784	0.0464	0.0108	0.0024	0.0015	0.0001	72.5
10.0	38.6	0.1519	0.2327	0.3550	0.1897	0.0525	0.0128	0.0031	0.0022	0.0001	73.8
11.0	42.0	0.1428	0.2227	0.3390	0.2083	0.0625	0.0163	0.0045	0.0037	0.0002	75.3

12.0	44.0	0.1371	0.2155	0.3226	0.2229	0.0709	0.0201	0.0057	0.0048	0.0004	75.8
13.0	45.2	0.1327	0.2098	0.3064	0.2352	0.0786	0.0236	0.0069	0.0057	0.0011	75.4
14.0	46.0	0.1289	0.2052	0.2902	0.2449	0.0862	0.0272	0.0081	0.0065	0.0028	74.5
15.0	46.5	0.1254	0.2012	0.2753	0.2531	0.0937	0.0306	0.0093	0.0072	0.0042	73.2
16.0	46.7	0.1222	0.1976	0.2617	0.2603	0.1005	0.0342	0.0105	0.0077	0.0053	71.7
17.0	46.5	0.1194	0.1946	0.2491	0.2665	0.1069	0.0377	0.0117	0.0082	0.0059	69.8
18.0	46.3	0.1167	0.1915	0.2381	0.2713	0.1133	0.0415	0.0128	0.0085	0.0063	67.9
19.0	46.0	0.1140	0.1885	0.2291	0.2748	0.1192	0.0452	0.0140	0.0089	0.0063	65.8
20.0	45.5	0.1115	0.1855	0.2224	0.2777	0.1238	0.0485	0.0152	0.0093	0.0061	63.7
22.0	44.4	0.1065	0.1811	0.2099	0.2813	0.1331	0.0553	0.0177	0.0098	0.0053	59.4
24.0	43.1	0.1019	0.1763	0.2006	0.2826	0.1419	0.0614	0.0202	0.0105	0.0046	55.2
26.0	41.7	0.0974	0.1716	0.1916	0.2821	0.1512	0.0679	0.0232	0.0111	0.0039	51.1
28.0	40.2	0.0933	0.1678	0.1837	0.2797	0.1603	0.0738	0.0265	0.0115	0.0034	47.1
30.0	38.8	0.0891	0.1636	0.1758	0.2764	0.1694	0.0806	0.0302	0.0119	0.0030	43.4
31.0	38.0	0.0872	0.1622	0.1728	0.2745	0.1727	0.0835	0.0322	0.0121	0.0028	41.6

TABLE 2.5. Selection of higher energy $^{3}He(n,d)^{2}H$ cross sections. The last column gives the angle-integrated (n,d) cross section.

E_n (MeV)	$\sigma_{0,cm}$ (mb/sr)	$\sigma_{n,d}$ (mb)
35.0	31.7	35.1
40.0	26.8	28.2
45.0	21.9	22.5
50.0	17.8	18.0
55.0	14.5	14.3
60.0	11.7	11.4
65.0	9.5	9.0
70.0	7.6	7.2

C. $^{3}H(d,n)^{4}He$ reactions

TABLE 3.1. Kinematic data.

Reaction (unit)	$^{3}H(d,n)^{4}He$ (MeV)	$^{2}H(t,n)^{4}He$ (MeV)	$^{4}He(n,d)^{3}H$ (MeV)	$^{4}He(n,t)^{2}H$ (MeV)
Q-value	+17.58925	+17.58925	-17.58925	
E_{thr} [a]	0	0	22.06449	
$E_{thrt+p+n}$ [b]	3.711	5.558	n/a	
$E_{thrHe-3+2n}$ [c]	4.985	7.466	n/a	
$E_{thr2d+n}$ [d]	10.443	15.639	n/a	
$E_{thr2n+p+d}$ [e]	14.159	21.204	n/a	
$E_{thr2p+3n}$ [f]	17.876	26.771	n/a	
E_{dbl} [g]	n/a	n/a	<26.5974	<35.7511
E_{n}(0deg) [h]	>14.03	>14.03	n/a	
E_{n}(0deg) [i]	<20.46	<23.01	n/a	
$E_{projmin}$ [j]	0.01	0.015	22.08	
$E_{projmax}$ [k]	40.00(400.)	59.9(599.)	52.2(323.5)	

[a] Energy threshold of two-body reaction.
[b] Energy threshold of first three-body reaction.
[c] Energy threshold of second three-body reaction.
[d] Energy threshold of third three-body reaction.
[e] Energy threshold of four-body reaction.
[f] Energy threshold of five-body reaction.
[g] Upper energy threshold of double valued angles.
[h] Minimum monoenergetic neutron energy at zero degree.
[i] Maximum monoenergetic neutron energy at zero degree.
[j] Minimum projectile energy covered by the evaluation.
[k] Maximum projectile energy covered by the evaluation; values in parenthesis are for excitation function(s), only.

TABLE 3.2. Legendre coefficients of the absolute differential cross sections of $^{3}H(d,n)^{4}He$.

