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LOS ALAMOS SCIENTIFIC LABORATORY

OF THE UNIVERSITY OF CALIFORNIA o LOS ALAMOS NEW MEXICO

SIX AND SIXTEEN GROUP CROSS SECTIONS FOR FAST AND INTERMEDIATE CRITICAL ASSEMBLIES

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LAMS-2543
PHYSICS
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LOS ALAMOS SCIENTIFIC LABORATORY
OF THE UNIVERSITY OF CALIFORNIA LOS ALAMOS NEW MEXICO

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SIX AND SIXTEEN GROUP CROSS SECTIONS FOR FAST AND INTERMEDIATE CRITICAL ASSEMBLIES

by

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ABSTRACT

This report lists six group neutron cross sections of the more common fissionable isotopes for study of fast neutron critical assemblies and sixteen group cross sections of the more common reactor material for study of intermediate neutron critical assemblies. Data sources and averaging scheme used for the development of these multigroup parameters are also given.

PREFACE

This document consists of the two informal reports N-2-731 and N-2-753 concerning multigroup parameters for fast and intermediate critical assemblies. These reports were intended as "work sheets" which could be revised repeatedly as additional neutron cross section data became available and/or as our errors in interpretation of existent data or plain arithmetic errors were uncovered. The incorporation of the current versions as a LAMS report merely facilitates referencing and implies no special permanence in the listed parameter values.

SIX GROUP CROSS SECTIONS FOR U-233, U-235, U-238, Pu-239, AND Pu-240

The appended set of multigroup parameters for Uranium and Plutonium isotopes is a modernization of that given in an internal document and again is intended primarily for S_n method calculations pertaining to Pajarito fast critical and exponential assemblies data. Although a number of important gaps in experimental cross-section information have been filled in the last couple years, some guiding "principles" are still required to complete the six group parameter listings. The cross-section data and "principles" used are as follows:

I. Fission Cross Sections: σ_f (U-233), σ_f(U-235), σ_f(U-238), and σ_f(Pu-239) are from D. W. Allan, R. L. Henkel, "Progress in Nuclear Energy" Series I, Vol. II. (The corrected LA-1714 data for Pu-239 and U-238 presented in the above paper are given highest weight.) σ_f(Pu-240) is from R. L. Henkel (Unpublished). The energy range of interest is completely covered.

II. Fission Spectrum: Fifty-fifty split of the Rosen and Watt type formula, $E^{1/2}e^{-0.775E}$ and $e^{-E/0.965}$ sinh $(2.29E)^{1/2}$, is given by Cranberg, Frye, Nereson, and Rosen (Phys. Rev. 103, 662, 1956). The Rosen formula fits the spectral data on U-235 fission better than the Watt formula, especially for low neutron energies, the 50-50 split being a compromise to help boost the fission spectrum averaged U-238 fission cross section towards Leachman's experimental value. Despite the evidence that the fission neutron spectrum of Pu-239 is harder than that of U-235 (Grundl and Neuer), the above split is adopted for all U and Pu isotopes and for all fission-inducing neutron energies. Two arguments for this simplification are: 1) some "experimental" determinations of inelastic scattering parameters have involved this assumption, and 2) the present S_n code handles only a unique fission spectrum.

III. Number of Neutrons per Fission: Thermal ν values are taken as lower limits of those given in BNL-325 for U-233, U-235, and Pu-239; ν(U-238, E ~ 1.6 mev) is taken from Leachman (International Conference on the Peaceful Uses of Atomic Energy, Vol. II, 193, 1956); ν(Pu-240) is obtained from reactivity coefficient measurements at Pajarito and the assumption σ_c(Pu-240) = σ_c(U-238). $d\nu/dE$ is taken as roughly constant (Leachman and Terrell theories) and intermediate in value between that indicated by spontaneous fission ν(Pu-240) vs. thermal fission ν(Pu-239) and by Leachman (loc. cit.).

IV. Capture Cross Sections: σ_c(U-238) is from

BNL-325 and H. Newson (Duke Univ., 1956, unpub.). σ_c (U-235) for $0.2 \leq E \leq 1$ mev is from α(U-235) data of B. C. Diven, J. Terrell, and A. Hemmendinger, Phys. Rev. 109, 144-150 (1958). Little data are available on σ_c(U-233), σ_c(Pu-239), and σ_c(Pu-240); but burnout measurements, principally at Argonne (Okrent, International Conference on the Peaceful Uses of Atomic Energy, Vol. 5, 347, 1956) indicate σ_c(Pu-239) and σ_c(U-235) to be similar monotonically decreasing functions of energy not unlike σ_c(U-238). Gaps are filled by taking σ_c(U-233) $\simeq$ σ_c(Pu-240) $\simeq$ σ_c (U-238) and energy dependences as similar to σ_c(U-238) as permitted by the Diven, et al., and Argonne data.

V. Inelastic Cross Sections: Inelastic transfer parameters for U-238 for incident neutron energies less than 2 mev are obtained from the data of Cranberg and Levin, "Inelastic Neutron Scattering by U-238" - internal Los Alamos report. Their general heavy element data together with the 14 mev data of Graves and Rosen (Phys. Rev. 89, 343, 1953) indicate the utility of the statistical model inelastic spectrum $E\, e^{-E/\beta\sqrt{E_o}}$ with $\beta \simeq 0.2$ (mev)$^{1/2}$ and incident neutron energy $E_o \geq 2.5$ mev. The measurements of Batchelor (AERE NP/R 1629) and Bethe, Beyster, and Carter (LA-1939), although in less detail, give additional confirmation, the net result being that, for

U-238, the inelastic multigroup parameters are adequately determined. Inelastic transfer parameters for the other isotopes are obtained with the help of the following "principles" which do not appear to overly violate existing data (BNL-325, LA-1939, and Cranberg and Levin): 1) the nonelastic cross sections of the Pu and U isotopes are the same (a prediction of the cloudy crystal ball model), 2) the level spacing parameter β, and hence inelastic spectra, are similar for the Pu and U isotopes (a prediction of the statistical model). Specifically, both the results of Cranberg and Levin and of LA-1939 indicate that inelastic spectra from U-235 and Pu-239 are a little softer than from U-238 for $1 \leq E_o \leq 2$ mev, and we assume this difference in spectral character persists for $E_o < 1$ mev.

VI. Transport Cross Sections: These are from $\sigma_{tr} = \sigma_t - \sigma_{el.} + (\sigma_{el.})_{tr}$, thus assuming isotropicity of fission neutrons and inelastically scattered neutrons. Angular distributions of elastically scattered neutrons from U-235, Pu-239, and U-238 are obtained from BNL-400 and some additional Los Alamos results (Walt and Beyster, Cranberg and Levin, and Allen). Some of these data presumably include small amounts of inelastic scattering, e.g., due, in U-238, to excitation of the 45 kev level. To fill in gaps, $(\sigma_{el.})_{tr}/(\sigma_{el.})$ is assumed to be the same function of energy for all Pu and U isotopes.

Fission spectrum, $\chi(E)$, weighting within energy groups is used throughout. Cross-section information is graphed in Figs. 1-8 against $\int_0^E \chi(E)\,dE$. Multigroup parameters are given in Tables I-VI and six group activation cross sections for a number of "detector" elements are given in Table VII. The "detector" cross sections are based on data given in BNL-325, LA-2122, and on data from B. C. Diven ($\sigma_{n,\gamma}$ of gold), J. D. Knight ($\sigma_{n,2n}$ of U-238), and AERE/TP/21 ($\sigma_{n,\gamma}$ of U-238 and Th-232) by J. Lynn and A. Lane.

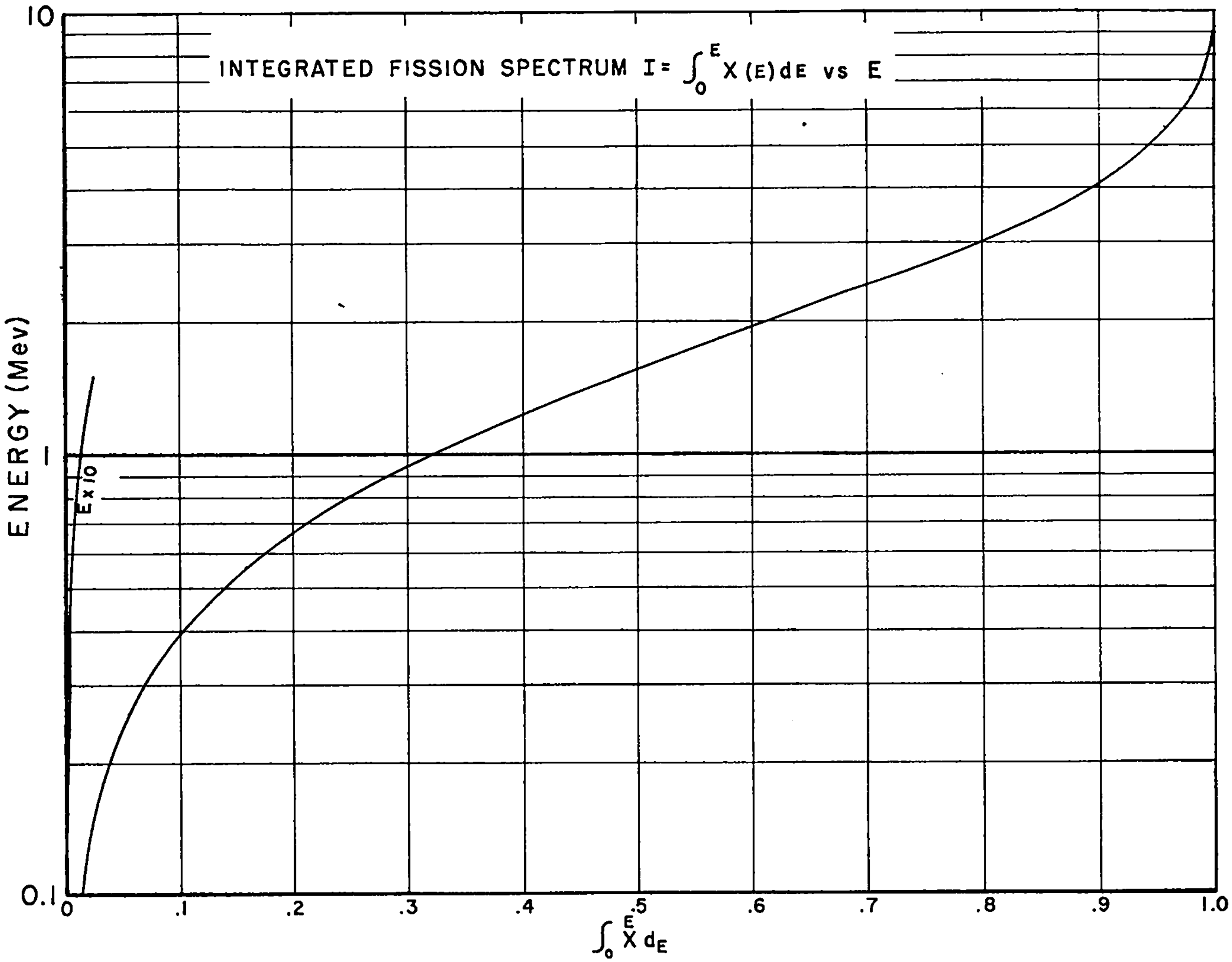

Fig. 1 Energy versus fraction of fission neutron spectrum below this energy.

