LA-9971-MS

Los Alamos National Laboratory is operated by the University of California for the United States Department of Energy under contract W-7405-ENG-36.

Cross Sections and Maxwellian Reaction Rates for Polarized d+d Reactions

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This work was supported by the US Department of Energy, Office of Basic Energy Sciences.

Prepared by A. D. Mutschlecner, Group T-2

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UC-34c
Issued: February 1984

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CROSS SECTIONS AND MAXWELLIAN REACTION RATES FOR POLARIZED d+d REACTIONS

by

G. M. Hale and G. D. Doolen

ABSTRACT

Cross sections and Maxwellian reaction rates, averaged over incident relative directions, are given for the $\vec{D}(\vec{d},p)T$ and $\vec{D}(\vec{d},n)^3He$ reactions at low energies. These results are calculated from the current parameters of an extensive R-matrix analysis of reactions in the four-nucleon system. The analysis indicates that the averaged cross sections for deuterons interacting in spin-parallel polarized states are not strongly suppressed. The characteristic angular distributions could be used to obtain information about polarized deuterium plasmas.

I. INTRODUCTION

Recent work by Kulsrud and others[1-3] has raised practical interest in fusion reactions induced by polarized particles. The d+d reactions have received particular attention because early theoretical work[4,5] suggested that these reactions might be strongly suppressed if the deuteron spins were parallel. Such an effect, if real, could be used to reduce unwanted secondary neutron and tritium production from the d+d reactions in a d-^{3}He reactor.

This report contains predictions for polarized d+d cross sections based on the extensive R-matrix analysis of Hale and Dodder[6] for reactions in the four-nucleon system. The analysis is not yet completed, but it represents the low-energy data sufficiently well to give qualitatively reliable predictions. These predictions indicate that the spin-parallel d-d cross sections are not strongly suppressed.

II. DEFINITIONS AND RELATIONS

Assume that some direction has been established (for example, by an external magnetic field) as the axis (Z) of quantization. Then $\sigma_{m,n}(\underline{v}',\underline{v})$ is the center-of-mass differential cross section for deuterons having spin projections m,n (m,n = 1,0,-1) on the Z-axis colliding with relative velocity $\underline{v}$ to form reaction products with relative velocity $\underline{v}'$. The quantities of interest in plasma applications are the cross section averaged over isotropic incident directions, for fixed incident energy,

$$\bar{\sigma}_{m,n}(\hat{v}') = \frac{1}{4\pi} \int d\Omega_{\underline{v}} \, \sigma_{m,n}(\underline{v}',\underline{v}) \quad ,$$

the integral of this averaged cross section over final directions,

$$\bar{\sigma}_{m,n} = \int d\Omega_{\underline{v}'} \, \bar{\sigma}_{m,n}(\hat{v}') \quad ,$$

and the corresponding reaction rates,

$$\langle\sigma_{m,n}v\rangle(\hat{v}') = \frac{1}{4\pi} \int d\underline{v} \, f(v,kT) \, \sigma_{m,n} \, (\underline{v}',\underline{v})v$$

$$= \int dv \, f(v,kT) \, \bar{\sigma}_{m,n}(\hat{v}')v \quad ,$$

$$\langle\sigma_{m,n}v\rangle = \int d\Omega_{\underline{v}'} \, \langle\sigma_{m,n}v\rangle \, (\hat{v}') \quad ,$$

averaged over the normalized Maxwellian speed distribution f(v,kT) for temperature T.

The exchange symmetry of the deuterons plus reflection invariance imply that the only independent (m,n) combinations are (1,1), (1,0), (1,-1), and (0,0). The unpolarized cross section is expressed in terms of these as

$$\sigma_0 = \frac{1}{9} \, (2\sigma_{1,1} + 4\sigma_{1,0} + 2\sigma_{1,-1} + \sigma_{0,0}) \quad .$$

This relation holds for any initial and final relative velocities $\underline{v}$ and $\underline{v}'$ and therefore for any of the cross-section averages defined above. The unpolarized differential cross section averaged over incident directions is isotropic: $\bar{\sigma}_0(\hat{v}') = \sigma_0/4\pi$, with σ_0 the usual unpolarized integrated reaction cross section. The polarized differential cross sections averaged over incident directions, $\bar{\sigma}_{m,n}(\hat{v}')$, are in general anisotropic but are invariant under rotations about the Z-axis and reflections through the plane at the origin perpendicular to the Z-axis.

III. RESULTS

Table I lists the unpolarized integrated cross section σ_0 and the ratios of the four independent polarized integrated cross sections $\bar{\sigma}_{m,n}$ to σ_0 for the D(d,p) and D(d,n) reactions at incident laboratory energies (E_d) between 10 and 500 keV.

TABLE I

POLARIZED CROSS SECTIONS FOR THE d-d REACTIONS

A. D(d,p)T[a]

E_d(keV)	σ_0(mb)	$\bar{\sigma}_{1,1}/\sigma_0$	$\bar{\sigma}_{1,0}/\sigma_0$	$\bar{\sigma}_{1,-1}/\sigma_0$	$\bar{\sigma}_{0,0}/\sigma_0$
10	9.430×10^{-3}	1.266	0.850	0.884	1.299
50	4.649	1.153	0.914	0.933	1.172
100	15.55	1.031	0.981	0.987	1.037
150	25.06	0.933	1.036	1.031	0.929
200	32.75	0.855	1.079	1.066	0.843
300	44.35	0.741	1.140	1.119	0.721
400	52.78	0.666	1.177	1.157	0.645
500	59.18	0.613	1.200	1.186	0.600

B. D(d,n)^{3}He[a]

E_d(keV)	σ_0(mb)	$\bar{\sigma}_{1,1}/\sigma_0$	$\bar{\sigma}_{1,0}/\sigma_0$	$\bar{\sigma}_{1,-1}/\sigma_0$	$\bar{\sigma}_{0,0}/\sigma_0$
10	8.418×10^{-3}	1.095	0.888	1.017	1.223
50	4.372	0.949	0.977	1.075	1.047
100	15.41	0.808	1.060	1.132	0.879
150	25.84	0.704	1.122	1.173	0.755
200	34.82	0.628	1.168	1.204	0.664
300	49.17	0.525	1.229	1.246	0.543
400	60.02	0.462	1.264	1.274	0.472
500	68.38	0.422	1.285	1.293	0.430

[a]The cross sections satisfy

$$(2\bar{\sigma}_{1,1} + 4\bar{\sigma}_{1,0} + 2\bar{\sigma}_{1,-1} + \bar{\sigma}_{0,0})/9 = \sigma_0.$$

Table II lists the unpolarized integrated reaction rates $\langle\sigma_0 v\rangle$ and the ratios of the four independent polarized integrated reaction rates $\langle\sigma_{m,n} v\rangle$ to $\langle\sigma_0 v\rangle$ for the D(d,p) and D(d,n) reactions at kT = 2, 4, 6, 8, and 10 keV.

TABLE II

POLARIZED REACTION RATES FOR THE d-d REACTIONS

A. D(d,p)T[a]

kT (keV)	$\langle\sigma_0 v\rangle$ (cm^3/sec)	$\frac{\langle\sigma_{1,1}v\rangle}{\langle\sigma_0 v\rangle}$	$\frac{\langle\sigma_{1,0}v\rangle}{\langle\sigma_0 v\rangle}$	$\frac{\langle\sigma_{1,-1}v\rangle}{\langle\sigma_0 v\rangle}$	$\frac{\langle\sigma_{0,0}v\rangle}{\langle\sigma_0 v\rangle}$
2	3.239×10^{-21}	1.223	0.875	0.902	1.251
4	4.550×10^{-20}	1.181	0.898	0.921	1.203
6	1.585×10^{-19}	1.146	0.918	0.936	1.165
8	3.432×10^{-19}	1.115	0.935	0.950	1.131
10	5.905×10^{-19}	1.088	0.950	0.962	1.100

B. D(d,n)^{3}He[a]

kT (keV)	$\langle\sigma_0 v\rangle$ (cm^3/sec)	$\frac{\langle\sigma_{1,1}v\rangle}{\langle\sigma_0 v\rangle}$	$\frac{\langle\sigma_{1,0}v\rangle}{\langle\sigma_0 v\rangle}$	$\frac{\langle\sigma_{1,-1}v\rangle}{\langle\sigma_0 v\rangle}$	$\frac{\langle\sigma_{0,0}v\rangle}{\langle\sigma_0 v\rangle}$
2	2.950×10^{-21}	1.038	0.923	1.039	1.154
4	4.224×10^{-20}	0.984	0.955	1.061	1.089
6	1.494×10^{-19}	0.941	0.981	1.078	1.038
8	3.280×10^{-19}	0.904	1.003	1.093	0.994
10	5.711×10^{-19}	0.872	1.022	1.106	0.955

[a]The reaction rates satisfy
$(2\langle\sigma_{1,1}\rangle + 4\langle\sigma_{1,0}v\rangle + 2\langle\sigma_{1,-1}v\rangle + \langle\sigma_{0,0}v\rangle)/9 = \langle\sigma_0 v\rangle$.

Figure 1 gives polar plots of the relative shapes of the four independent angular distributions $\bar{\sigma}_{m,n}(\hat{v}')$ for the D(d,p) reaction at E_d = 10, 100, 300, and 500 keV. Figure 2 gives the same angular distribution plots for the D(d,n) reaction. Polar plots of the relative shapes of the four independent reaction rates $\langle\sigma_{m,n}v\rangle(\hat{v}')$ for the D(d,p) and D(d,n) reactions at kT = 2 and 10 keV are given in Fig. 3.