E_d (MeV)	$\sigma_{0,cm}$ (mb/sr)	A_0	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}	A_{11}	A_{12}	A_{13}	A_{14}	A_{15}	A_{16}
0.010	0.138	0.9990	0.0002	0.0008														
0.020	4.757	0.9983	0.0009	0.0008														
0.030	22.406	0.9978	0.0014	0.0008														
0.040	57.146	0.9976	0.0018	0.0006														
0.050	109.33	0.9974	0.0022	0.0004														
0.060	175.732	0.9972	0.0026	0.0002														
0.070	248.48	0.99704	0.00295	0.00001														
0.080	315.841	0.9970	0.0033	-0.0003														
0.090	366.390	0.9970	0.0037	-0.0007														
0.100	394.084	0.9969	0.0041	-0.0010														
0.105	399.296	0.9969	0.0043	-0.0012														
0.110	400.017	0.9969	0.005	-0.0014														
0.115	396.370	0.9969	0.0047	-0.0016														
0.120	389.296	0.9969	0.0049	-0.0018														
0.130	369.411	0.9969	0.0053	-0.0022														
0.140	343.458	0.9969	0.0058	-0.0027														
0.150	317.349	0.9969	0.0062	-0.0032	0.00005													
0.160	291.151	0.9969	0.0067	-0.0037	0.0001													
0.170	267.446	0.9970	0.0072	-0.0042	0.0001													
0.180	245.230	0.9970	0.0077	-0.0048	0.0001													
0.190	225.733	0.9970	0.0082	-0.0053	0.0001													
0.200	207.933	0.9970	0.0088	-0.0059	0.0001													
0.220	178.245	0.9970	0.00995	-0.0071	0.00015													

0.240	154.594	0.9970	0.0111	-0.0083	0.0002				
0.260	135.567	0.9970	0.0123	-0.0096	0.0002	0.0001			
0.280	120.093	0.9970	0.0136	-0.0109	0.0002	0.0001			
0.300	107.343	0.9970	0.0149	-0.0123	0.0003	0.0001			
0.320	96.717	0.9969	0.0163	-0.0136	0.0003	0.0001			
0.340	87.768	0.9968	0.0177	-0.0150	0.0004	0.0001			
0.360	80.154	0.9967	0.0192	-0.0165	0.0004	0.0002			
0.380	73.61	0.99655	0.02065	-0.0179	0.0005	0.0002			
0.400	67.947	0.9964	0.0221	-0.0193	0.0005	0.0002	0.0001		
0.420	63.005	0.99615	0.02365	-0.0208	0.0006	0.0003	0.0001		
0.440	58.666	0.9959	0.0252	-0.0222	0.0007	0.0003	0.0001		
0.460	54.829	0.9956	0.0268	-0.0237	0.0008	0.0004	0.0001		
0.480	51.421	0.9953	0.0284	-.02515	0.00085	0.00045	0.00015		
0.500	48.376	0.9950	0.0300	-0.0266	0.0009	0.0005	0.0002		
0.550	42.039	0.9939	0.0342	-0.0301	0.0012	0.0006	0.0002		
0.600	37.082	0.9925	0.0384	-0.0336	0.0015	0.00085	0.0003	0.00005	
0.650	33.123	0.9908	0.0426	-0.0369	0.00185	0.0011	0.00045	0.0001	
0.700	29.905	0.9887	0.0469	-0.0399	0.0022	0.0014	0.0006	0.0001	
0.750	27.253	0.9863	0.05115	-0.0428	0.00265	0.0018	0.00075	0.0001	
0.800	25.039	0.9835	0.0554	-0.0453	0.0031	0.0022	0.0009	0.0002	
0.850	23.171	0.9802	0.0596	-0.0475	0.0037	0.00265	0.00115	0.0002	
0.900	21.583	0.9765	0.06375	-.04945	0.0043	0.0032	0.0014	0.0003	
0.950	20.220	0.9723	0.0678	-0.0509	0.0049	0.0038	0.0017	0.0004	
1.000	19.046	0.9676	0.0718	-0.0521	0.0057	0.00435	0.0021	0.0005	0.00005
1.100	17.140	0.9567	0.0795	-.05305	0.00725	0.0059	0.0029	0.0007	0.0001
1.200	15.685	0.9438	0.0866	-0.0522	0.0092	0.0076	0.0039	0.00095	0.00015

1.300	14.563	0.9289	0.0932	-0.0495	0.0113	0.0095	0.0051	0.0013	0.0002			
1.400	13.694	0.9120	0.0992	-0.0449	0.0137	0.0117	0.0064	0.0017	0.0002			
1.500	13.023	0.8933	0.1045	-0.0385	0.0163	0.0140	0.0079	0.0022	0.0003			
1.600	12.511	0.8730	0.1091	-0.0304	0.0191	0.0165	0.0096	0.0027	0.0004			
1.700	12.125	0.8513	0.1130	-0.0206	0.0220	0.0191	0.0113	0.0033	0.0005	0.0001		
1.800	11.848	0.8284	0.1163	-0.0094	0.0250	0.0218	0.0132	0.0040	0.0006	0.0001		
1.900	11.659	0.8045	0.1190	0.0030	0.0282	0.0245	0.0153	0.0047	0.0007	0.0001		
2.000	11.547	0.7801	0.1211	0.0165	0.0313	0.0272	0.0173	0.0054	0.00095	0.00015		
2.200	11.514	0.7303	0.1237	0.0458	0.0376	0.0324	0.0217	0.00715	0.0012	0.00015		
2.400	11.685	0.6810	0.1246	0.0767	0.0436	0.0371	0.0261	0.0090	0.0017	0.0002		
2.600	12.018	0.6337	0.1242	0.1079	0.0491	0.0411	0.0306	0.0109	0.0022	0.0003		
2.800	12.478	0.5895	0.1230	0.1381	0.0541	0.0443	0.0350	0.0130	0.0027	0.0003		
3.000	13.037	0.5493	0.1212	0.16635	0.0584	0.04665	0.0394	0.01505	0.00325	0.0004		
3.200	13.667	0.5137	0.1193	0.1917	0.0620	0.0482	0.0437	0.0171	0.0038	0.0005		
3.400	14.337	0.4822	0.1175	0.2137	0.0649	0.04915	0.04815	0.0193	0.0045	0.0006		
3.600	15.022	0.4554	0.11645	0.2316	0.0670	0.0495	0.0526	0.0215	0.0052	0.00075		
3.800	15.786	0.4298	0.1178	0.2461	0.0690	0.04985	0.0569	0.0236	0.0060	0.0009	0.00005	
4.000	16.458	0.4084	0.1170	0.25845	0.0712	0.0495	0.0617	0.0258	0.0068	0.0011	0.00005	
4.200	17.050	0.3909	0.1160	0.2668	0.0729	0.0493	0.0668	0.0283	0.0076	0.0013	0.0001	
4.400	17.563	0.3764	0.1152	0.2714	0.0741	0.0496	0.0724	0.0308	0.0085	0.0015	0.0001	
4.600	17.997	0.3641	0.1145	0.2725	0.07495	0.0506	0.0784	0.0336	0.0095	0.0017	0.0001	0.00005
4.800	18.353	0.3535	0.1140	0.2705	0.0756	0.0524	0.0848	0.0365	0.0105	0.0020	0.00015	0.00005
5.000	18.639	0.3440	0.1136	0.2659	0.07585	0.0552	0.0916	0.0396	0.01165	0.0023	0.0002	0.0001
5.200	18.860	0.3355	0.1133	0.2593	0.0756	0.0589	0.0989	0.0428	0.0128	0.0026	0.0002	0.0001
5.400	19.025	0.3276	0.1128	0.2511	0.0748	0.0635	0.1064	0.0463	0.01405	0.0030	0.0003	0.00015
5.600	19.143	0.3202	0.1122	0.2420	0.0733	0.0688	0.1142	0.0500	0.0153	0.0035	0.0003	0.0002