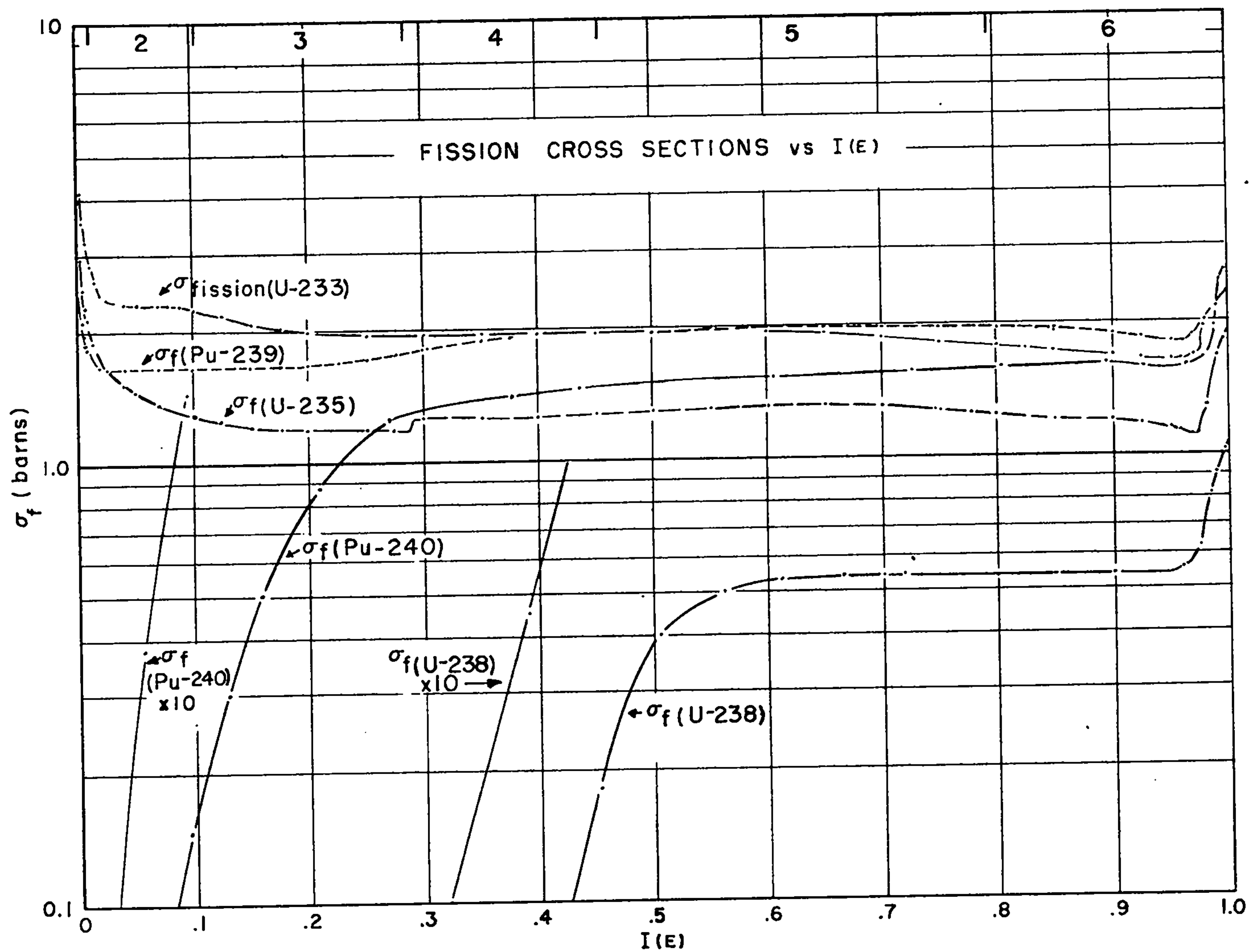

Fig. 2 Energy dependence of fission cross sections over the range of the fission neutron spectrum.

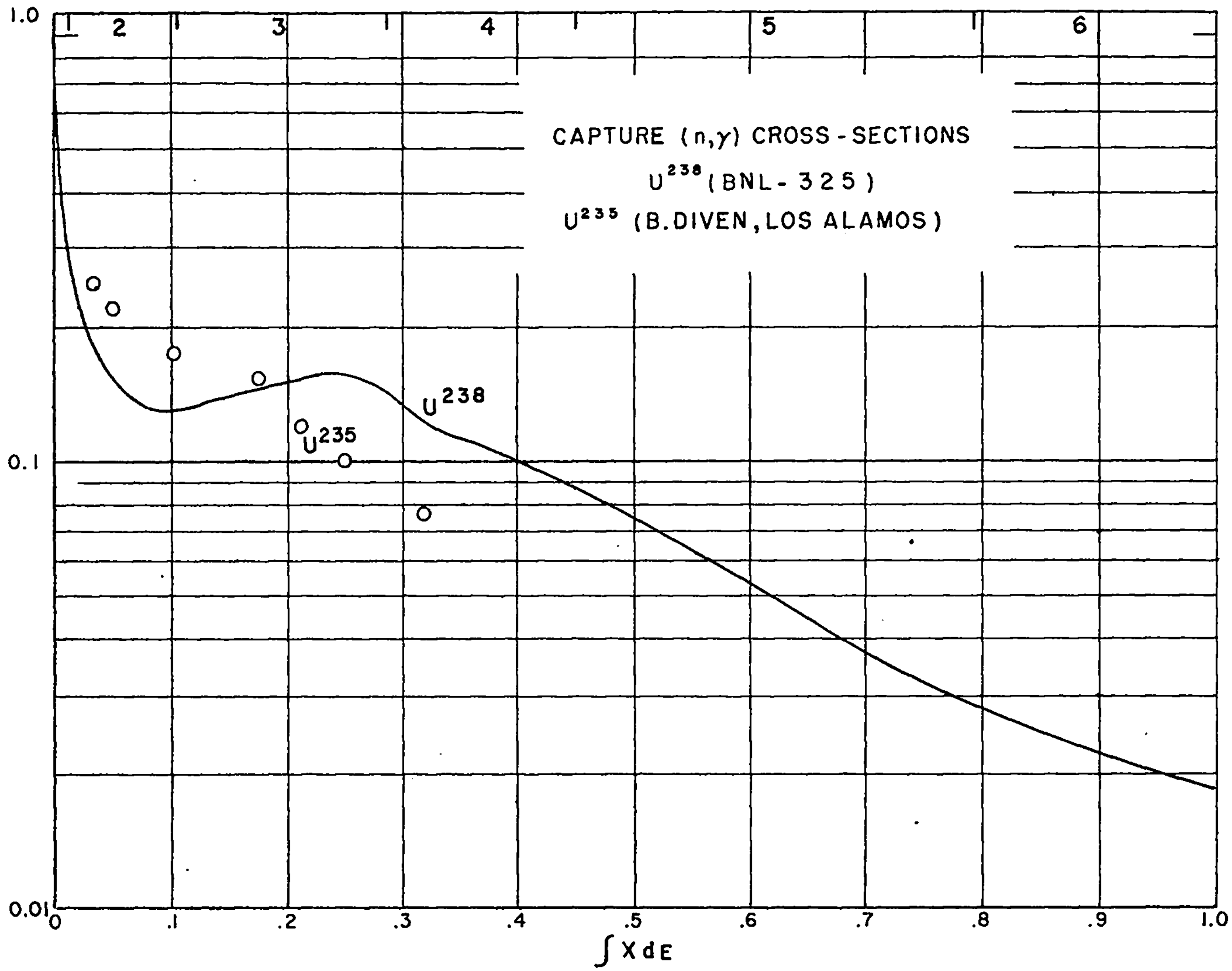

Fig. 3 Energy dependence of U-235 and U-238 capture cross sections over the range of the fission neutron spectrum.

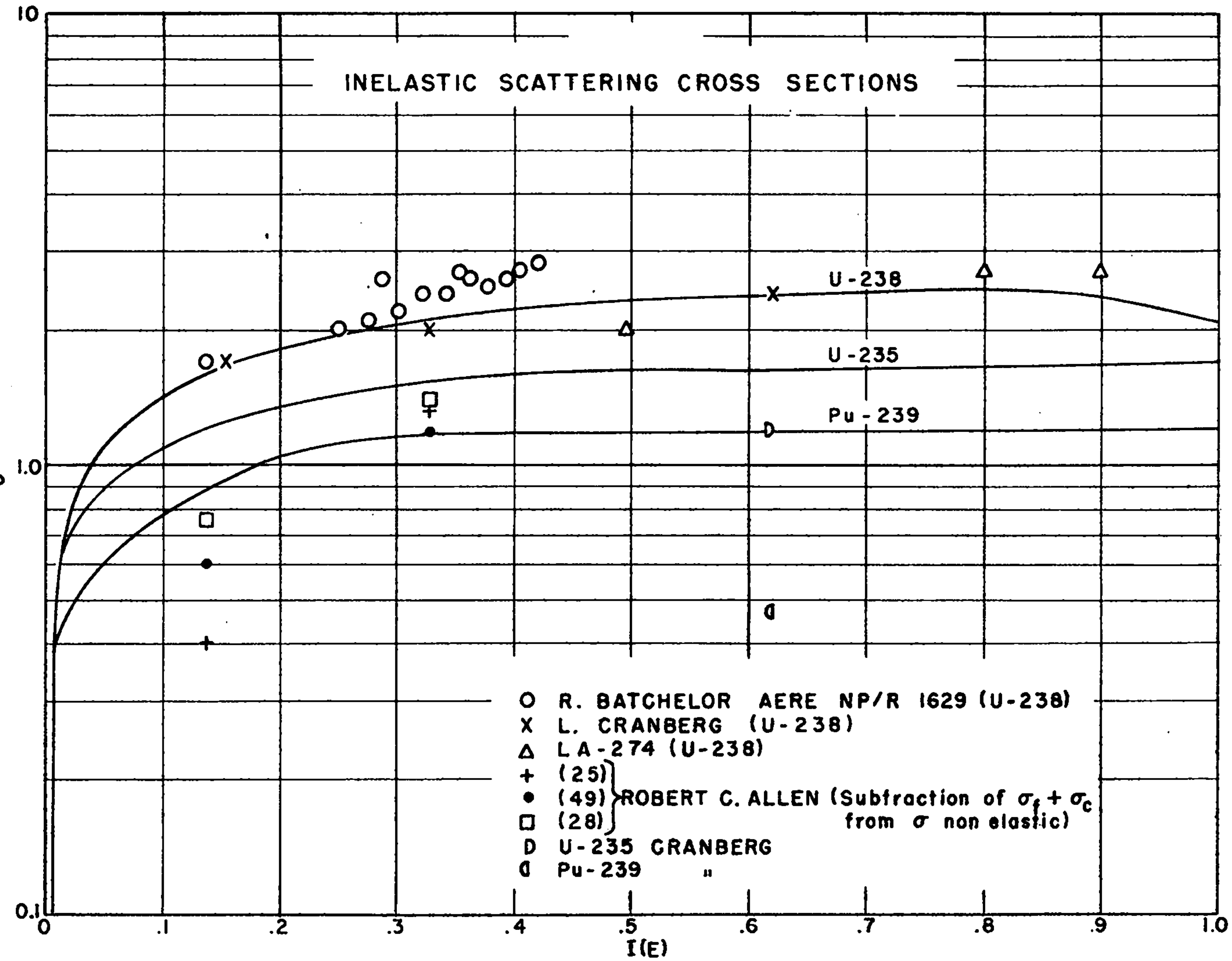

Fig. 4 Energy dependence of inelastic scattering cross sections over the range of the fission neutron spectrum.