Listed in the Appendix are numerical values of the averaged differential cross sections $\bar{\sigma}_{m,n}(\hat{v}')$ and reaction rates $\langle\sigma_{m,n}v\rangle(\hat{v}')$ as functions of the angle between $\hat{v}'$ and the Z-axis for the D(d,p) and D(d,n) reactions at various energies and temperatures.

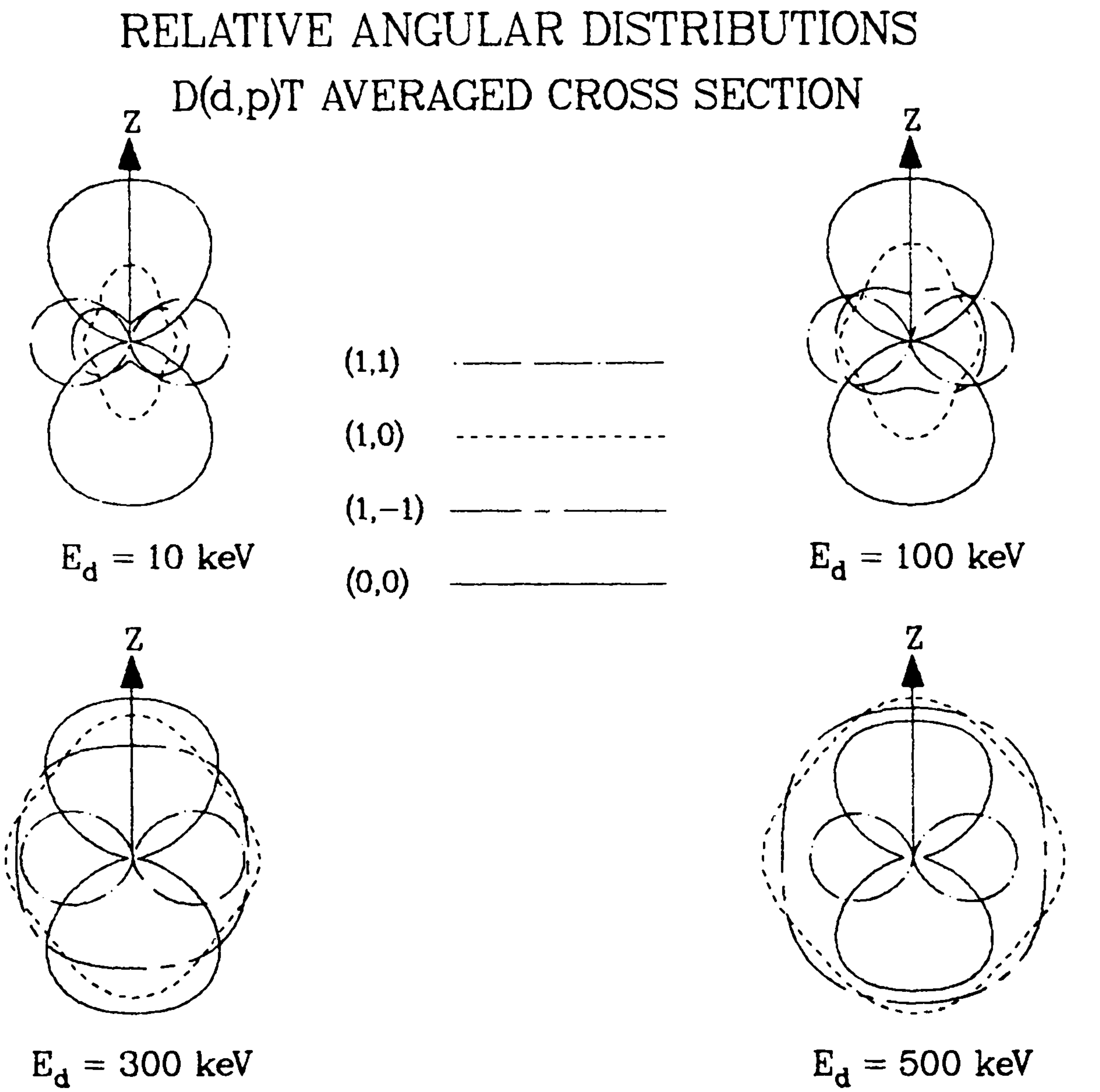

Fig. 1. Relative shapes of the four independent averaged cross sections $\bar{\sigma}_{m,n}(\hat{v}')$ for the D(d,p) reaction at energies between 10 and 500 keV. The polar angle is that between $\hat{v}'$ and the Z-axis.

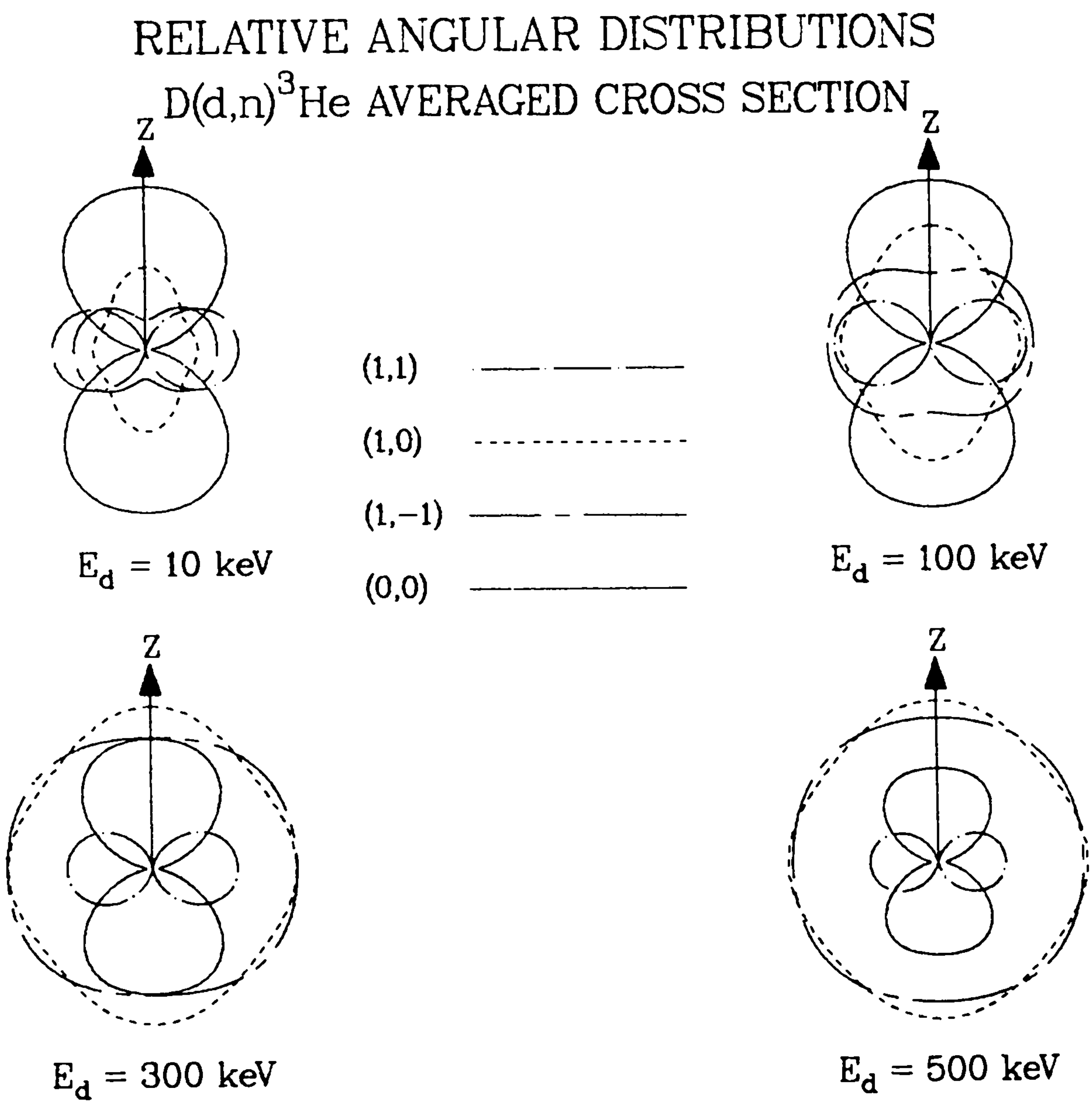

Fig. 2. Relative shapes of the four independent averaged cross sections $\bar{\sigma}_{m,n}(\hat{v}')$ for the D(d,n) reaction at energies between 10 and 500 keV. The polar angle is that between $\hat{v}'$ and the Z-axis.