5.800	19.223	0.3134	0.1114	0.2324	0.0709	0.0747	0.12215	0.0539	0.0166	0.0040	0.00035	0.0002				
6.000	19.272	0.3070	0.1102	0.2228	0.0678	0.0809	0.1301	0.0579	0.0181	0.0045	0.0004	0.0003				
6.200	19.299	0.3011	0.1087	0.2136	0.0639	0.0873	0.1378	0.0621	0.0196	0.0051	0.0005	0.0003				
6.400	19.306	0.2956	0.1067	0.2049	0.0593	0.0938	0.1453	0.0665	0.0211	0.0058	0.0006	0.0004				
6.600	19.297	0.2905	0.1044	0.1971	0.0540	0.1002	0.1525	0.0710	0.0227	0.0065	0.0007	0.0004				
6.800	19.270	0.2858	0.1017	0.1901	0.0483	0.1063	0.1591	0.0756	0.0244	0.0074	0.0008	0.0005				
7.000	19.222	0.2814	0.0986	0.1842	0.0422	0.1121	0.1652	0.0803	0.0261	0.0083	0.0010	0.0006				
7.500	18.942	0.27082	0.08835	0.17470	0.0278	0.12491	0.17694	0.09247	0.03044	0.01073	0.00171	0.00105	0.00006	0.00002		
8.000	18.564	0.26178	0.07872	0.17121	0.01522	0.13170	0.18370	0.10478	0.03395	0.01364	0.00320	0.00167	0.00025	0.00018		
8.500	18.136	0.25404	0.0709	0.1681	0.0051	0.1349	0.18795	0.11715	0.03663	0.01711	0.00435	0.00253	0.00044	0.00080		
9.000	17.81	0.24749	0.06635	0.16375	-0.0039	0.13506	0.1906	0.12942	0.03895	0.0213	0.00518	0.00345	0.00064	0.0017		
9.500	17.530	0.24173	0.06391	0.15933	-0.0120	0.1336	0.19189	0.14172	0.04109	0.0246	0.0060	0.0044	0.0008	0.0028	0.00013	
10.000	17.293	0.2365	0.0626	0.1546	-0.0192	0.1305	0.1928	0.1541	0.0431	0.0273	0.0068	0.0053	0.0011	0.0040	0.0005	
10.250	17.177	0.2341	0.0621	0.1523	-0.0224	0.1288	0.1930	0.1602	0.0440	0.0285	0.0072	0.0058	0.0012	0.0045	0.0007	
10.500	17.080	0.2316	0.0618	0.1501	-0.0251	0.1270	0.1929	0.1663	0.0448	0.0297	0.0076	0.0063	0.0013	0.0049	0.0008	
10.750	16.995	0.2290	0.0617	0.1479	-0.0275	0.1251	0.1927	0.1721	0.0456	0.0310	0.0080	0.0068	0.0014	0.0052	0.0010	
11.000	16.915	0.2263	0.0617	0.1458	-0.0296	0.1232	0.1924	0.1778	0.0463	0.0322	0.0083	0.0073	0.0015	0.0055	0.0011	0.0002
11.400	16.799	0.2218	0.0618	0.1425	-0.0323	0.1199	0.1918	0.1862	0.0474	0.0341	0.0088	0.0081	0.0017	0.0059	0.0013	0.0010
12.000	16.67	0.2152	0.0621	0.1379	-0.0347	0.1146	0.1904	0.1975	0.0494	0.0368	0.0096	0.0092	0.0020	0.0064	0.0016	0.0020
12.750	16.567	0.2071	0.0630	0.1323	-0.0352	0.1077	0.1883	0.2095	0.0516	0.0402	0.0107	0.0103	0.0023	0.0068	0.0019	0.0035
13.000	16.530	0.2045	0.0635	0.1305	-0.0348	0.1052	0.1878	0.2127	0.0524	0.0412	0.0110	0.0107	0.0024	0.0069	0.0020	0.0040
13.250	16.490	0.2021	0.0641	0.1287	-0.0343	0.1027	0.1871	0.2155	0.0532	0.0422	0.0113	0.0111	0.0025	0.0070	0.0020	0.0048
13.500	16.470	0.1997	0.0649	0.1271	-0.0335	0.1005	0.1864	0.2183	0.0539	0.0431	0.0116	0.0114	0.0026	0.0071	0.0020	0.0049
13.750	16.465	0.1973	0.0659	0.1254	-0.0327	0.0982	0.1856	0.2215	0.0546	0.0441	0.0118	0.0117	0.0027	0.0071	0.0020	0.0048
14.000	16.464	0.1949	0.0669	0.1237	-0.0318	0.0960	0.1848	0.2244	0.0553	0.0451	0.0120	0.0121	0.0028	0.0071	0.0020	0.0047
14.250	16.466	0.1927	0.0679	0.1221	-0.0307	0.0940	0.1837	0.2270	0.0559	0.0461	0.0123	0.0124	0.0029	0.0072	0.0020	0.0045