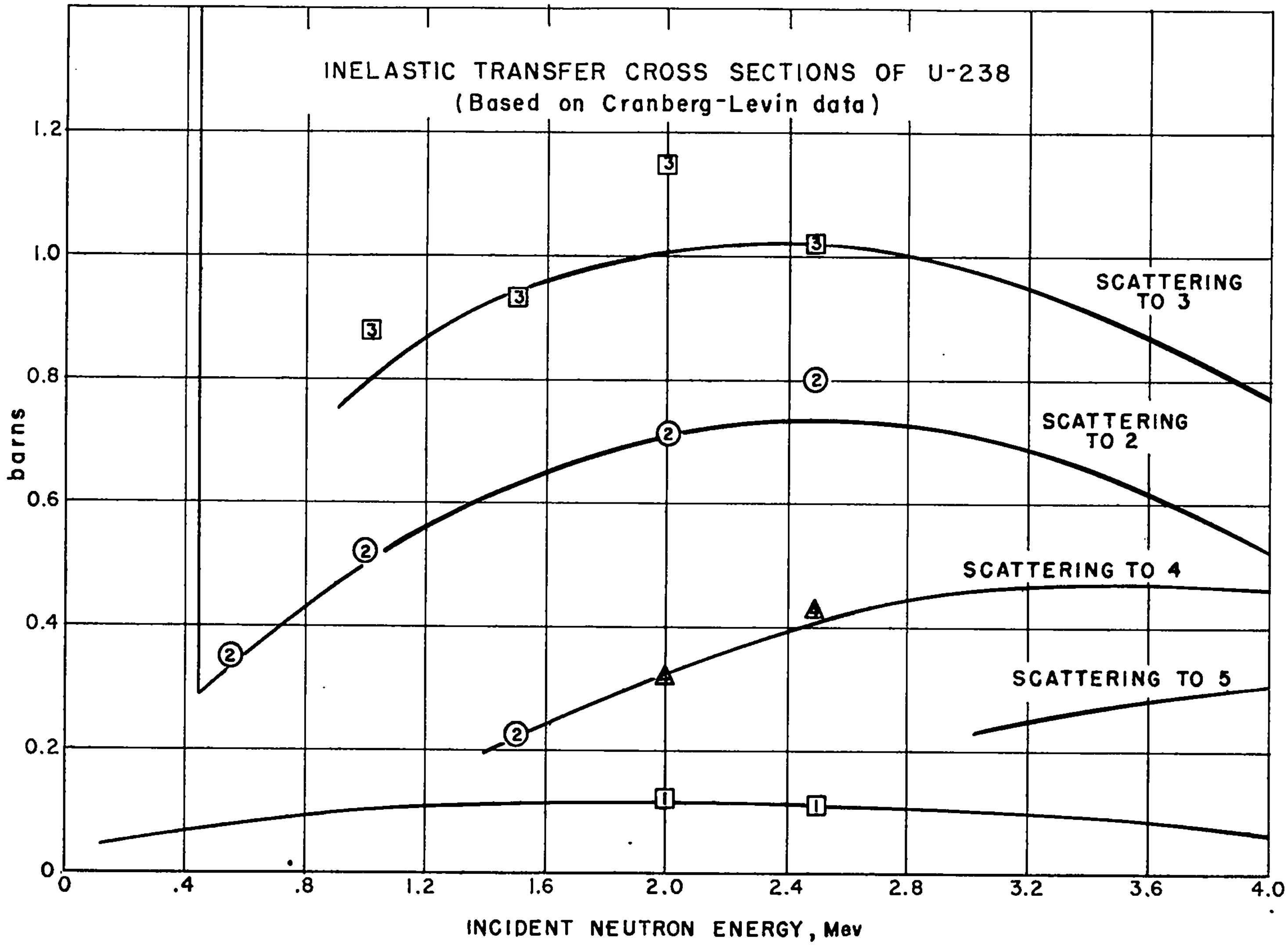

Fig. 5 Partial inelastic cross sections of U-238 for scattering into the labeled energy groups.

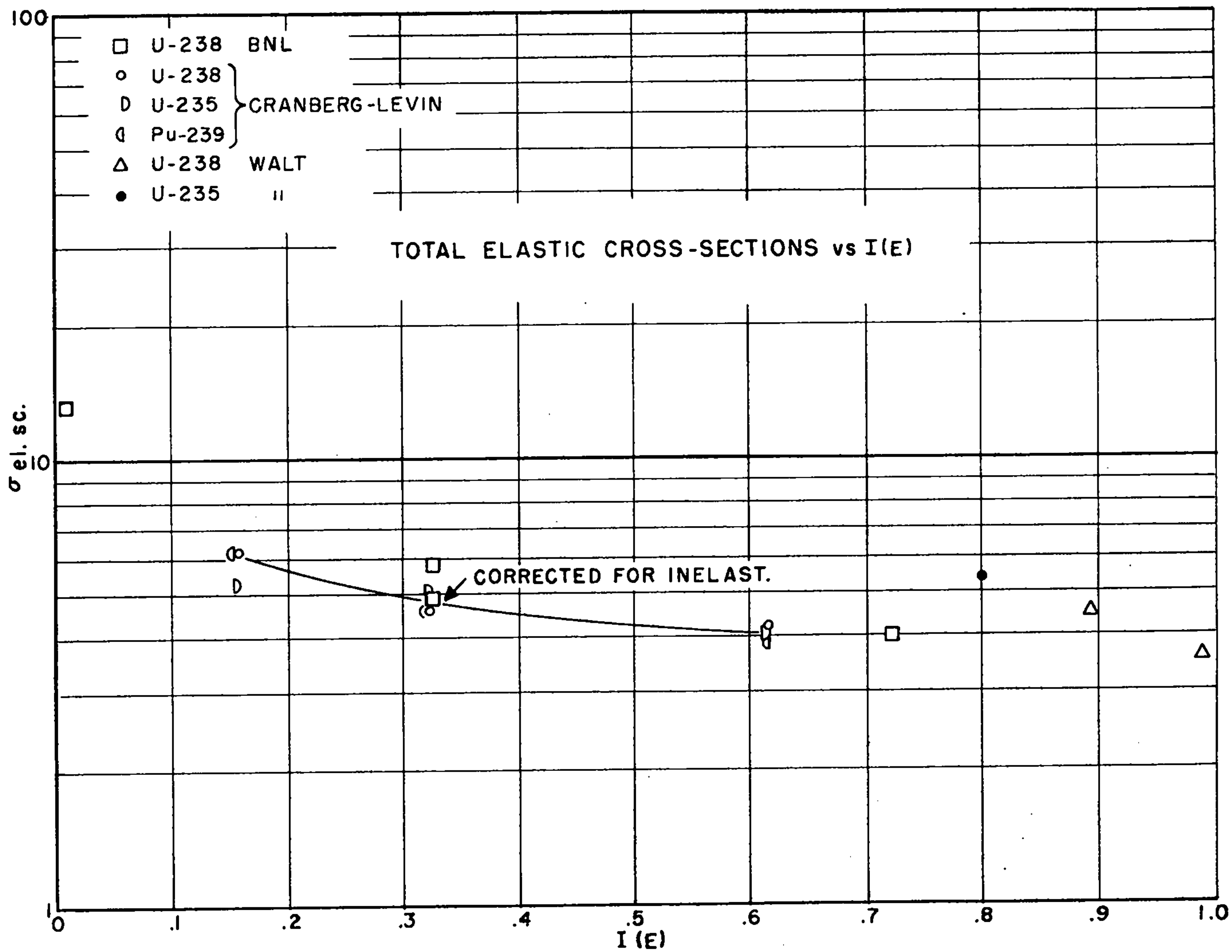

Fig. 6 Energy dependence of elastic scattering cross sections over the range of the fission neutron spectrum.

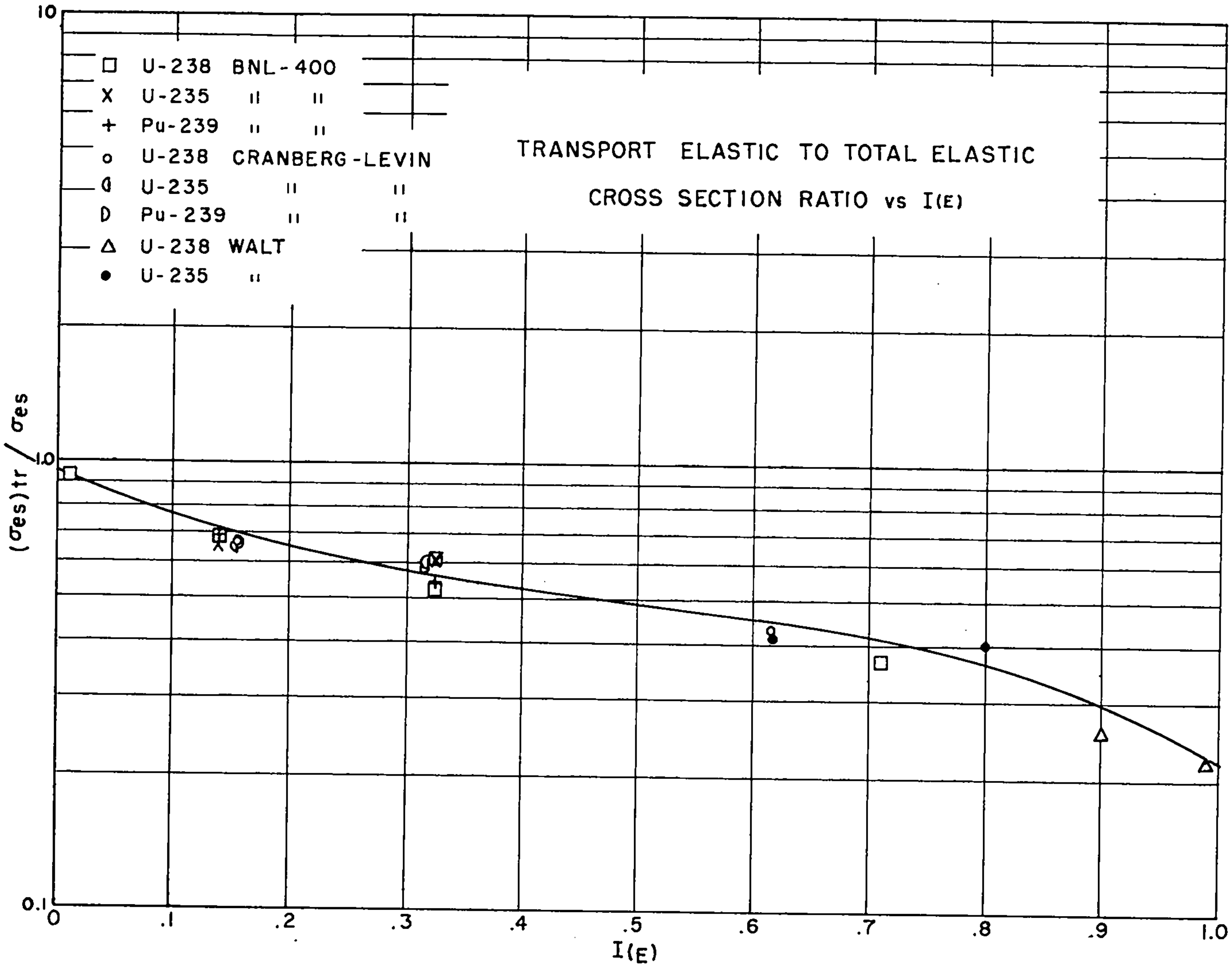

Fig. 7 Energy dependence of the ratio of transport elastic to total elastic cross sections.