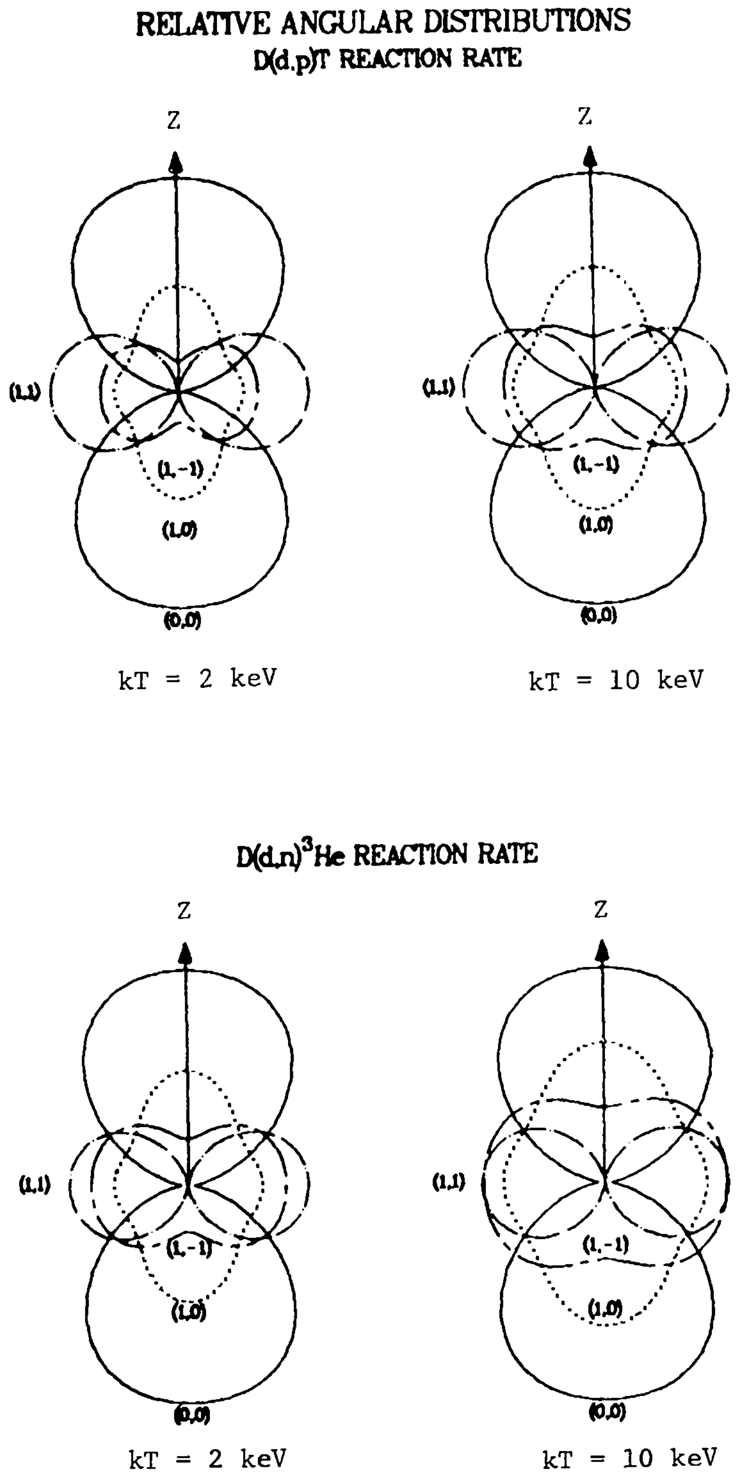

Fig. 3. Relative shapes of the four independent reaction rates $\langle\sigma_{m,n}v\rangle(\hat{v}')$ for the D(d,p) [top] and D(d,n) [bottom] reactions, at temperatures kT = 2 and 10 keV. The polar angle is that between $\hat{v}'$ and the Z-axis.

IV. CONCLUSIONS

It is apparent from Table I that the cross section for the spin-parallel case (1,1) is not strongly suppressed. This is because, contrary to the results and assumptions of earlier work, the J = 2, S-wave transitions make sizeable contributions to the d+d reactions at low energies, as is evident in measurements of large second-rank analyzing tensors.[7,8]

On the other hand, Fig. 3 shows that the (1,1) angular distribution remains highly directional in a plasma at moderate temperatures, with most of the reaction products being emitted perpendicular to the axis of quantization. This characteristic angular distribution would be a useful diagnostic for measuring the depolarization rate during fusion of an initially polarized deuterium plasma.

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APPENDIX

NUMERICAL VALUES OF $\bar{\sigma}_{m,n}(\hat{v}')$ AND $\langle\sigma_{m,n}v\rangle(\hat{v}')$

The following computer listings tabulate values of polarized average cross sections $\bar{\sigma}_{m,n}$ and reaction rates $\langle\sigma_{m,n}v\rangle$ for the d+d reactions as functions of the "angle" between $\hat{v}'$ and the Z-axis for various deuteron laboratory energies "ed" or temperatures "kt." Columns labeled "axs" give cross sections averaged over incident directions in barns (= 10^{-24} cm^2), and those labeled "svb" give Maxwellian reaction rates in cm^3/sec.' Rows labeled "intgr" are integrals of the preceding angular distributions over the angles of $\hat{v}'$. Because of the symmetry properties of the angular distributions (see Figs. 1-3), only angles up to 90° are tabulated.

$$\bar{\sigma}_{m,n}(\hat{v}')\ D(d,p)$$

ed= 10 kev

angle	axs(1,1)	axs(1,0)	axs(1,-1)	axs(0,0)
0	0.377094e-10	0.102411e-05	0.250523e-06	0.215588e-05
5	0.135125e-07	0.101440e-05	0.257881e-06	0.215304e-05
10	0.532273e-07	0.986173e-06	0.279432e-06	0.214341e-05
15	0.117112e-06	0.942013e-06	0.313658e-06	0.212383e-05
20	0.201901e-06	0.885909e-06	0.358194e-06	0.208959e-05
25	0.303396e-06	0.822810e-06	0.410065e-06	0.203525e-05
30	0.416785e-06	0.758091e-06	0.465967e-06	0.195555e-05
35	0.536999e-06	0.696964e-06	0.522578e-06	0.184641e-05
40	0.659063e-06	0.643933e-06	0.576854e-06	0.170586e-05
45	0.778403e-06	0.602337e-06	0.626282e-06	0.153470e-05
50	0.891093e-06	0.574039e-06	0.669061e-06	0.133695e-05
55	0.994010e-06	0.559301e-06	0.704190e-06	0.111981e-05
60	0.108489e-05	0.556842e-06	0.731467e-06	0.893337e-06
65	0.116230e-05	0.564090e-06	0.751385e-06	0.669700e-06
70	0.122550e-05	0.577577e-06	0.764963e-06	0.462189e-06
75	0.127430e-05	0.593439e-06	0.773516e-06	0.284021e-06
80	0.130885e-05	0.607948e-06	0.778408e-06	0.147103e-06
85	0.132942e-05	0.618015e-06	0.780812e-06	0.608880e-07
90	0.133625e-05	0.621607e-06	0.781521e-06	0.314517e-07
intgr	0.119337e-04	0.801939e-05	0.833561e-05	0.122499e-04

ed= 50 kev

angle	axs(1,1)	axs(1,0)	axs(1,-1)	axs(0,0)
0	0.812187e-07	0.503293e-03	0.180879e-03	0.954546e-03
5	0.613747e-05	0.499014e-03	0.183951e-03	0.953403e-03
10	0.239867e-04	0.486580e-03	0.192938e-03	0.949469e-03
15	0.526967e-04	0.467148e-03	0.207176e-03	0.941302e-03
20	0.907974e-04	0.442503e-03	0.225636e-03	0.926760e-03
25	0.136398e-03	0.414860e-03	0.247024e-03	0.903353e-03
30	0.187333e-03	0.386620e-03	0.269910e-03	0.868672e-03
35	0.241322e-03	0.360106e-03	0.292865e-03	0.820839e-03
40	0.296127e-03	0.337320e-03	0.314594e-03	0.758916e-03
45	0.349692e-03	0.319733e-03	0.334047e-03	0.683226e-03
50	0.400255e-03	0.308151e-03	0.350498e-03	0.595526e-03
55	0.446415e-03	0.302655e-03	0.363582e-03	0.499022e-03
60	0.487158e-03	0.302632e-03	0.373292e-03	0.398208e-03
65	0.521846e-03	0.306888e-03	0.379929e-03	0.298536e-03
70	0.550156e-03	0.313826e-03	0.384027e-03	0.205967e-03
75	0.572009e-03	0.321677e-03	0.386239e-03	0.126434e-03
80	0.587474e-03	0.328735e-03	0.387232e-03	0.652857e-04
85	0.596678e-03	0.333591e-03	0.387574e-03	0.267701e-04
90	0.599732e-03	0.335318e-03	0.387643e-03	0.136178e-04
intgr	0.535831e-02	0.425000e-02	0.433885e-02	0.544715e-02

ed=100 kev

angle	axs(1,1)	axs(1,0)	axs(1,-1)	axs(0,0)
0	0.686124e-06	0.167692e-02	0.811271e-03	0.280583e-02
5	0.188315e-04	0.166442e-02	0.819563e-03	0.280294e-02
10	0.723081e-04	0.162813e-02	0.843778e-03	0.279271e-02
15	0.158316e-03	0.157150e-02	0.882004e-03	0.277076e-02
20	0.272440e-03	0.149986e-02	0.931281e-03	0.273055e-02
25	0.409004e-03	0.141979e-02	0.987900e-03	0.266447e-02
30	0.561507e-03	0.133843e-02	0.104779e-02	0.256512e-02
35	0.723107e-03	0.126267e-02	0.110692e-02	0.242667e-02
40	0.887093e-03	0.119842e-02	0.116170e-02	0.224614e-02
45	0.104731e-02	0.114998e-02	0.120929e-02	0.202431e-02
50	0.119847e-02	0.111964e-02	0.124782e-02	0.176628e-02
55	0.133640e-02	0.110750e-02	0.127655e-02	0.148153e-02
60	0.145808e-02	0.111158e-02	0.129576e-02	0.118341e-02
65	0.156162e-02	0.112816e-02	0.130668e-02	0.888186e-03
70	0.164607e-02	0.115231e-02	0.131119e-02	0.613661e-03
75	0.171123e-02	0.117860e-02	0.131150e-02	0.377582e-03
80	0.175732e-02	0.120180e-02	0.130981e-02	0.195958e-03
85	0.178474e-02	0.121762e-02	0.130797e-02	0.815121e-04
90	0.179383e-02	0.122323e-02	0.130721e-02	0.424232e-04
intgr	0.160365e-01	0.152607e-01	0.153551e-01	0.161309e-01