14.500	16.469	0.1902	0.0689	0.1205	-0.0294	0.0920	0.1827	0.2293	0.0566	0.0472	0.0126	0.0128	0.0030	0.0072	0.0021	0.0043		
14.750	16.476	0.1876	0.0699	0.1190	-0.0280	0.0900	0.1817	0.2314	0.0572	0.0484	0.0128	0.0132	0.0031	0.0074	0.0021	0.0042		
15.000	16.481	0.1850	0.0710	0.1175	-0.0263	0.0883	0.1807	0.2333	0.0578	0.0494	0.0130	0.0135	0.0032	0.0074	0.0021	0.0041		
15.500	16.489	0.1797	0.0729	0.1145	-0.0226	0.0853	0.1788	0.2367	0.0590	0.0514	0.0134	0.0141	0.0034	0.0074	0.0021	0.0039		
16.000	16.496	0.1748	0.0744	0.1116	-0.0186	0.0825	0.1770	0.2393	0.0602	0.0534	0.0138	0.0147	0.0036	0.0075	0.0021	0.0037		
16.500	16.500	0.1704	0.0759	0.1087	-0.0146	0.0799	0.1754	0.2411	0.0613	0.0552	0.0143	0.0153	0.0038	0.0077	0.0021	0.0035		
17.000	16.503	0.1668	0.0775	0.1060	-0.0109	0.0775	0.1738	0.2423	0.0624	0.0568	0.0148	0.0158	0.0040	0.0078	0.0021	0.0033		
17.250	16.504	0.1653	0.0783	0.1047	-0.0091	0.0764	0.1730	0.2426	0.0630	0.0575	0.0150	0.0160	0.0041	0.0078	0.0022	0.0032		
17.500	16.505	0.1639	0.0791	0.1034	-0.0073	0.0752	0.1722	0.2428	0.0635	0.0582	0.0153	0.0162	0.0043	0.0079	0.0022	0.0031		
17.750	16.505	0.1626	0.0800	0.1021	-0.0055	0.0741	0.1715	0.2429	0.0640	0.0588	0.0155	0.0164	0.0044	0.0079	0.0023	0.0030		
18.000	16.505	0.1613	0.0808	0.1008	-0.0038	0.0730	0.1707	0.2428	0.0646	0.0595	0.0158	0.0166	0.0046	0.0080	0.0023	0.0030		
18.500	16.504	0.1590	0.0825	0.0982	-0.0005	0.0709	0.1694	0.2426	0.0657	0.0607	0.0163	0.0170	0.0049	0.0081	0.0023	0.0029		
19.000	16.503	0.1567	0.0841	0.0959	0.0025	0.0689	0.1681	0.2422	0.0668	0.0619	0.0169	0.0174	0.0053	0.0082	0.0023	0.0028		
19.690	16.500	0.1534	0.0862	0.0935	0.0060	0.0665	0.1662	0.2414	0.0682	0.0635	0.0178	0.0179	0.0059	0.0083	0.0024	0.0028		
20.000	16.496	0.1519	0.0871	0.0926	0.0075	0.0655	0.1653	0.2410	0.0688	0.0641	0.0182	0.0182	0.0061	0.0084	0.0024	0.0028	0.0001	
20.500	16.490	0.1495	0.0885	0.0912	0.0096	0.0640	0.1638	0.2401	0.0698	0.0653	0.0189	0.0187	0.0065	0.0086	0.0025	0.0029	0.0001	
21.000	16.480	0.1472	0.0899	0.0900	0.0116	0.0625	0.1622	0.2393	0.0707	0.0664	0.0197	0.0191	0.0069	0.0087	0.0027	0.0029	0.0002	
21.500	16.466	0.1449	0.0913	0.0891	0.0135	0.0611	0.1605	0.2383	0.0716	0.0673	0.0206	0.0195	0.0073	0.0089	0.0028	0.0030	0.0003	
22.000	16.438	0.1427	0.0926	0.0884	0.0153	0.0597	0.1588	0.2372	0.0724	0.0683	0.0214	0.0200	0.0077	0.0091	0.0029	0.0031	0.0004	
22.500	16.401	0.1405	0.0939	0.0879	0.0171	0.0583	0.1570	0.2362	0.0732	0.0691	0.0223	0.0205	0.0081	0.0092	0.0030	0.0032	0.0005	
23.000	16.366	0.1385	0.0951	0.0877	0.0188	0.0570	0.1551	0.2351	0.0740	0.0700	0.0230	0.0209	0.0084	0.0094	0.0031	0.0033	0.0006	
24.000	16.280	0.1340	0.0968	0.0878	0.0217	0.0547	0.1517	0.2323	0.0755	0.0718	0.0249	0.0221	0.0093	0.0097	0.0033	0.0035	0.0008	0.0001
24.250	16.257	0.1329	0.0972	0.0879	0.0223	0.0542	0.1509	0.2316	0.0758	0.0722	0.0254	0.0224	0.0095	0.0098	0.0034	0.0036	0.0008	0.0001
25.000	16.177	0.1297	0.0983	0.0881	0.0242	0.0527	0.1484	0.2294	0.0769	0.0736	0.0269	0.0232	0.0101	0.0100	0.0036	0.0038	0.0009	0.0002
26.000	16.066	0.1256	0.0996	0.0881	0.0265	0.0508	0.1447	0.2260	0.0785	0.0755	0.0293	0.0243	0.0108	0.0105	0.0040	0.0043	0.0011	0.0004
26.500	16.003	0.1237	0.1002	0.0881	0.0276	0.0500	0.1428	0.2242	0.0792	0.0764	0.0305	0.0249	0.0111	0.0107	0.0042	0.0046	0.0012	0.0006