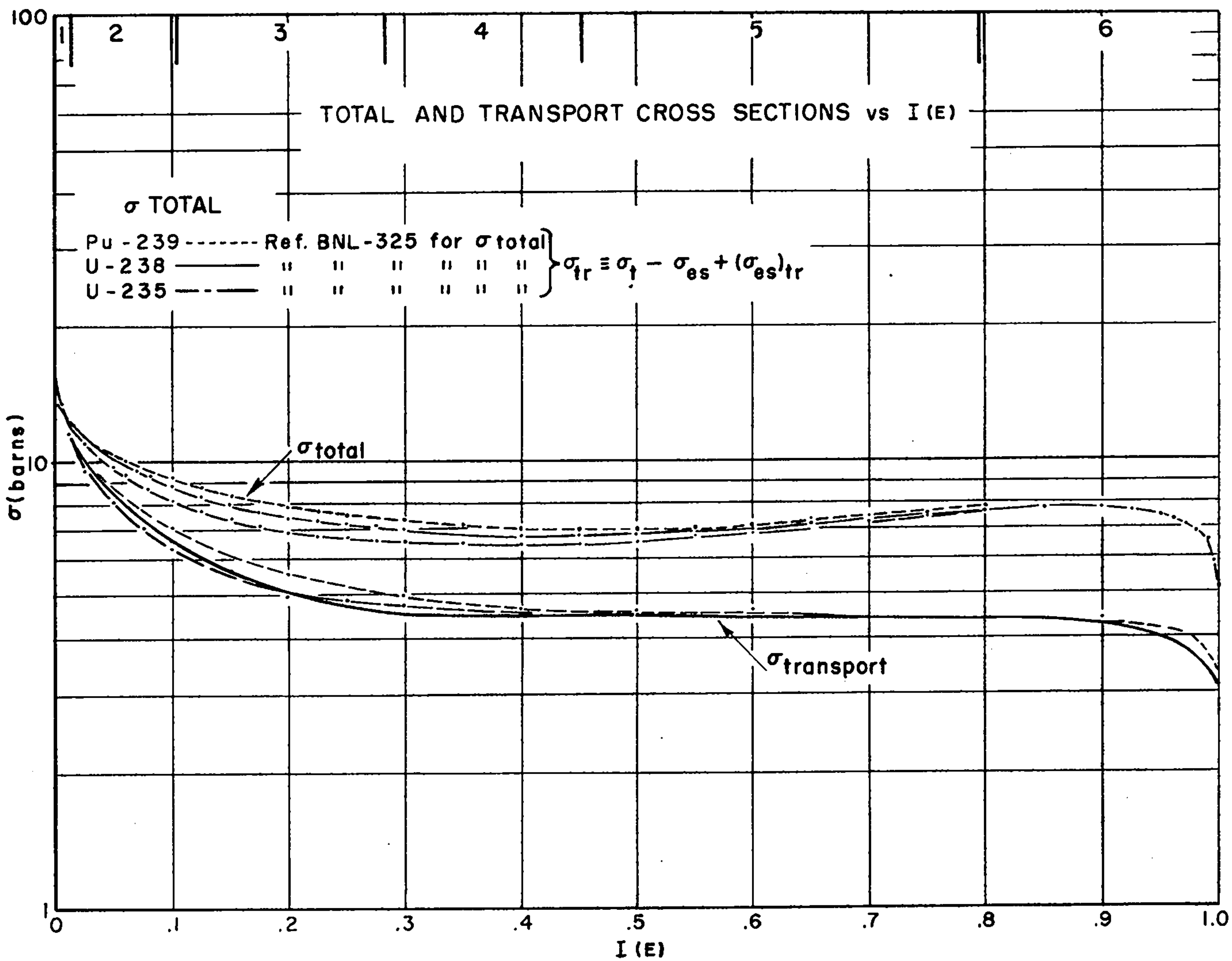

Fig. 8 Energy dependence of total and transport cross sections over the range of the fission neutron spectrum.

TABLE I

SIX GROUP SPECIFICATIONS

Group No.	1	2	3	4	5	6
En. range	0-0.1	0.1-0.4	0.4-0.9	0.9-1.4	1.4-3.0	3.0-∞
Vel.(cm/sh)	2.9	6.7	11.0	14.7	19.9	28.5
Fission Spectrum	0.014	0.090	0.180	0.168	0.344	0.204
E(Mev)*	0.059	0.26	0.65	1.14	2.10	4.41
			U-235			
ν	2.44	2.46	2.49	2.53	2.62	2.94
σ_f	2.34	1.43	1.20	1.22	1.22	1.21
σ_c	0.6	0.23	0.15	0.11	0.08	0.05
σ_{tr}	12.0	7.9	5.2	4.65	4.5	4.25
$\sigma_{i\to i}$	9.06	6.16	3.42	2.30	1.77	1.20
$\sigma_{i\to i-1}$		0.08	0.35	0.55	0.24	0.27
$\sigma_{i\to i-2}$			0.08	0.40	0.67	0.37
$\sigma_{i\to i-3}$				0.07	0.45	0.65
$\sigma_{i\to i-4}$					0.07	0.44
$\sigma_{i\to i-5}$						0.06
$\nu\sigma_f$	5.71	3.518	2.988	3.087	3.196	3.557

*Flux averaged group neutron energy.

TABLE II

U-238

Group	1	2	3	4	5	6
ν	0	0	0	2.46	2.50	2.80
σ_f	0	0	0	0.044	0.485	0.616
$\sigma_{n,2n}$	0	0	0	0	0	0.07
σ_c	0.40	0.16	0.14	0.10	0.05	0.02
σ_{tr}	11.8	8.2	5.25	4.50	4.4	4.00
$\sigma_{i \to i}$	11.4	7.96	4.53	2.906	1.825	1.254
$\sigma_{i \to i-1}$		0.08	0.50	0.80	0.35	0.33
$\sigma_{i \to i-2}$			0.08	0.55	0.96	0.46
$\sigma_{i \to i-3}$				0.10	0.64	0.79
$\sigma_{i \to i-4}$					0.09	0.53
$\sigma_{i \to i-5}$						0.07
$\nu\sigma_f$	0	0	0	0.108	1.213	1.725

TABLE III

Pu-239						
Group	1	2	3	4	5	6
ν	2.86	2.88	2.93	2.99	3.09	3.48
σ_f	2.05	1.67	1.70	1.83	1.95	1.90
σ_c	0.5	0.17	0.11	0.07	0.05	0.03
σ_{tr}	12.0	8.4	5.7	4.8	4.5	4.25
$\sigma_{i\rightarrow i}$	9.45	6.51	3.55	2.09	1.42	1.05
$\sigma_{i\rightarrow i-1}$		0.05	0.29	0.45	0.18	0.20
$\sigma_{i\rightarrow i-2}$			0.05	0.30	0.50	0.27
$\sigma_{i\rightarrow i-3}$				0.06	0.35	0.45
$\sigma_{i\rightarrow i-4}$					0.05	0.31
$\sigma_{i\rightarrow i-5}$						0.04
$\nu\sigma_f$	5.863	4.810	4.981	5.472	6.026	6.612

TABLE IV

	Pu-239 Revised*					
Group	1	2	3	4	5	6
Energy	0-.1	.1-.4	.4-.9	.9-1.4	1.4-3	3-∞
χ	.013	.084	.170	.161	.347	.225
$\nu\sigma_f$	5.863	4.810	4.981	5.472	6.026	6.517
σ_{tr}	12.0	8.4	5.7	4.8	4.5	4.25
$\sigma_{i\to i}$	9.45	6.51	3.64	2.28	1.51	1.20
$\sigma_{i\to i-1}$		.05	.20	.37	.30	.20
$\sigma_{i\to i-2}$			.05	.21	.40	.30
$\sigma_{i\to i-3}$				.04	.25	.38
$\sigma_{i\to i-4}$					.04	.21
$\sigma_{i\to i-5}$						.03
$(\nu-1-\alpha)\sigma_f$	3.313	2.970	3.171	3.572	4.026	4.587

* This revised set has smaller inelastic scattering cross sections and yields predicted spectral index values of Jezebel in better agreement with observation. Note that the fission spectrum, χ, is somewhat different also; it is more energetic than χ (U-235).

TABLE V

			Pu-240			
Group	1	2	3	4	5	6
ν		3.18	3.23	3.30	3.42	3.72
σ_f	0	0.05	0.77	1.39	1.54	1.60
σ_c	0.60	0.23	0.15	0.11	0.08	0.05
σ_{tr}	11.8	8.2	5.45	4.65	4.5	4.25
$\sigma_{i \to i}$	11.2	7.87	4.07	2.24	1.62	1.03
$\sigma_{i \to i-1}$		0.05	0.40	0.50	0.22	0.24
$\sigma_{i \to i-2}$			0.06	0.35	0.58	0.33
$\sigma_{i \to i-3}$				0.06	0.40	0.55
$\sigma_{i \to i-4}$					0.06	0.40
$\sigma_{i \to i-5}$						0.05
$\nu\sigma_f$	0	0.159	2.487	4.587	5.267	5.952

TABLE VI

U-233						
Group	1	2	3	4	5	6
ν	2.51	2.53	2.57	2.61	2.70	3.02
σ_f	3.23	2.24	1.94	1.89	1.83	1.75
σ_c	0.40	0.15	0.11	0.08	0.06	0.04
σ_{tr}	11.8	8.1	5.3	4.6	4.5	4.25
$\sigma_{i\to i}$	8.17	5.66	2.91	1.82	1.53	1.19
$\sigma_{i\to i-1}$		0.05	0.29	0.45	0.18	0.20
$\sigma_{i\to i-2}$			0.05	0.30	0.50	0.27
$\sigma_{i\to i-3}$				0.06	0.35	0.45
$\sigma_{i\to i-4}$					0.05	0.31
$\sigma_{i\to i-5}$						0.04
$\nu\sigma_f$	8.107	5.667	4.986	4.933	4.941	5.285