$\bar{\sigma}_{m,n}(\hat{v}')$ D(d,p)

ed=150 kev

angle	axs(1,1)	axs(1,0)	axs(1,-1)	axs(0,0)
0	0.198878e-05	0.269455e-02	0.157787e-02	0.400877e-02
5	0.284749e-04	0.267677e-02	0.158862e-02	0.400542e-02
10	0.106529e-03	0.262516e-02	0.161997e-02	0.399306e-02
15	0.232054e-03	0.254474e-02	0.166921e-02	0.396517e-02
20	0.398590e-03	0.244325e-02	0.173223e-02	0.391203e-02
25	0.597834e-03	0.233026e-02	0.180385e-02	0.382225e-02
30	0.820279e-03	0.221611e-02	0.187845e-02	0.368478e-02
35	0.105592e-02	0.211075e-02	0.195052e-02	0.349080e-02
40	0.129496e-02	0.202267e-02	0.201522e-02	0.323563e-02
45	0.152840e-02	0.195801e-02	0.206886e-02	0.292012e-02
50	0.174856e-02	0.191992e-02	0.210922e-02	0.255146e-02
55	0.194933e-02	0.190836e-02	0.213566e-02	0.214325e-02
60	0.212636e-02	0.192024e-02	0.214911e-02	0.171480e-02
65	0.227690e-02	0.194990e-02	0.215180e-02	0.128970e-02
70	0.239962e-02	0.198995e-02	0.214690e-02	0.893841e-03
75	0.249425e-02	0.203227e-02	0.213801e-02	0.553068e-03
80	0.256116e-02	0.206909e-02	0.212864e-02	0.290708e-03
85	0.260095e-02	0.209401e-02	0.212172e-02	0.125312e-03
90	0.261415e-02	0.210280e-02	0.211919e-02	0.688076e-04
intgr	0.233853e-01	0.259499e-01	0.258397e-01	0.232751e-01

ed=200 kev

angle	axs(1,1)	axs(1,0)	axs(1,-1)	axs(0,0)
0	0.396820e-05	0.351386e-02	0.234674e-02	0.469508e-02
5	0.357028e-04	0.349306e-02	0.235805e-02	0.469218e-02
10	0.129220e-03	0.343273e-02	0.239094e-02	0.468069e-02
15	0.279597e-03	0.333888e-02	0.244231e-02	0.465263e-02
20	0.479076e-03	0.322071e-02	0.250742e-02	0.459610e-02
25	0.717687e-03	0.308966e-02	0.258038e-02	0.449717e-02
30	0.984017e-03	0.295802e-02	0.265481e-02	0.434221e-02
35	0.126606e-02	0.283762e-02	0.272454e-02	0.412028e-02
40	0.155207e-02	0.273848e-02	0.278426e-02	0.382536e-02
45	0.183126e-02	0.266779e-02	0.283008e-02	0.345811e-02
50	0.209443e-02	0.262914e-02	0.285988e-02	0.302678e-02
55	0.233431e-02	0.262225e-02	0.287348e-02	0.254737e-02
60	0.254569e-02	0.264318e-02	0.287254e-02	0.204278e-02
65	0.272534e-02	0.268490e-02	0.286029e-02	0.154108e-02
70	0.287170e-02	0.273834e-02	0.284100e-02	0.107316e-02
75	0.298450e-02	0.279355e-02	0.281943e-02	0.669898e-03
80	0.306421e-02	0.284102e-02	0.280014e-02	0.359174e-03
85	0.311160e-02	0.287294e-02	0.278690e-02	0.163188e-03
90	0.312732e-02	0.288418e-02	0.278219e-02	0.962171e-04
intgr	0.279961e-01	0.353209e-01	0.349182e-01	0.275934e-01

ed=300 kev

angle	axs(1,1)	axs(1,0)	axs(1,-1)	axs(0,0)
0	0.972239e-05	0.474436e-02	0.374660e-02	0.527572e-02
5	0.470484e-04	0.472090e-02	0.375653e-02	0.527507e-02
10	0.157032e-03	0.465294e-02	0.378515e-02	0.526969e-02
15	0.333852e-03	0.454751e-02	0.382912e-02	0.524984e-02
20	0.568339e-03	0.441540e-02	0.388330e-02	0.520092e-02
25	0.848710e-03	0.426995e-02	0.394139e-02	0.510579e-02
30	0.116149e-02	0.412549e-02	0.399667e-02	0.494752e-02
35	0.149252e-02	0.399573e-02	0.404280e-02	0.471228e-02
40	0.182793e-02	0.389220e-02	0.407458e-02	0.439202e-02
45	0.215507e-02	0.382300e-02	0.408856e-02	0.398657e-02
50	0.246313e-02	0.379196e-02	0.408346e-02	0.350480e-02
55	0.274361e-02	0.379830e-02	0.406030e-02	0.296480e-02
60	0.299046e-02	0.383688e-02	0.402226e-02	0.239288e-02
65	0.319999e-02	0.389891e-02	0.397429e-02	0.182161e-02
70	0.337049e-02	0.397322e-02	0.392250e-02	0.128698e-02
75	0.350173e-02	0.404761e-02	0.387344e-02	0.825063e-03
80	0.359438e-02	0.411052e-02	0.383324e-02	0.468530e-03
85	0.364942e-02	0.415243e-02	0.380692e-02	0.243402e-03
90	0.366767e-02	0.416713e-02	0.379777e-02	0.166432e-03
intgr	0.328873e-01	0.505429e-01	0.496302e-01	0.319746e-01

$$\bar{\sigma}_{m,n}(\hat{v}')\ D(d,p)$$

ed=400 kev

angle	axs(1,1)	axs(1,0)	axs(1,-1)	axs(0,0)
0	0.174677e-04	0.562784e-02	0.492221e-02	0.540880e-02
5	0.573853e-04	0.560355e-02	0.492974e-02	0.541107e-02
10	0.174993e-03	0.553327e-02	0.495118e-02	0.541409e-02
15	0.364032e-03	0.542453e-02	0.498317e-02	0.540701e-02
20	0.614643e-03	0.528884e-02	0.502065e-02	0.537360e-02
25	0.914167e-03	0.514042e-02	0.505741e-02	0.529469e-02
30	0.124813e-02	0.499453e-02	0.508698e-02	0.515119e-02
35	0.160134e-02	0.486569e-02	0.510341e-02	0.492727e-02
40	0.195895e-02	0.476604e-02	0.510209e-02	0.461328e-02
45	0.230741e-02	0.470399e-02	0.508037e-02	0.420803e-02
50	0.263519e-02	0.468327e-02	0.503797e-02	0.372009e-02
55	0.293328e-02	0.470267e-02	0.497713e-02	0.316802e-02
60	0.319530e-02	0.475622e-02	0.490237e-02	0.257933e-02
65	0.341740e-02	0.483405e-02	0.482007e-02	0.198837e-02
70	0.359788e-02	0.492372e-02	0.473780e-02	0.143329e-02
75	0.373662e-02	0.501176e-02	0.466341e-02	0.952421e-03
80	0.383447e-02	0.508540e-02	0.460421e-02	0.580575e-03
85	0.389256e-02	0.513417e-02	0.456612e-02	0.345502e-03
90	0.391180e-02	0.515122e-02	0.455298e-02	0.265086e-03
intgr	0.351419e-01	0.621340e-01	0.610584e-01	0.340662e-01

ed=500 kev

angle	axs(1,1)	axs(1,0)	axs(1,-1)	axs(0,0)
0	0.267767e-04	0.628692e-02	0.589575e-02	0.538986e-02
5	0.680351e-04	0.626239e-02	0.590088e-02	0.539522e-02
10	0.189580e-03	0.619149e-02	0.591513e-02	0.540721e-02
15	0.384905e-03	0.608201e-02	0.593526e-02	0.541422e-02
20	0.643765e-03	0.594589e-02	0.595635e-02	0.539881e-02
25	0.953010e-03	0.579784e-02	0.597247e-02	0.534029e-02
30	0.129762e-02	0.565361e-02	0.597751e-02	0.521793e-02
35	0.166183e-02	0.552815e-02	0.596602e-02	0.501432e-02
40	0.203027e-02	0.543390e-02	0.593404e-02	0.471840e-02
45	0.238893e-02	0.537934e-02	0.587974e-02	0.432790e-02
50	0.272594e-02	0.536809e-02	0.580379e-02	0.385079e-02
55	0.303204e-02	0.539853e-02	0.570946e-02	0.330548e-02
60	0.330072e-02	0.546412e-02	0.560245e-02	0.271977e-02
65	0.352815e-02	0.555424e-02	0.549031e-02	0.212871e-02
70	0.371270e-02	0.565558e-02	0.538173e-02	0.157140e-02
75	0.385439e-02	0.575382e-02	0.528565e-02	0.108728e-02
80	0.395419e-02	0.583538e-02	0.521025e-02	0.712200e-03
85	0.401338e-02	0.588918e-02	0.516216e-02	0.474798e-03
90	0.403299e-02	0.590795e-02	0.514563e-02	0.393539e-03
intgr	0.363052e-01	0.710162e-01	0.702104e-01	0.354994e-01