27.000	15.938	0.1219	0.1007	0.0881	0.0285	0.0492	0.1409	0.2225	0.0800	0.0772	0.0317	0.0254	0.0115	0.0110	0.0044	0.0050	0.0013	0.0007
27.500	15.87	0.1201	0.1012	0.0881	0.0294	0.0485	0.1389	0.2207	0.0807	0.0780	0.0330	0.0260	0.0119	0.0112	0.0046	0.0054	0.0015	0.0008
28.000	15.78	0.1185	0.1017	0.0882	0.0303	0.0479	0.1370	0.2188	0.0814	0.0787	0.0342	0.0265	0.0123	0.0115	0.0048	0.0057	0.0016	0.0009
29.000	15.621	0.1154	0.1025	0.0884	0.0320	0.0465	0.1328	0.2147	0.0828	0.0802	0.0367	0.0278	0.0130	0.0123	0.0053	0.0065	0.0019	0.0012
30.000	15.464	0.1125	0.1034	0.0890	0.0338	0.0451	0.1283	0.2103	0.0840	0.0816	0.0390	0.0292	0.0138	0.0131	0.0059	0.0072	0.0023	0.0015
31.000	15.298	0.1098	0.1042	0.0896	0.0354	0.0437	0.1240	0.2059	0.0854	0.0831	0.0412	0.0304	0.0147	0.0139	0.0064	0.0079	0.0026	0.0018
31.560	15.205	0.1083	0.1046	0.0900	0.0362	0.0430	0.1217	0.2033	0.0862	0.0839	0.0424	0.0310	0.0152	0.0143	0.0068	0.0082	0.0029	0.0020
32.000	15.133	0.1071	0.1049	0.0903	0.0368	0.0425	0.1200	0.2012	0.0868	0.0845	0.0434	0.0315	0.0156	0.0147	0.0071	0.0084	0.0031	0.0021
32.500	15.051	0.1058	0.1052	0.0906	0.0375	0.0420	0.1181	0.1988	0.0874	0.0852	0.0445	.03205	0.0160	0.0152	0.0074	0.0087	0.0033	.00225
33.000	14.970	0.1045	0.1054	0.0910	0.0383	0.0415	0.1162	0.1962	0.0880	0.0859	0.0457	0.0326	0.0164	0.0157	0.0077	0.0090	0.0035	0.0024
33.500	14.889	.10315	0.1056	0.0913	.03905	0.0410	.11435	0.1936	0.0884	0.0866	0.0470	.03315	0.0168	0.0164	0.0081	0.0093	0.0037	0.0025
34.000	14.809	0.1018	0.1058	0.0915	0.0398	0.0405	0.1125	0.1909	0.0888	0.0873	0.0483	0.0337	0.0172	0.0172	0.0085	.00965	0.0039	.00265
34.500	14.729	0.1005	0.1060	0.0917	0.0406	0.0400	0.1106	0.1882	0.0891	0.0880	0.0496	0.0342	0.0176	0.0181	0.0089	0.0100	0.0041	0.0028
35.000	14.650	0.0991	0.1062	0.0918	0.0414	0.0395	0.1087	.18555	0.0894	0.0888	0.0509	0.0348	0.0179	0.0190	0.0093	0.0104	0.0043	.00295
36.000	14.492	0.0963	0.1065	0.0918	0.0431	0.0384	0.1049	0.1806	.09005	0.0902	0.0535	0.0360	.01855	0.0208	0.0101	0.0113	0.0047	0.0032
37.000	14.336	0.0935	0.1067	0.0917	0.0448	0.0373	0.1011	0.1760	0.0907	0.0915	0.0560	0.0372	0.0192	0.0226	0.0109	0.0123	0.0051	0.0034
38.000	14.182	0.0908	0.1067	0.0915	0.0465	0.0361	0.0973	.17195	.09135	0.0928	0.0583	0.0384	0.0198	0.0244	.01165	0.0134	.00545	0.0036
39.000	14.037	.08825	.10675	.09125	0.0483	0.0348	0.0936	0.1679	0.0920	0.09405	0.0605	0.0395	0.0204	0.0262	0.0124	0.0145	0.0058	0.0038
40.000	13.893	0.0857	0.1068	0.0910	0.0501	.03345	0.0899	0.1640	.09275	0.09525	0.0627	0.0406	0.0209	0.0280	.01315	0.0156	0.0061	0.0040

TABLE 3.3. Selection of higher energy $^{3}H(d,n)^{4}He$ cross sections. The second column gives the angle-integrated (d,n) cross section.