TABLE VII

SIX-GROUP DETECTOR CROSS SECTIONS

Group	1	2	3	4	5	6
En. (Mev)	0–0.1	0.1–0.4	0.4–0.9	0.9–1.4	1.4–3.0	3.0–∞
$\sigma_{n,2n}$(U-238)	0	0	0	0	0	0.07
σ_f(U-238)	0	0	0	0.044	0.485	0.616
σ_f(Th-232)	0	0	0	0.009	0.10	0.16
σ_f(U-236)	0	0	0.064	0.51	0.76	0.96
σ_f(Np-237)	0	0.069	0.95	1.63	1.72	1.63
σ_f(U-234)	0	0.065	0.85	1.20	1.34	1.41
σ_f(Pu-239)	2.05	1.67	1.70	1.83	1.95	1.90
σ_f(U-235)	2.34	1.43	1.20	1.22	1.22	1.21
σ_f(U-233)	3.23	2.24	1.94	1.89	1.83	1.75
$\sigma_{n,\alpha}$(Li^6)	1.10	1.76	0.43	0.26	0.21	0.08
$\sigma_{n,\gamma}$(Au)	0.60	0.25	0.14	0.10	0.06	0.02
$\sigma_{n,\alpha}$(B)	0.61	0.27	0.08	0.04	0.06	0.04
$\sigma_{n,\gamma}$(U-238)	0.40	0.16	0.14	0.10	0.05	0.02
$\sigma_{n,\gamma}$(Th-232)	0.46	0.21	0.13	0.07	0.05	0.02

SIXTEEN GROUP CROSS SECTIONS

The set of sixteen group cross sections given here was prepared primarily for calculations of homogeneous epithermal critical systems with the view of testing the importance of resonance shielding on criticality. The top five energy groups are identical with and have the same cross-section specifications as those in the six group set used for Pajarito metal systems, e.g., employ fission spectrum weighting. With one exception, specification of the remaining group cross sections is by means of flat collision density (in lethargy) flux weighting; e.g., $\langle \sigma_{tr} \rangle_i = \int_i du/\sigma \Big/ \int_i du/\sigma\sigma_{tr}$ with BNL-325 and BNL-400 as the data source. The exception is in the specification of capture and fission group cross sections in the resonance region where $\langle \sigma_x \rangle_i$ ($x = n,\gamma$ or n,f) is defined by

$$\langle \sigma_x \rangle_i = \frac{1}{\Delta u_i} \sum_r \frac{\frac{\pi}{2}\, \sigma_{xr}^{o}\, \Gamma_r/E_r}{(1 + \sigma_r^o/\sigma_s)^{1/2}} \qquad \text{for } E \leq 3 \text{ kev,}$$

$$\text{or} \quad \frac{1}{\Delta u_i} \int_i \sigma_x \, du \qquad \text{for } E \geq 3 \text{ kev,}$$

where the resonances, r, are given their non-Doppler broadened widths (BNL-325 and extrapolation using Porter-Thomas distribution of neutron widths), σ_r^o denotes the *presumably – to group of [illegible]*

maximum reaction cross section rather than total cross section of the r^{th} resonance, and σ_s is the potential scattering cross section of the medium per atom of the reacting element. The above formula thus neglects the effects of Doppler broadening, resonance scattering, and resonance overlap, the first two effects being somewhat compensatory, and the last partially justifying the resonance structure cut-off artifice at 3 kev. This over-simplified approach is, nevertheless, expected to yield the gross features of resonance self-shielding.

The effective capture and fission group cross sections for U-235, U-238, Pu-239, U-233, Th-232, and Pu-240 in the resonance region are graphed against σ_s in Figures 9-17. The tabulated sixteen group cross sections for these isotopes are those for infinite dilution. For finite dilution, the graphs must be used and the transport cross sections recomputed. The implied effective resonance integral for U-238 compares favorably with the 300° results of Dresner (Nuc. Sci. and Eng., Vol. 1, No. 1, 1946) for $\sigma_s > 200b$ and is too large by ~ 30% at $\sigma_s = 45b$.

On file at T-1 are the labeled sets of 16 group cross sections of fissionable isotopes corresponding to the following values of σ_s per atom:

Telecon with Hansen
σ_s - for light elements σ_s is constant across the res. region
for heavy elements, e.g. U, Hansen usually ignores them since they can not always scatter n across the resonance.
a value at 100 ev is typical

σ_s (barns per atom)	Label				
	U^{235}	U^{238}	U^{233}	Pu^{239}	Pu^{240}
20	25-1	28-1	23-1	49-1	-
40	25-2	28-2	23-2	49-2	-
50	-	-	-	-	40-1
60	25-3	28-3	23-3	49-3	-
100	25-4	28-4	23-4	49-4	40-2
200	25-5	28-5	23-5	49-5	40-3
400	25-6	28-6	23-6	49-6	40-4
600	25-7	28-7	23-7	49-7	40-5
1×10^3	25-8	28-8	23-8	49-8	40-6
2×10^3	25-9	28-9	23-9	49-9	40-7
4×10^3	25-10	28-10	23-10	49-10	40-8
6×10^3	25-11	28-11	23-11	49-11	40-9
1×10^4	25-12	28-12	23-12	49-12	40-10
2×10^4	-	28-13	-	49-13	40-11
4×10^4	-	28-14	-	49-14	40-12
6×10^4	-	28-15	-	49-15	40-13
1×10^5	-	28-16	-	49-16	40-14
2×10^5	-	-	-	-	40-15
4×10^5	-	-	-	-	40-16
6×10^5	-	-	-	-	40-17
1×10^6	-	-	-	-	40-18
∞	25-Y	28-Y	U-233	Pu-239	Pu-240

Finally, for Hydrogen and Deuterium, two-table multigroup cross sections are given for use with S_n calculations in the "linear approximation." Here, if the differential scattering cross section is represented as $\sigma_s(E' \to E)\,dE = \sigma_s(\mu)\,d\mu = 1/2\ \Sigma\ \sigma_{s,n}(E)P_n(\mu)$, the multigroup parameters are defined by

Table A

$$"\sigma_{tr}" = \sigma_t - \sigma_{s,2}/5$$

$$\sigma_{g\to g'} = \frac{\int_g \phi(E)\, dE\ \sigma_s(E\to g')}{\int_g \phi(E)\, dE} - \delta_{gg'}\ (\sigma_{s,2}/5)_g$$

Table B

$$\sigma_{g\to g'} = \frac{\int_g \phi(E)\, dE \int_{g'} \sigma_s(E\to E')\ \mu\ (E',E)\, dE'}{\int_g \phi(E)\, dE}$$

$$- \delta_{gg'}\ (\sigma_{s,2}/5)_g$$

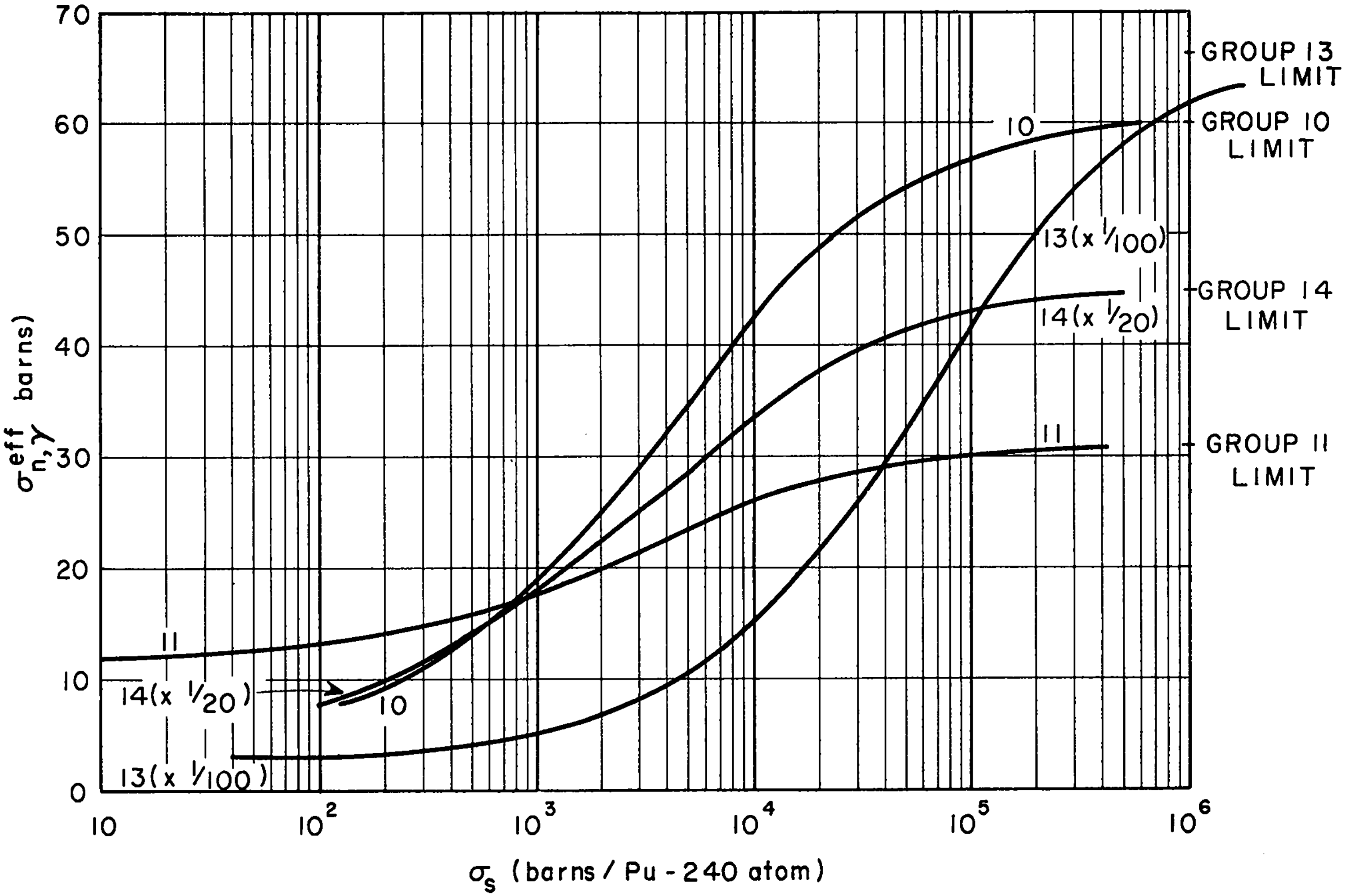

Fig. 9 Shielded capture cross sections for Pu^{240}.