$\bar{\sigma}_{m,n}(\hat{v}')$ D(d,n)

ed= 10 kev

angle	axs(1.1)	axs(1.0)	axs(1.-1)	axs(0.0)
0	0.361292e-10	0.897729e-06	0.320517e-06	0.179713e-05
5	0.104401e-07	0.890184e-06	0.326676e-06	0.179419e-05
10	0.411045e-07	0.868243e-06	0.344732e-06	0.178451e-05
15	0.904310e-07	0.833904e-06	0.373472e-06	0.176574e-05
20	0.155900e-06	0.790253e-06	0.411000e-06	0.173434e-05
25	0.234269e-06	0.741123e-06	0.454924e-06	0.168628e-05
30	0.321824e-06	0.690671e-06	0.502577e-06	0.161767e-05
35	0.414652e-06	0.642937e-06	0.551256e-06	0.152560e-05
40	0.508911e-06	0.601412e-06	0.598463e-06	0.140876e-05
45	0.601071e-06	0.568693e-06	0.642096e-06	0.126805e-05
50	0.688101e-06	0.546235e-06	0.680598e-06	0.110682e-05
55	0.767586e-06	0.534258e-06	0.713031e-06	0.930890e-06
60	0.837779e-06	0.531794e-06	0.739076e-06	0.748272e-06
65	0.897568e-06	0.536874e-06	0.758962e-06	0.568600e-06
70	0.946389e-06	0.546839e-06	0.773338e-06	0.402345e-06
75	0.984092e-06	0.558721e-06	0.783100e-06	0.259889e-06
80	0.101078e-05	0.569652e-06	0.789205e-06	0.150573e-06
85	0.102667e-05	0.577258e-06	0.792488e-06	0.818020e-07
90	0.103195e-05	0.579975e-06	0.793515e-06	0.583319e-07
intgr	0.921558e-05	0.747877e-05	0.856053e-05	0.102973e-04

ed= 50 kev

angle	axs(1.1)	axs(1.0)	axs(1.-1)	axs(0.0)
0	0.778364e-07	0.471231e-03	0.224913e-03	0.796457e-03
5	0.476463e-05	0.467879e-03	0.227538e-03	0.795240e-03
10	0.185779e-04	0.458134e-03	0.235230e-03	0.791210e-03
15	0.407961e-04	0.442895e-03	0.247454e-03	0.783280e-03
20	0.702823e-04	0.423551e-03	0.263375e-03	0.769844e-03
25	0.105573e-03	0.401822e-03	0.281942e-03	0.749043e-03
30	0.144994e-03	0.379575e-03	0.301990e-03	0.719094e-03
35	0.186779e-03	0.358620e-03	0.322340e-03	0.678641e-03
40	0.229197e-03	0.340519e-03	0.341914e-03	0.627063e-03
45	0.270658e-03	0.326424e-03	0.359814e-03	0.564723e-03
50	0.309796e-03	0.316973e-03	0.375392e-03	0.493093e-03
55	0.345528e-03	0.312243e-03	0.388280e-03	0.414771e-03
60	0.377069e-03	0.311777e-03	0.398387e-03	0.333342e-03
65	0.403924e-03	0.314662e-03	0.405868e-03	0.253130e-03
70	0.425842e-03	0.319678e-03	0.411063e-03	0.178838e-03
75	0.442762e-03	0.325465e-03	0.414418e-03	0.115139e-03
80	0.454737e-03	0.330714e-03	0.416398e-03	0.662335e-04
85	0.461864e-03	0.334342e-03	0.417404e-03	0.354578e-04
90	0.464229e-03	0.335634e-03	0.417707e-03	0.249531e-04
intgr	0.414750e-02	0.426957e-02	0.469955e-02	0.457747e-02

ed=100 kev

angle	axs(1.1)	axs(1.0)	axs(1.-1)	axs(0.0)
0	0.657751e-06	0.167748e-02	0.991174e-03	0.234281e-02
5	0.147397e-04	0.166758e-02	0.998495e-03	0.233961e-02
10	0.562409e-04	0.163881e-02	0.101992e-02	0.232883e-02
15	0.122989e-03	0.159387e-02	0.105388e-02	0.230716e-02
20	0.211559e-03	0.153692e-02	0.109796e-02	0.226966e-02
25	0.317545e-03	0.147312e-02	0.114909e-02	0.221063e-02
30	0.435906e-03	0.140805e-02	0.120391e-02	0.212455e-02
35	0.561330e-03	0.134712e-02	0.125903e-02	0.200721e-02
40	0.688610e-03	0.129496e-02	0.131138e-02	0.185656e-02
45	0.812967e-03	0.125500e-02	0.135846e-02	0.167355e-02
50	0.930306e-03	0.122907e-02	0.139852e-02	0.146246e-02
55	0.103738e-02	0.121733e-02	0.143067e-02	0.123099e-02
60	0.113184e-02	0.121831e-02	0.145483e-02	0.989796e-03
65	0.121222e-02	0.122920e-02	0.147166e-02	0.751809e-03
70	0.127779e-02	0.124623e-02	0.148238e-02	0.531110e-03
75	0.132839e-02	0.126524e-02	0.148848e-02	0.341699e-03
80	0.136417e-02	0.128222e-02	0.149148e-02	0.196184e-03
85	0.138547e-02	0.129387e-02	0.149270e-02	0.104573e-03
90	0.139253e-02	0.129801e-02	0.149300e-02	0.732972e-04
intgr	0.124487e-01	0.163409e-01	0.174395e-01	0.135474e-01

$\bar{\sigma}_{m,n}(\hat{v}')\ D(d,n)$

ed=150 kev

angle	axs(1,1)	axs(1,0)	axs(1,-1)	axs(0,0)
0	0.190711e-05	0.283579e-02	0.190731e-02	0.334816e-02
5	0.225189e-04	0.282152e-02	0.191720e-02	0.334422e-02
10	0.832619e-04	0.278009e-02	0.194610e-02	0.333065e-02
15	0.180948e-03	0.271545e-02	0.199179e-02	0.330249e-02
20	0.310552e-03	0.263366e-02	0.205082e-02	0.325237e-02
25	0.465613e-03	0.254226e-02	0.211888e-02	0.317173e-02
30	0.638735e-03	0.244939e-02	0.219122e-02	0.305227e-02
35	0.822134e-03	0.236293e-02	0.226311e-02	0.288752e-02
40	0.100818e-02	0.228962e-02	0.233031e-02	0.267428e-02
45	0.118988e-02	0.223436e-02	0.238944e-02	0.241364e-02
50	0.136125e-02	0.219978e-02	0.243824e-02	0.211167e-02
55	0.151754e-02	0.218598e-02	0.247569e-02	0.177940e-02
60	0.165534e-02	0.219070e-02	0.250199e-02	0.143229e-02
65	0.177254e-02	0.220968e-02	0.251840e-02	0.108913e-02
70	0.186809e-02	0.223731e-02	0.252695e-02	0.770430e-03
75	0.194177e-02	0.226737e-02	0.253005e-02	0.496613e-03
80	0.199386e-02	0.229391e-02	0.253015e-02	0.286094e-03
85	0.202485e-02	0.231199e-02	0.252930e-02	0.153494e-03
90	0.203513e-02	0.231840e-02	0.252885e-02	0.108214e-03
intgr	0.182059e-01	0.290041e-01	0.303235e-01	0.195253e-01

ed=200 kev

angle	axs(1,1)	axs(1,0)	axs(1,-1)	axs(0,0)
0	0.380639e-05	0.384477e-02	0.281468e-02	0.392149e-02
5	0.285700e-04	0.382787e-02	0.282561e-02	0.391772e-02
10	0.101545e-03	0.377879e-02	0.285751e-02	0.390425e-02
15	0.218890e-03	0.370229e-02	0.290779e-02	0.387501e-02
20	0.374555e-03	0.360566e-02	0.297243e-02	0.382094e-02
25	0.560759e-03	0.349793e-02	0.304642e-02	0.373148e-02
30	0.768600e-03	0.338886e-02	0.312427e-02	0.359637e-02
35	0.988711e-03	0.328788e-02	0.320055e-02	0.340751e-02
40	0.121192e-02	0.320302e-02	0.327047e-02	0.316070e-02
45	0.142982e-02	0.314010e-02	0.333028e-02	0.285694e-02
50	0.163523e-02	0.310217e-02	0.337760e-02	0.250322e-02
55	0.182246e-02	0.308925e-02	0.341155e-02	0.211252e-02
60	0.198746e-02	0.309849e-02	0.343272e-02	0.170322e-02
65	0.212770e-02	0.312463e-02	0.344296e-02	0.129769e-02
70	0.224196e-02	0.316078e-02	0.344501e-02	0.920466e-03
75	0.233002e-02	0.319936e-02	0.344205e-02	0.595980e-03
80	0.239226e-02	0.323308e-02	0.343721e-02	0.346296e-03
85	0.242926e-02	0.325595e-02	0.343314e-02	0.188944e-03
90	0.244153e-02	0.326403e-02	0.343158e-02	0.135198e-03
intgr	0.218584e-01	0.406729e-01	0.419268e-01	0.231123e-01