E_d (MeV)	$\sigma_{d,n}$ (mb)	$\sigma_{0,cm}$ (mb/sr)	$\sigma_{180,cm}$ (mb/sr)
45.	12.36	13.208	1.252
50.	10.41	12.591	1.005
55.	8.91	12.039	0.824
60.	7.738	11.525	0.684
65.	6.79	11.062	0.575
70.	6.020	10.613	0.490
75.	5.38	10.185	0.419
80.	4.844	9.779	0.363
85.	4.39	9.360	0.314
90.	4.000	8.935	0.273
95.	3.64	8.484	0.238
100.	3.330	8.029	0.207
105.	3.03	7.586	0.181
110.	2.764	7.156	0.157
115.	2.53	6.751	0.138
120.	2.314	6.371	0.122
125.	2.12	6.024	0.108
130.	1.952	5.709	9.591E-02
135.	1.79	5.402	8.495E-02
140.	1.645	5.101	7.549E-02
145.	1.52	4.803	6.772E-02
150.	1.403	4.510	6.025E-02
155.	1.30	4.236	5.388E-02
160.	1.198	3.982	4.810E-02
165.	1.11	3.746	4.293E-02
170.	1.033	3.528	3.832E-02
175.	0.96	3.314	3.460E-02
180.	8.979E-01	3.112	3.037E-02
185.	0.84	2.921	2.740E-02
190.	7.868E-01	2.734	2.461E-02
195.	0.74	2.555	2.192E-02
200.	6.938E-01	2.388	2.011E-02
210.	6.153E-01	2.097	1.640E-02
220.	5.489E-01	1.851	1.333E-02
230.	4.923E-01	1.640	1.082E-02
240.	4.438E-01	1.457	9.092E-03

250.	4.016E-01	1.295	7.485E-03
260.	3.645E-01	1.156	6.242E-03
270.	3.324E-01	1.032	5.408E-03
280.	3.040E-01	0.920	4.400E-03
290.	2.791E-01	0.821	3.743E-03
300.	2.568E-01	0.731	3.101E-03
310.	2.369E-01	0.655	2.618E-03
320.	2.191E-01	0.587	2.241E-03
330.	2.032E-01	0.527	1.906E-03
340.	1.888E-01	0.473	1.684E-03
350.	1.759E-01	0.425	1.427E-03
360.	1.642E-01	0.382	1.206E-03
370.	1.535E-01	0.343	1.030E-03
380.	1.438E-01	0.310	9.223E-04
390.	1.351E-01	0.279	7.820E-04
400.	1.267E-01	0.252	6.552E-04

TABLE 3.4. Legendre coefficients of the absolute differential cross sections of $^{4}He(n,d)^{3}H$.

E_n (MeV)	$\sigma_{0,cm}$ (mb/sr)	A_0	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}	A_{11}	A_{12}	A_{13}	A_{14}	A_{15}	A_{16}
22.08	0.017	0.99825	0.00093	0.00080														
22.10	0.664	0.99746	0.00209	0.00045														
22.12	3.066	0.9970	0.0031	-0.0001														
22.14	6.000	0.9969	0.00410	-0.0010														
22.16	7.242	0.9969	0.0051	-0.0020														
22.18	7.172	0.9969	0.0064	-0.0034	0.0001													
22.20	6.688	0.99700	0.0077	-0.0048	0.0001													
22.25	5.515	0.99700	0.01147	-0.0087	0.00020	0.00003												
22.30	4.734	0.99694	0.01575	-0.0131	0.00030	0.00010												
22.35	4.214	0.99656	0.02055	-0.0178	0.00050	0.00020												
22.40	3.850	0.99583	0.02563	-0.0226	0.00073	0.00032	0.00010											
22.45	3.581	0.99479	0.03092	-0.0274	0.00095	0.00052	0.00020											
22.50	3.379	0.99315	0.0366	-0.0321	0.00137	0.00073	0.00024	0.00002										
22.60	3.096	0.9882	0.0478	-0.0405	0.00229	0.00148	0.00063	0.00010										
22.70	2.923	0.98067	0.05903	-0.0472	0.00362	0.00258	0.00112	0.00020										
22.80	2.819	0.96991	0.06992	-0.0516	0.00530	0.00408	0.00190	0.00045	0.00002									
22.90	2.766	0.95565	0.0801	-0.0530	0.00740	0.00605	0.00298	0.00072	0.00010									
23.00	2.755	0.93787	0.08939	-0.0513	0.01005	0.00835	0.00438	0.00109	0.00018									
23.20	2.834	0.89197	0.10484	-0.0380	0.01648	0.01416	0.00801	0.00223	0.00031									
23.40	3.033	0.83488	0.11541	-0.0126	0.02414	0.02105	0.01264	0.00380	0.00058	0.00010								
23.60	3.343	0.77080	0.12174	0.02182	0.03247	0.02820	0.01809	0.00570	0.00102	0.00015								
23.80	3.766	0.70471	0.12434	0.06162	0.04075	0.03489	0.02398	0.00811	0.00143	0.00016								
24.00	4.300	0.64100	0.12432	0.10301	0.04826	0.04051	0.02990	0.01059	0.00213	0.00029								