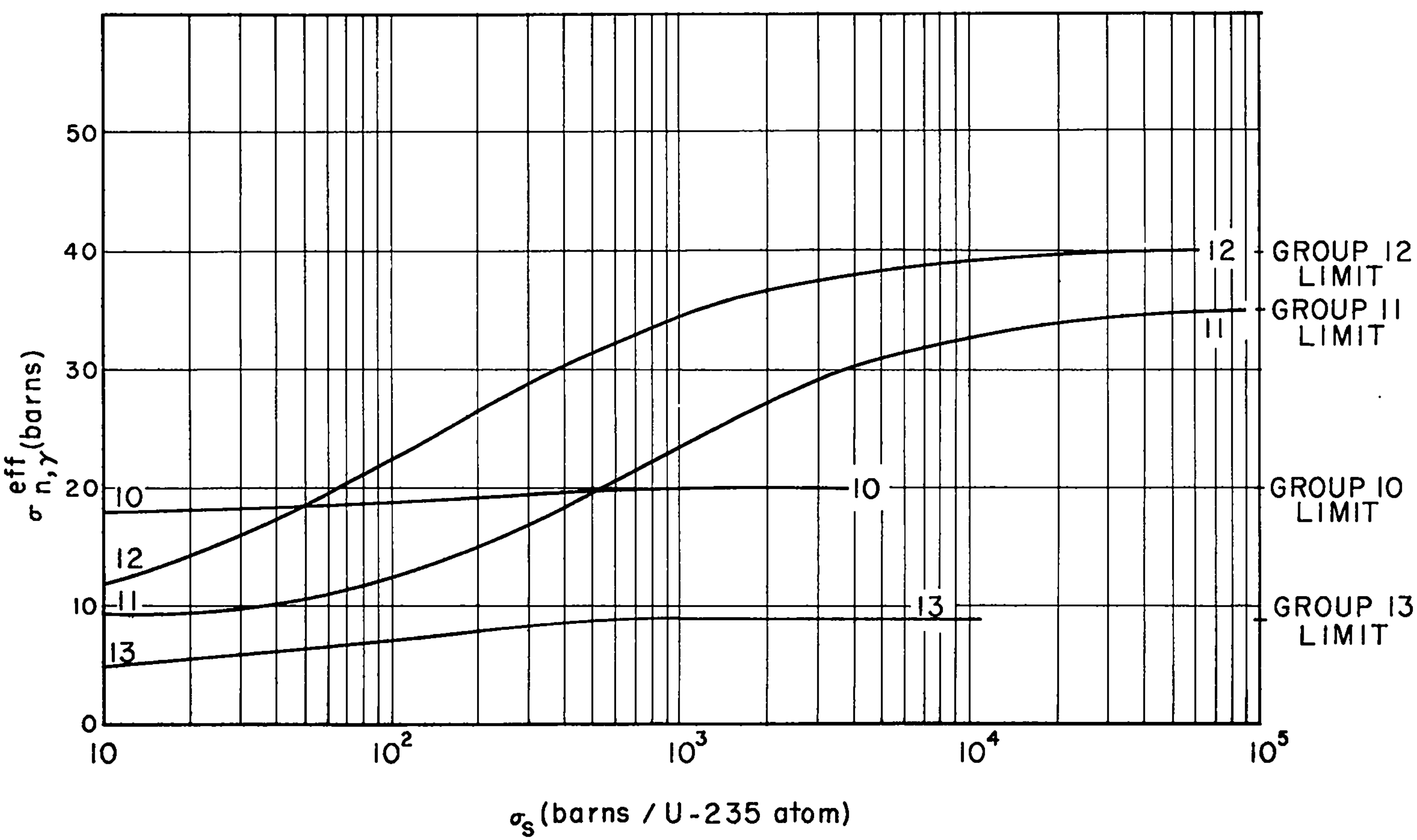

Fig. 10 Shielded capture cross sections for U^{235}.

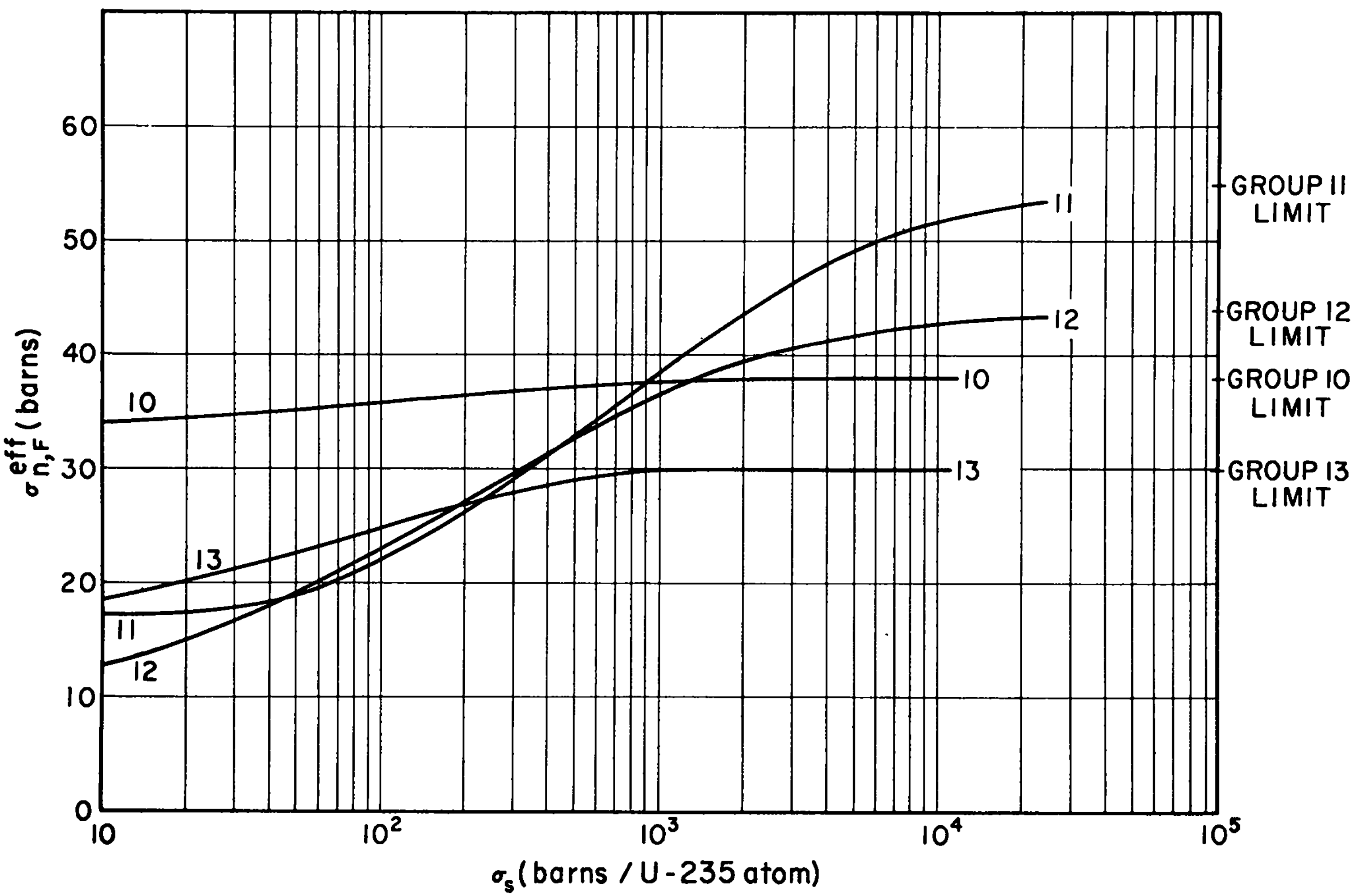

Fig. 11 Shielded fission cross sections for U^{235}.

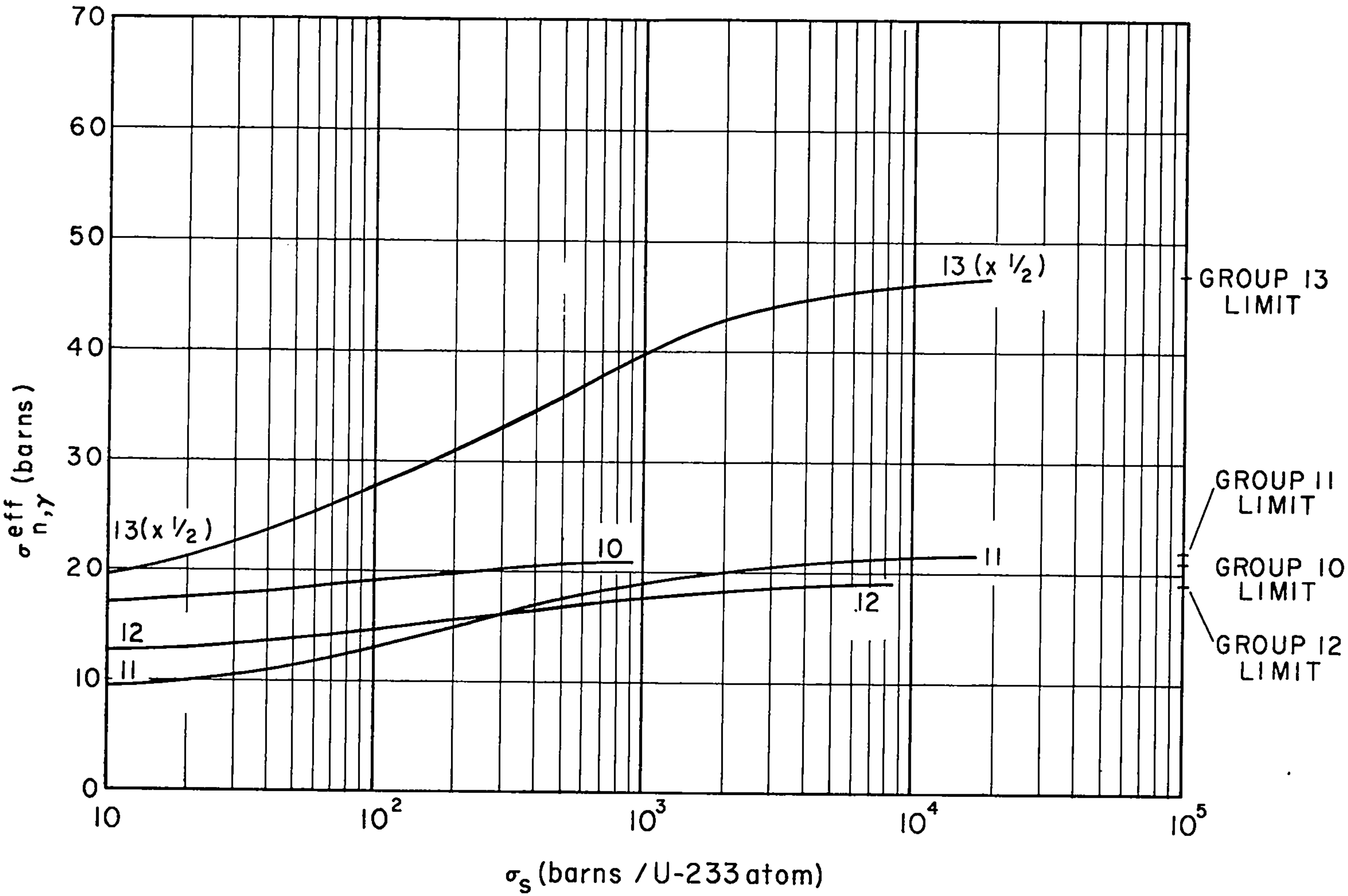

Fig. 12 Shielded capture cross sections for U^{233}.