ed=300 kev

angle	axs(1,1)	axs(1,0)	axs(1,-1)	axs(0,0)
0	0.933153e-05	0.547806e-02	0.444024e-02	0.440529e-02
5	0.386134e-04	0.545847e-02	0.445118e-02	0.440318e-02
10	0.124894e-03	0.540167e-02	0.448298e-02	0.439421e-02
15	0.263609e-03	0.531326e-02	0.453275e-02	0.437088e-02
20	0.447567e-03	0.520189e-02	0.459598e-02	0.432199e-02
25	0.667524e-03	0.507824e-02	0.466712e-02	0.423442e-02
30	0.912911e-03	0.495384e-02	0.474009e-02	0.409528e-02
35	0.117262e-02	0.483978e-02	0.480905e-02	0.389418e-02
40	0.143578e-02	0.474548e-02	0.486891e-02	0.362533e-02
45	0.169246e-02	0.467769e-02	0.491592e-02	0.328913e-02
50	0.193418e-02	0.463982e-02	0.494796e-02	0.289309e-02
55	0.215426e-02	0.463167e-02	0.496475e-02	0.245194e-02
60	0.234797e-02	0.464961e-02	0.496771e-02	0.198686e-02
65	0.251241e-02	0.468712e-02	0.495973e-02	0.152389e-02
70	0.264621e-02	0.473577e-02	0.494471e-02	0.109171e-02
75	0.274921e-02	0.478631e-02	0.492699e-02	0.718998e-03
80	0.282193e-02	0.482989e-02	0.491076e-02	0.431685e-03
85	0.286514e-02	0.485924e-02	0.489949e-02	0.250412e-03
90	0.287946e-02	0.486958e-02	0.489547e-02	0.188460e-03
intgr	0.258245e-01	0.604167e-01	0.612740e-01	0.266818e-01

$\bar{\sigma}_{m,n}(\hat{v}')\ D(d,n)$

ed=400 kev

angle	axs(1,1)	axs(1,0)	axs(1,-1)	axs(0,0)
0	0.167751e-04	0.672238e-02	0.577600e-02	0.451462e-02
5	0.482515e-04	0.670157e-02	0.578600e-02	0.451487e-02
10	0.140989e-03	0.664126e-02	0.581498e-02	0.451268e-02
15	0.290054e-03	0.654751e-02	0.585993e-02	0.449965e-02
20	0.487675e-03	0.642965e-02	0.591625e-02	0.446321e-02
25	0.723868e-03	0.629923e-02	0.597824e-02	0.438855e-02
30	0.987223e-03	0.616866e-02	0.603979e-02	0.426100e-02
35	0.126576e-02	0.604987e-02	0.609506e-02	0.406853e-02
40	0.154778e-02	0.595296e-02	0.613912e-02	0.380402e-02
45	0.182259e-02	0.588511e-02	0.616851e-02	0.346705e-02
50	0.208110e-02	0.584984e-02	0.618161e-02	0.306489e-02
55	0.231621e-02	0.584676e-02	0.617875e-02	0.261273e-02
60	0.252287e-02	0.587172e-02	0.616214e-02	0.213275e-02
65	0.269805e-02	0.591750e-02	0.613552e-02	0.165253e-02
70	0.284042e-02	0.597472e-02	0.610369e-02	0.120255e-02
75	0.294987e-02	0.603321e-02	0.607184e-02	0.813427e-03
80	0.302706e-02	0.608321e-02	0.604491e-02	0.512891e-03
85	0.307288e-02	0.611673e-02	0.602697e-02	0.323047e-03
90	0.308806e-02	0.612851e-02	0.602069e-02	0.258128e-03
intgr	0.277515e-01	0.758793e-01	0.764439e-01	0.283160e-01

ed=500 kev

angle	axs(1,1)	axs(1,0)	axs(1,-1)	axs(0,0)
0	0.257290e-04	0.767898e-02	0.685620e-02	0.449718e-02
5	0.584252e-04	0.765746e-02	0.686512e-02	0.449999e-02
10	0.154747e-03	0.759512e-02	0.689085e-02	0.450524e-02
15	0.309538e-03	0.749831e-02	0.693038e-02	0.450387e-02
20	0.514683e-03	0.737678e-02	0.697909e-02	0.448225e-02
25	0.759759e-03	0.724263e-02	0.703131e-02	0.442430e-02
30	0.103286e-02	0.710882e-02	0.708100e-02	0.431394e-02
35	0.132151e-02	0.698780e-02	0.712246e-02	0.413777e-02
40	0.161352e-02	0.689009e-02	0.715102e-02	0.388750e-02
45	0.189778e-02	0.682310e-02	0.716358e-02	0.356182e-02
50	0.216489e-02	0.679042e-02	0.715899e-02	0.316752e-02
55	0.240750e-02	0.679149e-02	0.713816e-02	0.271968e-02
60	0.262047e-02	0.682182e-02	0.710395e-02	0.224082e-02
65	0.280075e-02	0.687367e-02	0.706081e-02	0.175915e-02
70	0.294704e-02	0.693708e-02	0.701424e-02	0.130605e-02
75	0.305936e-02	0.700121e-02	0.697012e-02	0.913127e-03
80	0.313848e-02	0.705574e-02	0.693398e-02	0.609059e-03
85	0.318541e-02	0.709219e-02	0.691032e-02	0.416745e-03
90	0.320095e-02	0.710498e-02	0.690209e-02	0.350943e-03
intgr	0.288303e-01	0.878755e-01	0.884483e-01	0.294031e-01

$\langle \sigma_{m,n} v \rangle (\hat{v}')$ D(d,p)

kt= 2 kev

angle	svb(1,1)	svb(1,0)	svb(1,-1)	svb(0,0)
0	0.261331e-25	0.351473e-21	0.100933e-21	0.711933e-21
5	0.450199e-23	0.348267e-21	0.103323e-21	0.711020e-21
10	0.176910e-22	0.338958e-21	0.110320e-21	0.707933e-21
15	0.389053e-22	0.324398e-21	0.121422e-21	0.701606e-21
20	0.670604e-22	0.305918e-21	0.135831e-21	0.690466e-21
25	0.100762e-21	0.285149e-21	0.152584e-21	0.672702e-21
30	0.138407e-21	0.263875e-21	0.170581e-21	0.646541e-21
35	0.178321e-21	0.243821e-21	0.188740e-21	0.610630e-21
40	0.218840e-21	0.226483e-21	0.206066e-21	0.564304e-21
45	0.258456e-21	0.212958e-21	0.221762e-21	0.507803e-21
50	0.295854e-21	0.203855e-21	0.235240e-21	0.442453e-21
55	0.330010e-21	0.199256e-21	0.246191e-21	0.370640e-21
60	0.360158e-21	0.198720e-21	0.254575e-21	0.295702e-21
65	0.385837e-21	0.201392e-21	0.260578e-21	0.221666e-21
70	0.406801e-21	0.206102e-21	0.264557e-21	0.152944e-21
75	0.422984e-21	0.211565e-21	0.266962e-21	0.939264e-22
80	0.434445e-21	0.216529e-21	0.268267e-21	0.485647e-22
85	0.441259e-21	0.219953e-21	0.268867e-21	0.199990e-22
90	0.443519e-21	0.221182e-21	0.269035e-21	0.102447e-22
intgr	0.396161e-20	0.283347e-20	0.292335e-20	0.405119e-20

kt= 4 kev

angle	svb(1,1)	svb(1,0)	svb(1,-1)	svb(0,0)
0	0.622561e-24	0.493079e-20	0.162663e-20	0.960569e-20
5	0.613515e-22	0.488765e-20	0.165818e-20	0.959384e-20
10	0.240285e-21	0.476225e-20	0.175052e-20	0.955335e-20
15	0.528090e-21	0.456629e-20	0.189691e-20	0.946990e-20
20	0.910054e-21	0.431773e-20	0.208666e-20	0.932193e-20
25	0.136721e-20	0.403861e-20	0.230676e-20	0.908463e-20
30	0.187785e-20	0.375312e-20	0.254260e-20	0.873417e-20
35	0.241921e-20	0.348467e-20	0.277971e-20	0.825148e-20
40	0.296873e-20	0.325334e-20	0.300483e-20	0.762754e-20
45	0.350593e-20	0.307394e-20	0.320743e-20	0.686561e-20
50	0.401302e-20	0.295472e-20	0.337992e-20	0.598341e-20
55	0.447602e-20	0.289656e-20	0.351836e-20	0.501321e-20
60	0.488467e-20	0.289336e-20	0.362257e-20	0.400012e-20
65	0.523270e-20	0.293334e-20	0.369533e-20	0.299882e-20
70	0.551674e-20	0.300057e-20	0.374183e-20	0.206907e-20
75	0.573599e-20	0.307737e-20	0.376835e-20	0.127039e-20
80	0.589122e-20	0.314672e-20	0.378152e-20	0.656427e-21
85	0.598356e-20	0.319445e-20	0.378691e-20	0.269742e-21
90	0.601418e-20	0.321154e-20	0.378826e-20	0.137693e-21
intgr	0.537282e-19	0.408759e-19	0.419042e-19	0.547526e-19