24.50	6.105	0.50835	0.11903	0.19544	0.06252	0.04840	0.04440	0.01744	0.00390	0.00051								
25.00	8.438	0.41906	0.11765	0.25229	0.07006	0.04975	0.05915	0.02461	0.00639	0.00099	0.00005							
25.50	10.76	0.36648	0.11463	0.27250	0.07478	0.05035	0.07714	0.03301	0.00930	0.00165	0.00010	0.00004						
26.00	12.74	0.33459	0.11325	0.25846	0.07554	0.05937	0.09973	0.04318	0.01293	0.00264	0.00021	0.00010						
26.50	14.36	0.31061	0.11092	0.22827	0.06965	0.07733	0.12557	0.05560	0.01723	0.00421	0.00037	0.00024						
27.00	15.72	0.29176	0.10501	0.19902	0.05539	0.09859	0.15071	0.06985	0.02228	0.00631	0.00068	0.00040						
27.50	16.85	0.27681	0.09455	0.17922	0.03593	0.11801	0.17083	0.08541	0.02796	0.00929	0.00122	0.00076	0.00001	0.00001				
28.00	17.63	0.26390	0.08103	0.17180	0.01813	0.13042	0.18233	0.10172	0.03317	0.01288	0.00281	0.00150	0.00020	0.00011				
29.00	18.85	0.24507	0.06517	0.16195	-0.0073	0.13468	0.19124	0.13440	0.03984	0.02276	0.00551	0.00384	0.00070	0.00212	0.00003			
30.00	20.11	0.23129	0.06178	0.14983	-0.0254	0.12677	0.19288	0.16701	0.04490	0.02986	0.00765	0.00636	0.00131	0.00494	0.00082			
31.00	21.43	0.21676	0.06201	0.13898	-0.0343	0.11587	0.19079	0.19491	0.04893	0.03615	0.00940	0.00896	0.00193	0.00629	0.00154	0.00177		
32.00	22.81	0.20280	0.06394	0.12916	-0.0345	0.10334	0.18719	0.21479	0.05301	0.04195	0.01124	0.01102	0.00250	0.00700	0.00200	0.00458		
34.00	25.78	0.17635	0.07393	0.11252	-0.0199	0.08339	0.17756	0.23854	0.05982	0.05276	0.01366	0.01450	0.00354	0.00745	0.00210	0.00376		
36.00	28.43	0.15903	0.08247	0.09829	-0.0006	0.07093	0.16942	0.24260	0.06568	0.06068	0.01629	0.01699	0.00490	0.00810	0.00230	0.00290		
38.00	30.74	0.14652	0.09031	0.08971	0.01217	0.06208	0.16171	0.23904	0.07097	0.06666	0.01996	0.01921	0.00702	0.00874	0.00274	0.00292	0.00023	
40.00	32.50	0.13493	0.09651	0.08774	0.02122	0.05512	0.15234	0.23287	0.07522	0.07144	0.02448	0.02186	0.00915	0.00961	0.00322	0.00342	0.00078	0.00009
42.00	33.78	0.12387	0.10015	0.08810	0.02751	0.05007	0.14297	0.22436	0.07913	0.07632	0.03039	0.02485	0.01107	0.01068	0.00418	0.00457	0.00119	0.00059
44.00	34.57	0.11509	0.10262	0.08846	0.03218	0.04638	0.13229	0.21426	0.08294	0.08032	0.03696	0.02792	0.01306	0.01236	0.00536	0.00656	0.00196	0.00126
46.00	35.07	0.10776	0.10473	0.09014	0.03647	0.04277	0.12091	0.20233	0.08650	0.08417	0.04287	0.03122	0.01538	0.01447	0.00694	0.00829	0.00300	0.00205
48.00	35.38	0.10075	0.10597	0.09167	0.04045	0.04011	0.11092	0.18866	0.08907	0.08787	0.04934	0.03411	0.01754	0.01791	0.00883	0.00993	0.00407	0.00278
50.00	35.53	0.09331	0.10670	0.09169	0.04492	0.03723	0.10083	0.17570	0.09075	0.09159	0.05616	0.03729	0.01924	0.02272	0.01095	0.01237	0.00513	0.00342
52.20	35.60	0.08572	0.10680	0.09100	0.05008	0.03346	0.08994	0.16402	0.09274	0.09524	0.06268	0.04060	0.02090	0.02798	0.01314	0.01560	0.00610	0.00400

TABLE 3.5. Numerical conversion of $^{3}H(d,n)^{4}He$ into $^{4}He(n,d)^{3}H$ cross sections. E_d is the corresponding deuteron incident energy in the (d,n) reaction.

E_n (MeV)	E_d (MeV)	$\sigma_{n,d}$ (mb)
22.100	0.0471178	8.322216
22.142	0.1028509	77.793918
22.143	0.1041779	79.008819
22.144	0.1055049	80.164174
22.145	0.1068318	81.266143
22.146	0.1081588	82.319743
22.147	0.1094858	83.302714
22.148	0.1108128	84.214933
22.149	0.1121398	85.058574
22.150	0.1134667	85.836031
22.151	0.1147937	86.549917
22.152	0.1161207	87.203069
22.153	0.1174477	87.798544
22.165	0.1333714	91.494494
22.166	0.1346984	91.524531
22.167	0.1360254	91.520650
22.168	0.1373524	91.485493
22.200	0.1798157	83.787596
22.300	0.3125136	59.303213
22.400	0.4452115	48.173332
22.500	0.5779094	42.170019
22.600	0.7106073	38.451298
22.700	0.8433052	36.016474
22.800	0.9760031	34.352846
22.900	1.1087010	33.215159
23.000	1.2413989	32.468977
23.100	1.3740968	32.006670
23.200	1.5067947	31.766040
23.300	1.6394926	31.717241
23.400	1.7721905	31.820767
23.500	1.9048884	32.042045
23.600	2.0375863	32.383408
23.700	2.1702842	32.826015
23.800	2.3029821	33.349248
23.900	2.4356800	33.953129
24.000	2.5683779	34.637085

25.000	3.8953569	44.436811
25.750	4.8905912	51.750456
26.000	5.2223360	53.566419
26.250	5.5540807	54.959591
26.500	5.8858255	56.047739
26.750	6.2175702	56.918754
27.000	6.5493150	57.650505
27.330	6.9872180	58.434597
27.670	7.4383909	58.597928
28.000	7.8762940	58.478119
28.500	8.5397835	58.027601
29.000	9.2032730	58.057377
29.500	9.8667625	58.242765
30.000	10.5302520	58.458264
31.000	11.8572311	58.381804
32.000	13.1842101	58.135230
33.000	14.5111891	58.040598
34.000	15.8381681	57.121631
35.000	17.1651471	56.561442
36.000	18.4921261	56.817220
37.000	19.8191051	56.887859
38.000	21.1460842	56.596826
39.000	22.4730632	55.981399
40.000	23.8000422	55.104217

TABLE 3.6 Selection of higher energy ^{4}He(n,d)^{3}H cross sections. The second column gives the angle-integrated (n,d) cross section.