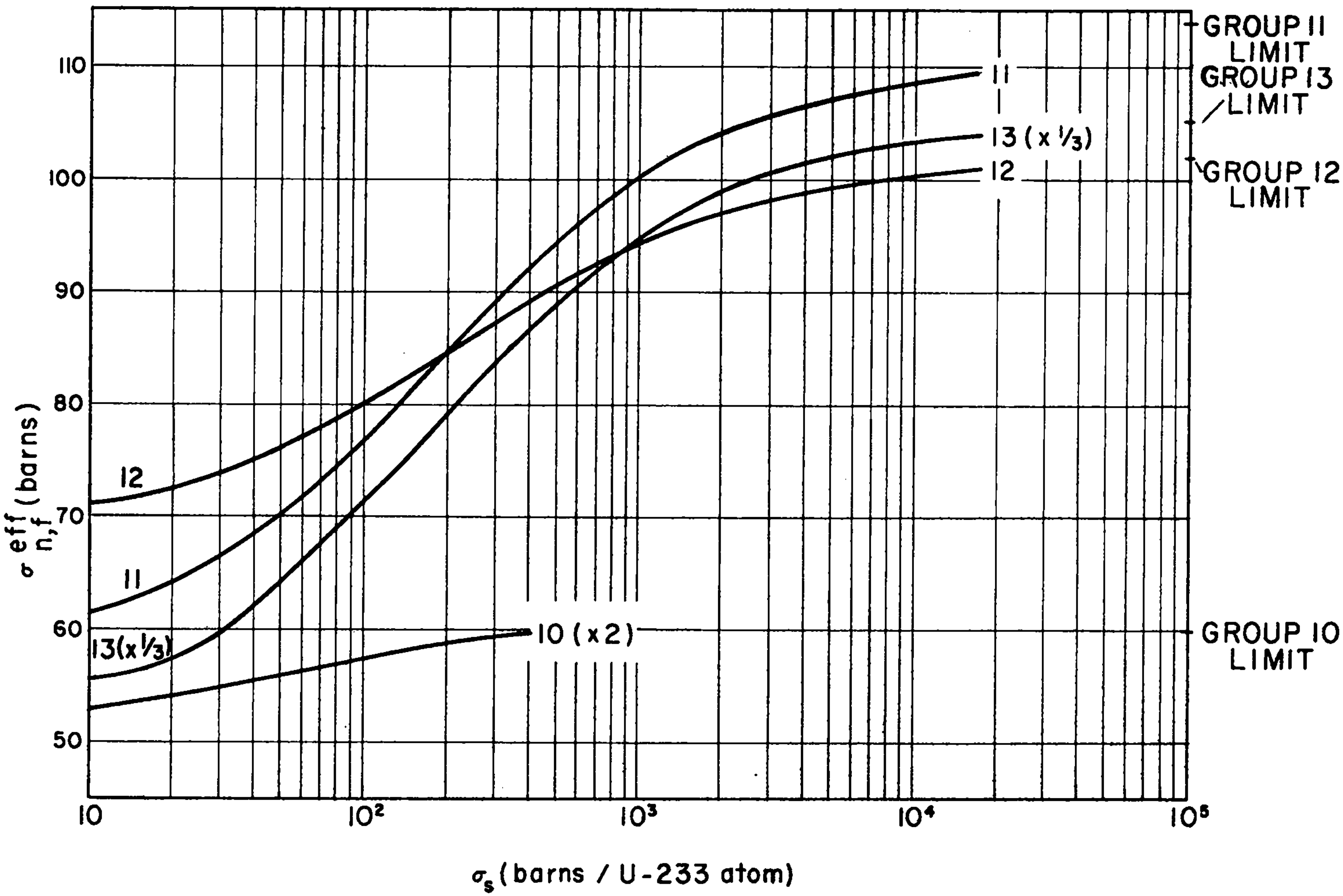

Fig. 13 Shielded fission cross sections for U^{233}.

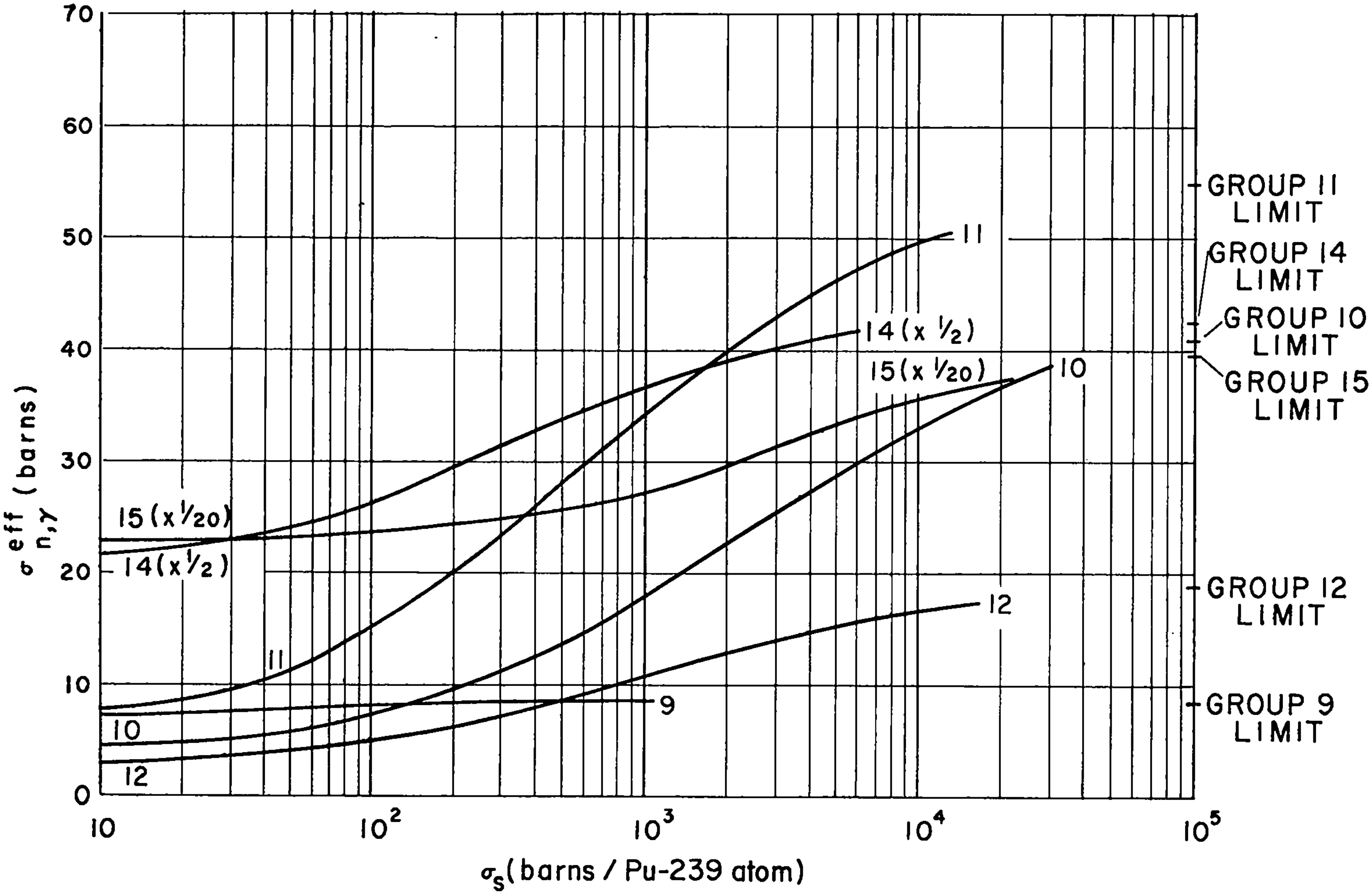

Fig. 14 Shielded Capture Cross Sections for Pu^{239}.

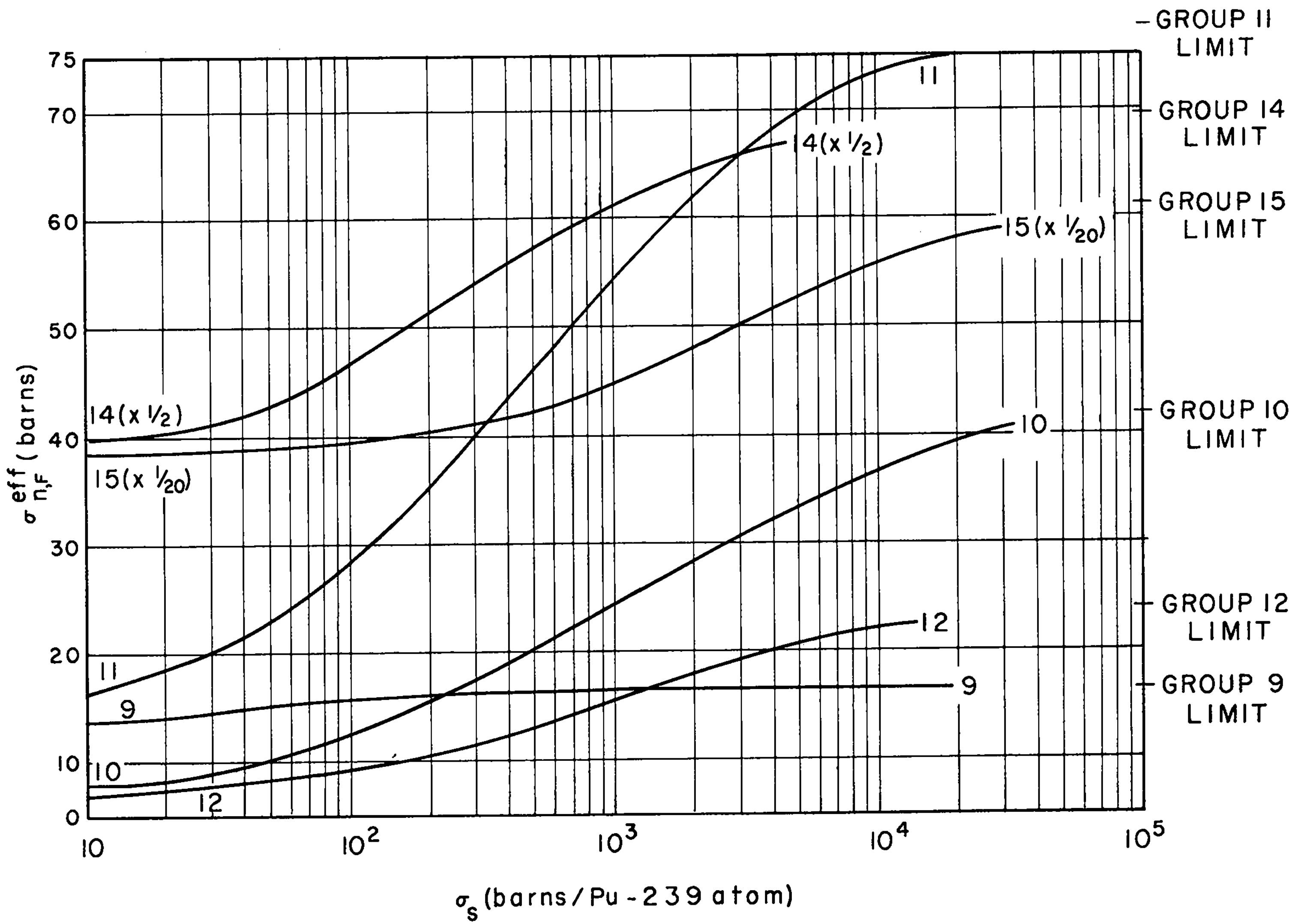

Fig. 15 Shielded Fission Cross Sections for Pu^{239}.