kt= 6 kev

angle	svb(1,1)	svb(1,0)	svb(1,-1)	svb(0,0)
0	0.312813e-23	0.171513e-19	0.626718e-20	0.323209e-19
5	0.208439e-21	0.170064e-19	0.637119e-20	0.322823e-19
10	0.813375e-21	0.165853e-19	0.667542e-20	0.321497e-19
15	0.178636e-20	0.159273e-19	0.715727e-20	0.318747e-19
20	0.307765e-20	0.150933e-19	0.778132e-20	0.313838e-19
25	0.462303e-20	0.141576e-19	0.850385e-20	0.305927e-19
30	0.634914e-20	0.132018e-19	0.927618e-20	0.294209e-19
35	0.817892e-20	0.123049e-19	0.100501e-19	0.278026e-19
40	0.100362e-19	0.115343e-19	0.107817e-19	0.257067e-19
45	0.118515e-19	0.109401e-19	0.114360e-19	0.231445e-19
50	0.135650e-19	0.105496e-19	0.119884e-19	0.201752e-19
55	0.151291e-19	0.103654e-19	0.124265e-19	0.169072e-19
60	0.165097e-19	0.103667e-19	0.127506e-19	0.134929e-19
65	0.176852e-19	0.105129e-19	0.129709e-19	0.101171e-19
70	0.186444e-19	0.107498e-19	0.131059e-19	0.698157e-20
75	0.193847e-19	0.110174e-19	0.131775e-19	0.428746e-20
80	0.199088e-19	0.112577e-19	0.132087e-19	0.221611e-20
85	0.202206e-19	0.114229e-19	0.132187e-19	0.911390e-21
90	0.203240e-19	0.114818e-19	0.132205e-19	0.465829e-21
intgr	0.181592e-18	0.145406e-18	0.148359e-18	0.184535e-18

$\langle \sigma_{m,n} v \rangle (\hat{v}')$ D(d,p)

kt= 8 kev

angle	svb(1.1)	svb(1.0)	svb(1,-1)	svb(0.0)
0	0.901920e-23	0.371132e-19	0.147311e-19	0.678438e-19
5	0.441914e-21	0.368096e-19	0.149451e-19	0.677656e-19
10	0.171745e-20	0.359272e-19	0.155709e-19	0.674947e-19
15	0.376900e-20	0.345487e-19	0.165612e-19	0.669290e-19
20	0.649161e-20	0.328025e-19	0.178424e-19	0.659128e-19
25	0.974978e-20	0.308451e-19	0.193232e-19	0.642677e-19
30	0.133889e-19	0.288481e-19	0.209024e-19	0.618225e-19
35	0.172461e-19	0.269778e-19	0.224795e-19	0.584378e-19
40	0.211610e-19	0.253757e-19	0.239638e-19	0.540462e-19
45	0.249872e-19	0.241469e-19	0.252829e-19	0.486716e-19
50	0.285983e-19	0.233479e-19	0.263868e-19	0.424374e-19
55	0.318943e-19	0.229841e-19	0.272515e-19	0.355714e-19
60	0.348033e-19	0.230102e-19	0.278792e-19	0.283942e-19
65	0.372796e-19	0.233401e-19	0.282932e-19	0.212953e-19
70	0.393001e-19	0.238585e-19	0.285340e-19	0.146996e-19
75	0.408592e-19	0.244383e-19	0.286494e-19	0.903139e-20
80	0.419628e-19	0.249566e-19	0.286889e-19	0.467274e-20
85	0.426194e-19	0.253120e-19	0.286939e-19	0.192698e-20
90	0.428373e-19	0.254386e-19	0.286923e-19	0.989277e-21
intgr	0.382797e-18	0.320799e-18	0.326029e-18	0.388012e-18

kt=10 kev

angle	svb(1.1)	svb(1.0)	svb(1,-1)	svb(0.0)
0	0.196043e-22	0.637963e-19	0.271352e-19	0.113367e-18
5	0.746115e-21	0.632896e-19	0.274862e-19	0.113241e-18
10	0.288685e-20	0.618174e-19	0.285113e-19	0.112801e-18
15	0.632994e-20	0.595179e-19	0.301327e-19	0.111874e-18
20	0.108991e-19	0.566067e-19	0.322279e-19	0.110200e-18
25	0.163668e-19	0.533462e-19	0.346454e-19	0.107476e-18
30	0.224736e-19	0.500235e-19	0.372171e-19	0.103414e-18
35	0.289458e-19	0.469174e-19	0.397769e-19	0.977789e-19
40	0.355144e-19	0.442643e-19	0.421751e-19	0.904544e-19
45	0.419333e-19	0.422401e-19	0.442926e-19	0.814802e-19
50	0.479910e-19	0.409378e-19	0.460486e-19	0.710611e-19
55	0.535193e-19	0.403657e-19	0.474056e-19	0.595785e-19
60	0.583982e-19	0.404467e-19	0.483704e-19	0.475694e-19
65	0.625506e-19	0.410343e-19	0.489847e-19	0.356869e-19
70	0.659386e-19	0.419343e-19	0.493190e-19	0.246435e-19
75	0.685522e-19	0.429319e-19	0.494561e-19	0.151511e-19
80	0.704022e-19	0.438200e-19	0.494803e-19	0.785066e-20
85	0.715027e-19	0.444280e-19	0.494632e-19	0.325125e-20
90	0.718679e-19	0.446441e-19	0.494517e-19	0.168047e-20
intgr	0.642305e-18	0.560954e-18	0.568180e-18	0.649512e-18

$<\sigma_{m,n} v>(\hat{v}')$ D(d,n)

kt= 2 kev

angle	svb(1,1)	svb(1,0)	svb(1,-1)	svb(0,0)
0	0.250410e-25	0.316002e-21	0.127490e-21	0.593674e-21
5	0.348398e-23	0.313505e-21	0.129501e-21	0.592729e-21
10	0.136760e-22	0.306250e-21	0.135401e-21	0.589601e-21
15	0.300695e-22	0.294894e-21	0.144792e-21	0.583505e-21
20	0.518277e-22	0.280460e-21	0.157028e-21	0.573260e-21
25	0.778714e-22	0.264227e-21	0.171338e-21	0.557515e-21
30	0.106966e-21	0.247579e-21	0.186824e-21	0.534978e-21
35	0.137813e-21	0.231850e-21	0.202603e-21	0.504653e-21
40	0.169128e-21	0.218200e-21	0.217864e-21	0.466108e-21
45	0.199748e-21	0.207479e-21	0.231909e-21	0.419622e-21
50	0.228655e-21	0.200186e-21	0.244246e-21	0.366307e-21
55	0.255046e-21	0.196378e-21	0.254580e-21	0.308086e-21
60	0.278358e-21	0.195725e-21	0.262805e-21	0.247619e-21
65	0.298210e-21	0.197575e-21	0.269027e-21	0.188106e-21
70	0.314420e-21	0.201026e-21	0.273464e-21	0.133012e-21
75	0.326926e-21	0.205095e-21	0.276435e-21	0.857925e-22
80	0.335787e-21	0.208815e-21	0.278259e-21	0.495521e-22
85	0.341059e-21	0.211398e-21	0.279224e-21	0.267509e-22
90	0.342811e-21	0.212325e-21	0.279528e-21	0.189684e-22
intgr	0.306188e-20	0.272255e-20	0.306629e-20	0.340505e-20

kt= 4 kev

angle	svb(1,1)	svb(1,0)	svb(1,-1)	svb(0,0)
0	0.596614e-24	0.454265e-20	0.203408e-20	0.801276e-20
5	0.475684e-22	0.450895e-20	0.206091e-20	0.800028e-20
10	0.185959e-21	0.441091e-20	0.213936e-20	0.795906e-20
15	0.408554e-21	0.425757e-20	0.226418e-20	0.787830e-20
20	0.703976e-21	0.406277e-20	0.242678e-20	0.774184e-20
25	0.105757e-20	0.384381e-20	0.261657e-20	0.753124e-20
30	0.145257e-20	0.361950e-20	0.282158e-20	0.722874e-20
35	0.187130e-20	0.340793e-20	0.302999e-20	0.682084e-20
40	0.229635e-20	0.322481e-20	0.323097e-20	0.630140e-20
45	0.271192e-20	0.308163e-20	0.341516e-20	0.567411e-20
50	0.310420e-20	0.298506e-20	0.357614e-20	0.495397e-20
55	0.346227e-20	0.293578e-20	0.371001e-20	0.416689e-20
60	0.377853e-20	0.292933e-20	0.381566e-20	0.334898e-20
65	0.404775e-20	0.295666e-20	0.389465e-20	0.254356e-20
70	0.426761e-20	0.300552e-20	0.395013e-20	0.179773e-20
75	0.443719e-20	0.306239e-20	0.398659e-20	0.115832e-20
80	0.455731e-20	0.311413e-20	0.400844e-20	0.667507e-21
85	0.462883e-20	0.314999e-20	0.401979e-20	0.358659e-21
90	0.465259e-20	0.316282e-20	0.402332e-20	0.253242e-21
intgr	0.415619e-19	0.403570e-19	0.448187e-19	0.460143e-19