E_n (MeV)	$\sigma_{n.d}$ (mb)	$\sigma_{0,cm}$ (mb/sr)	$\sigma_{180,cm}$ (mb/sr)
50.	41.66	35.53	4.641
55.	34.48	35.54	3.545
60.	28.85	35.17	2.778
65.	24.62	34.61	2.235
70.	21.32	33.90	1.827
75.	18.68	33.05	1.517
80.	16.53	32.09	1.270
85.	14.76	31.00	1.072
90.	13.28	29.70	0.905
95.	11.93	28.15	0.767

100.	10.71	26.51	0.648
110.	8.62	23.26	0.466
120.	7.00	20.46	0.344
130.	5.69	17.86	0.256
140.	4.66	15.33	0.192
150.	3.86	13.18	0.143
160.	3.24	11.27	0.107
170.	2.75	9.51	0.081
180.	2.36	8.05	0.063
190.	2.04	6.86	0.048
200.	1.78	5.89	0.0375
210.	1.57	5.05	0.0293
220.	1.38	4.36	0.0234
230.	1.23	3.76	0.0187
240.	1.10	3.24	0.0148
250.	0.99	2.79	0.0116
260.	0.89	2.42	0.0094
270.	0.81	2.10	0.0076
280.	0.73	1.82	0.0064
290.	0.67	1.58	0.00515
300.	0.61	1.38	0.00413
310.	0.56	1.20	0.00357
320.	0.52	1.05	0.00283
325.	0.50	0.98	0.00251

IV. SOME OF THE SUCCESSES

For each of the three reaction groups and each code in the software package DROSG-2000 one example is given;

- $^{3}H(p,n)^{3}He$, code WHIYIE: Figs. 1 through 4 of Ref. 21 show the excellent agreement of the measured with the calculated neutron spectra from the interaction of fully stopped 20.2 MeV tritons with the hydrogen in water.
- $^{2}H(d,n)^{3}He$, code NEUYIE: The lab cross section at zero degree 24.3 MeV is predicted as 89.0 mb which compares too well with the measured value of 89.2 mb[20].
- $^{3}H(d,n)^{4}He$, code TIMREV: The curves in Fig.1 as given by the code for the lab cross sections of $^{4}He(n,d)^{3}H$ and $^{4}He(n,t)^{2}H$ at 50 MeV agrees well with experimental data[22]. Using this information one could improve the quality of the charge symmetric evaluation.

APPENDIX. LIST OF DATA SETS COMPILED IN EXFOR

The evaluated data tabulated in this report are compiled in EXFOR D0756 (for charged-particle induced reaction data part) and V0103 (for neutron induced reaction data part). The contents of these EXFOR entries are summarized below:

Reaction	E_{min} (MeV)	E_{max} (MeV)	Quantity*	EXFOR #	Table #
$^{3}H(p,n)^{3}He$	1.019054	32.8	$\sigma_{0,cm}$	D0756.002	1.2
			A_i	D0756.003	
	40	318	$\sigma_{0,cm}$	D0756.004	1.3
$^{3}He(n,p)^{3}H$	0.1	31.786	$\sigma_{0,cm}$	V0103.002	1.4
			$\sigma_{n,p}$	V0103.003	
			A_i	V0103.004	
$^{2}H(d,n)^{3}He$	0.0018	40.0000	$\sigma_{0,cm}$	D0756.005	2.2
			A_i	D0756.006	
	45	100	$\sigma_{0,cm}$	D0756.007	2.3
	45	200	$\sigma_{d,n}$	D0756.008	
$^{3}He(n,d)^{2}H$	4.4	31.0	$\sigma_{0,cm}$	V0103.005	2.4
			$\sigma_{n,d}$	V0103.006	
			A_i	V0103.007	
	35.0	70.0	$\sigma_{0,cm}$	V0103.008	2.5
			$\sigma_{n,d}$	V0103.009	
$^{3}H(d,n)^{4}He$	0.010	40.000	$\sigma_{0,cm}$	D0756.009	3.2
			A_i	D0756.010	
	45	400	$\sigma_{0,cm},\sigma_{180,cm}$	D0756.011	3.3
			$\sigma_{d,n}$	D0756.012	
$^{4}He(n,d)^{3}H$	22.08	52.20	$\sigma_{0,cm}$	V0103.010	3.4
			A_i	V0103.012	
	22.100	40.000	$\sigma_{n,d}$	V0103.011	3.5
	50.	325.	$\sigma_{0,cm},\sigma_{180,cm}$	V0103.013	3.6
			$\sigma_{n,d}$	V0103.014	

* $\sigma_{0,cm}$ / $\sigma_{180,cm}$: angular differential cross section at 0 / 180 deg in the center-of-mass system.
A_i: Legendre coefficient (defined in the main text).
$\sigma_{n,p}$ / $\sigma_{d,n}$ / $\sigma_{n,d}$: angular-integrated (n,p) / (d,n) / (n,d) cross section.

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