kt= 6 kev

angle	svb(1,1)	svb(1,0)	svb(1,-1)	svb(0,0)
0	0.299811e-23	0.161151e-19	0.778339e-20	0.269674e-19
5	0.161914e-21	0.160016e-19	0.787249e-20	0.269264e-19
10	0.630120e-21	0.156714e-19	0.813293e-20	0.267907e-19
15	0.138321e-20	0.151551e-19	0.854705e-20	0.265234e-19
20	0.238263e-20	0.144996e-19	0.908618e-20	0.260697e-19
25	0.357881e-20	0.137632e-19	0.971457e-20	0.253669e-19
30	0.491498e-20	0.130096e-19	0.103925e-19	0.243540e-19
35	0.633129e-20	0.122997e-19	0.110801e-19	0.229856e-19
40	0.776888e-20	0.116868e-19	0.117414e-19	0.212401e-19
45	0.917422e-20	0.112095e-19	0.123453e-19	0.191296e-19
50	0.105007e-19	0.108900e-19	0.128704e-19	0.167045e-19
55	0.117114e-19	0.107305e-19	0.133044e-19	0.140522e-19
60	0.127805e-19	0.107157e-19	0.136439e-19	0.112944e-19
65	0.136905e-19	0.108146e-19	0.138950e-19	0.857759e-20
70	0.144335e-19	0.109856e-19	0.140686e-19	0.606111e-20
75	0.150066e-19	0.111827e-19	0.141805e-19	0.390318e-20
80	0.154125e-19	0.113613e-19	0.142461e-19	0.224648e-20
85	0.156541e-19	0.114848e-19	0.142792e-19	0.120389e-20
90	0.157343e-19	0.115289e-19	0.142894e-19	0.848019e-21
intgr	0.140577e-18	0.146577e-18	0.161093e-18	0.155064e-18

$$\langle\sigma_{m,n}v\rangle(\hat{v}')\quad D(d,n)$$

kt= 8 kev

angle	svb(1.1)	svb(1.0)	svb(1.-1)	svb(0.0)
0	0.864531e-23	0.354720e-19	0.181983e-19	0.566169e-19
5	0.343938e-21	0.352334e-19	0.183830e-19	0.565327e-19
10	0.133183e-20	0.345395e-19	0.189227e-19	0.562540e-19
15	0.292079e-20	0.334553e-19	0.197805e-19	0.557022e-19
20	0.502939e-20	0.320787e-19	0.208963e-19	0.547610e-19
25	0.755306e-20	0.305337e-19	0.221952e-19	0.532975e-19
30	0.103719e-19	0.289537e-19	0.235946e-19	0.511821e-19
35	0.133595e-19	0.274675e-19	0.250111e-19	0.483185e-19
40	0.163919e-19	0.261870e-19	0.263696e-19	0.446597e-19
45	0.193559e-19	0.251936e-19	0.276058e-19	0.402308e-19
50	0.221534e-19	0.245336e-19	0.286755e-19	0.351370e-19
55	0.247065e-19	0.242111e-19	0.295539e-19	0.295624e-19
60	0.269603e-19	0.241935e-19	0.302352e-19	0.237629e-19
65	0.288787e-19	0.244147e-19	0.307332e-19	0.180473e-19
70	0.304447e-19	0.247865e-19	0.310718e-19	0.127517e-19
75	0.316528e-19	0.252114e-19	0.312854e-19	0.820960e-20
80	0.325080e-19	0.255952e-19	0.314072e-19	0.472196e-20
85	0.330173e-19	0.258600e-19	0.314667e-19	0.252693e-20
90	0.331859e-19	0.259543e-19	0.314850e-19	0.177765e-20
intgr	0.296542e-18	0.329025e-18	0.358533e-18	0.325998e-18

kt=10 kev

angle	svb(1.1)	svb(1.0)	svb(1.-1)	svb(0.0)
0	0.187936e-22	0.619049e-19	0.333786e-19	0.946204e-19
5	0.581850e-21	0.615057e-19	0.336834e-19	0.944831e-19
10	0.224088e-20	0.603448e-19	0.345743e-19	0.940272e-19
15	0.490927e-20	0.585316e-19	0.359895e-19	0.931204e-19
20	0.845023e-20	0.562303e-19	0.378290e-19	0.915666e-19
25	0.126880e-19	0.536490e-19	0.399677e-19	0.891406e-19
30	0.174211e-19	0.510114e-19	0.422688e-19	0.856243e-19
35	0.224374e-19	0.485335e-19	0.445931e-19	0.808538e-19
40	0.275284e-19	0.464030e-19	0.468161e-19	0.747495e-19
45	0.325041e-19	0.447560e-19	0.488320e-19	0.673515e-19
50	0.371998e-19	0.436695e-19	0.505677e-19	0.588354e-19
55	0.414851e-19	0.431498e-19	0.519838e-19	0.495091e-19
60	0.452671e-19	0.431415e-19	0.530721e-19	0.398017e-19
65	0.484862e-19	0.435325e-19	0.538578e-19	0.302311e-19
70	0.511134e-19	0.441741e-19	0.543827e-19	0.213613e-19
75	0.531404e-19	0.449019e-19	0.547055e-19	0.137518e-19
80	0.545749e-19	0.455571e-19	0.548839e-19	0.790797e-20
85	0.554290e-19	0.460085e-19	0.549674e-19	0.422970e-20
90	0.557115e-19	0.461689e-19	0.549928e-19	0.297405e-20
intgr	0.497897e-18	0.583867e-18	0.631676e-18	0.545613e-18

Printed in the United States of America
Available from
National Technical Information Service
US Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

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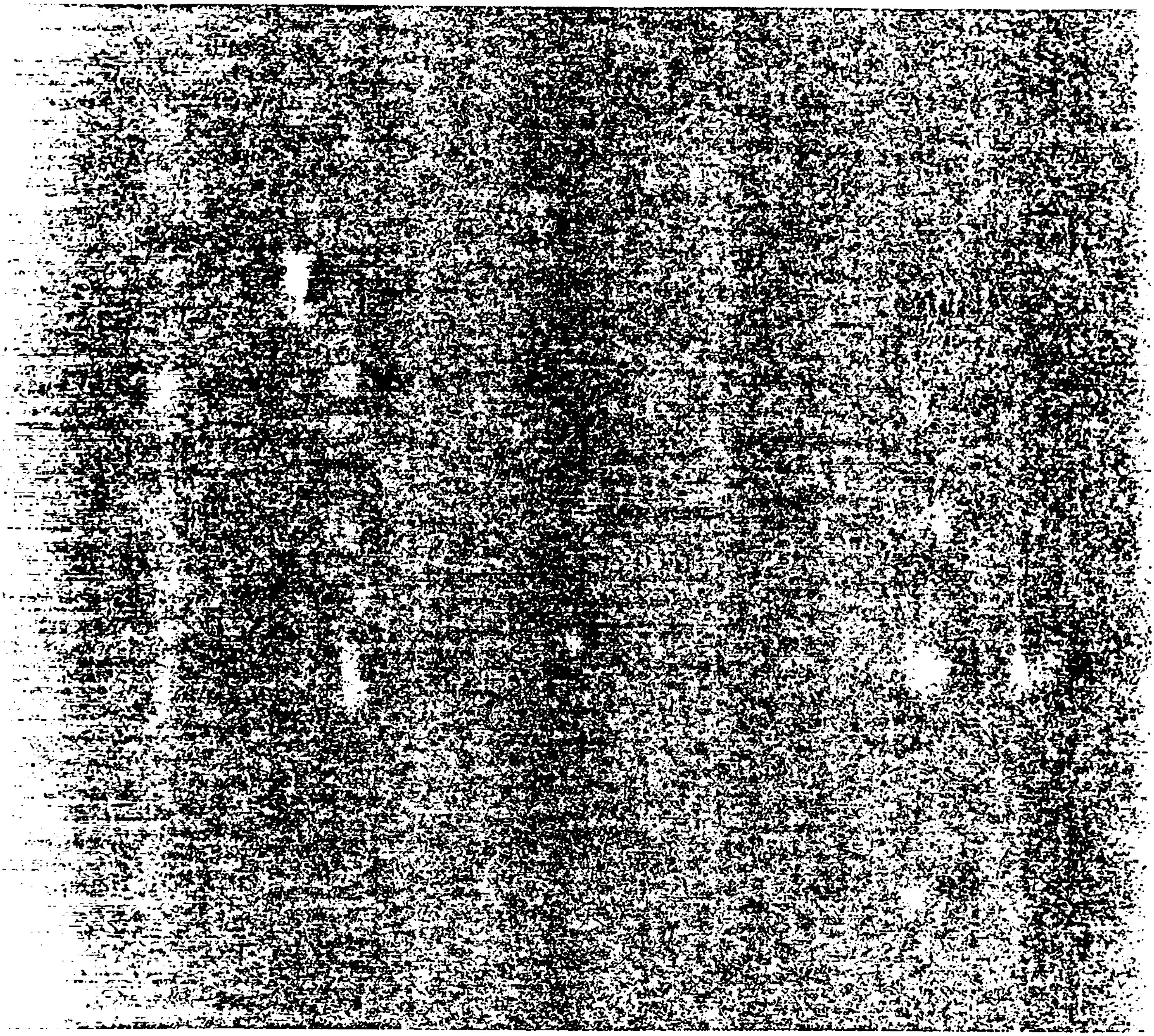

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