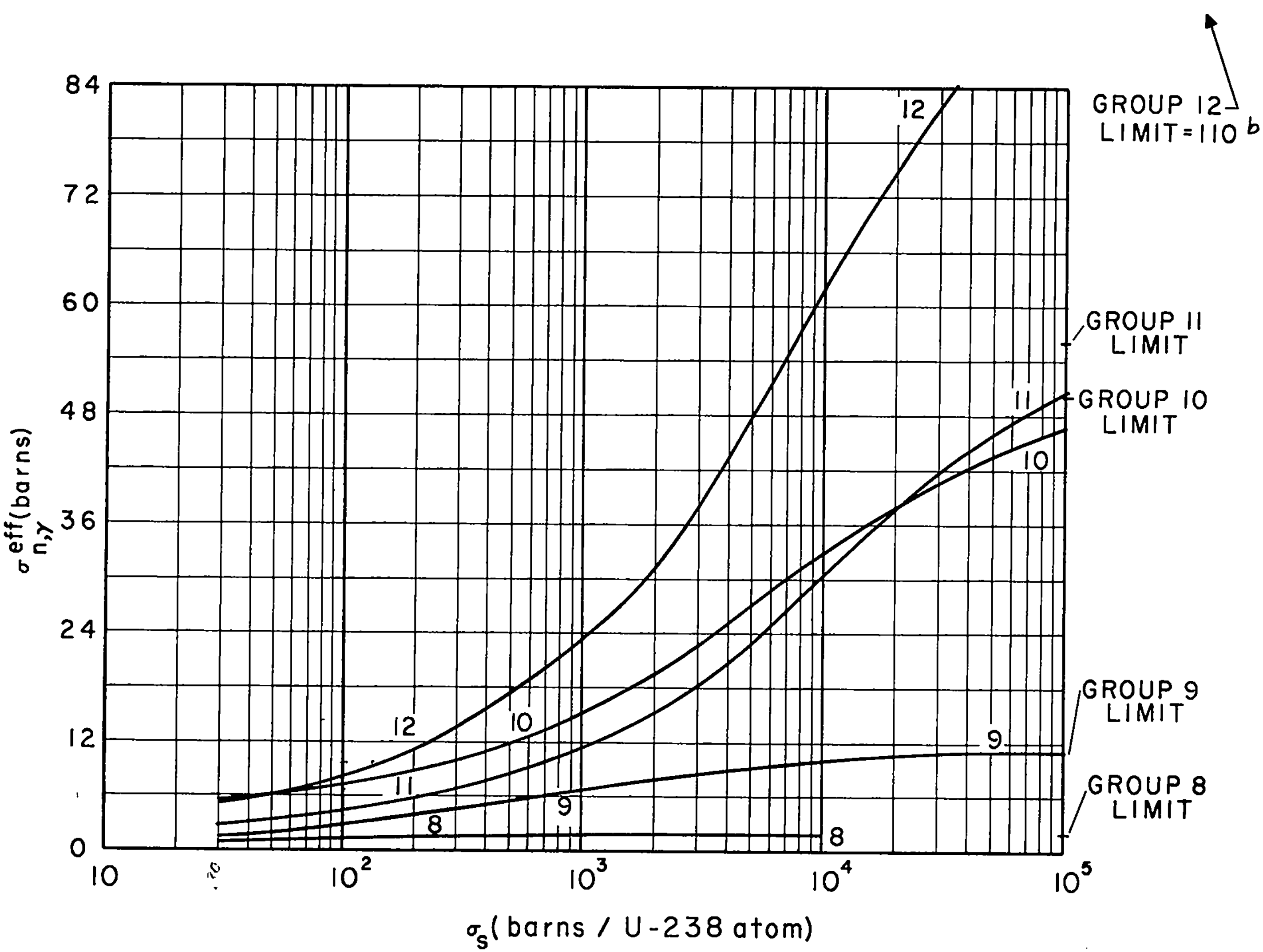

Fig. 16 Shielded Capture Cross Sections for U^{238}.

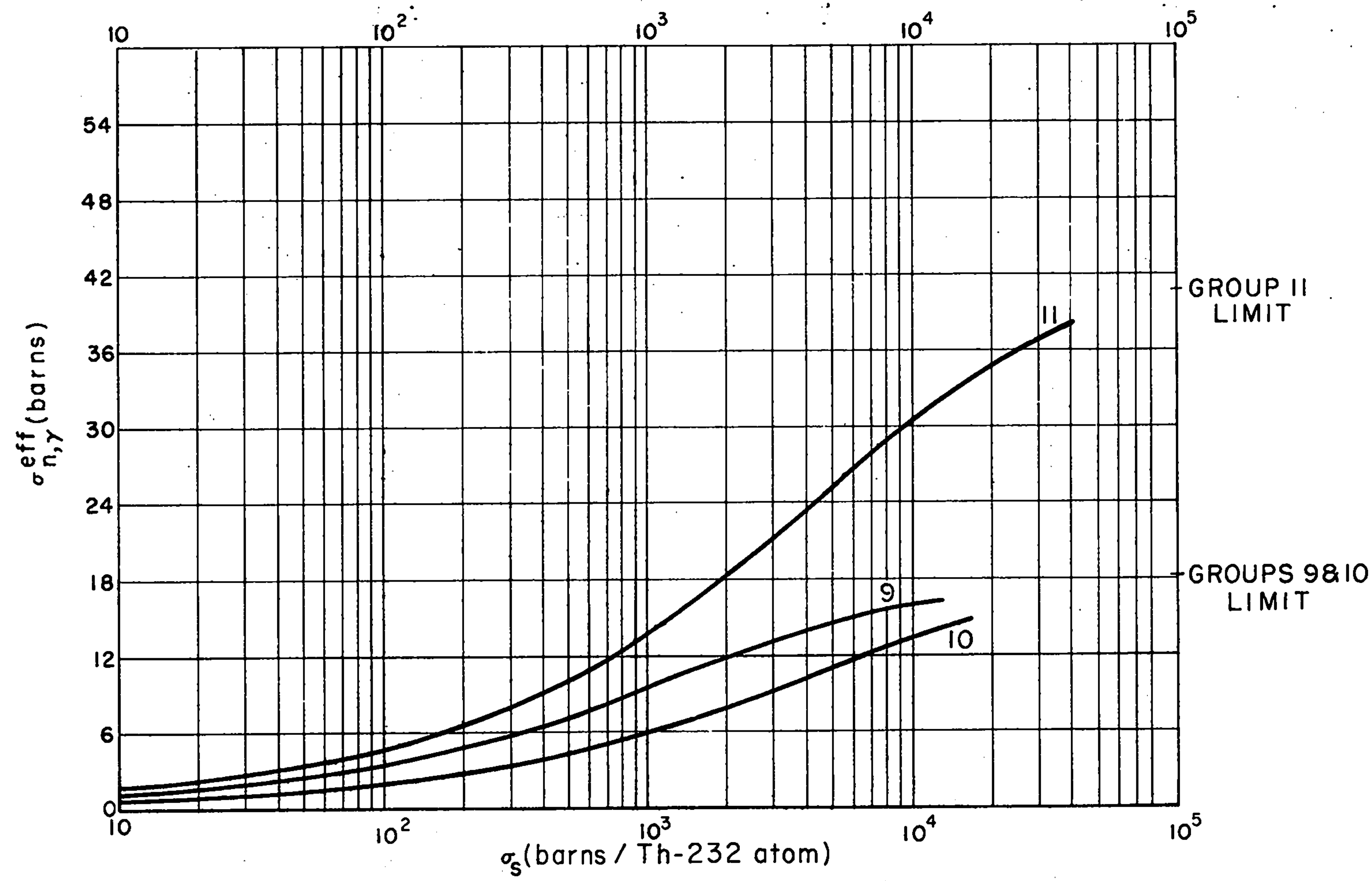

Fig. 17 Shielded Capture Cross Sections for Th^{232}.

TABLE VIII

SIXTEEN GROUP SPECIFICATIONS

Group	En. Range	Δu	v(cm/shake)	χ Fission Spectrum
1	3 - ∞ mev		28.5	0.204
2	1.4 - 3 mev	0.762	19.9	0.344
3	0.9 - 1.4 mev	0.442	14.7	0.168
4	0.4 - 0.9 mev	0.811	11.0	0.180
5	0.1 - 0.4 mev	1.386	6.7	0.090
6	17 - 100 kev	1.772	2.70	0.014
7	3 - 17 kev	1.735	1.14	0
8	0.55 - 3 kev	1.696	0.480	0
9	100 - 550 ev	1.705	0.206	0
10	30 - 100 ev	1.204	0.101	0
11	10 - 30 ev	1.099	0.0566	0
12	3 - 10 ev	1.204	0.0319	0
13	1 - 3 ev	1.099	0.0179	0
14	0.4 - 1 ev	0.916	0.0109	0
15	0.1 - 0.4 ev	1.386	0.00606	0
16	Thermal(0.025)		0.00218	0

TABLE IX

Pu-239

Group	σ_f	$\sigma_{n,\gamma}$	σ_{tr}	$\nu\sigma_f$	$\sigma_{i \to i}$	$\sigma_{i \to i+1}$	$\sigma_{i \to i+2}$	$\sigma_{i \to i+3}$	$\sigma_{i \to i+4}$	$\sigma_{i \to i+5}$
1	1.90	0.03	4.25	6.612	1.05	0.20	0.27	0.45	0.31	0.04
2	1.95	0.05	4.5	6.026	1.42	0.18	0.50	0.35	0.05	
3	1.83	0.07	4.8	5.472	2.09	0.45	0.30	0.06		
4	1.70	0.11	5.7	4.981	3.55	0.29	0.05			
5	1.67	0.17	8.4	4.810	6.51	0.05				
6	1.92	0.38	13.2	5.491	10.85	0.05				
7	2.5	1.0	13.5	7.150	9.96	0.04				
8	4.2	2.5	16.7	12.012	9.96	0.04				
9	16.5	8.6	35.1	47.19	9.96	0.04				
10	42.	41.	93.	120.12	9.94	0.06				
11	78.	55.	143.	223.08	9.93	0.07				
12	24.	19.	53.	68.64	9.94	0.06				
13	20.	3.	33.	57.2	9.93	0.07				
14	139.	85.	234.	397.54	9.92	0.08				
15	1221.	792.	2023.	3492.06	9.94	0.06				
16	705.	275.	990.	2016.3	10.0					

TABLE X

						Pu-240					
Group	$\sigma_{n,f}$	$\sigma_{n,\gamma}$	σ_s^{el}	σ_{tr}	$\nu\sigma_{n,f}$	$\sigma_{i\to i}$	$\sigma_{i\to i+1}$	$\sigma_{i\to i+2}$	$\sigma_{i\to i+3}$	$\sigma_{i\to i+4}$	$\sigma_{i\to i+5}$
1	1.60	0.05		4.25	5.952	1.03	0.24	0.33	0.55	0.40	0.05
2	1.54	.08		4.5	5.267	1.62	.22	.58	.40	.06	
3	1.39	.11		4.65	4.587	2.24	.50	.35	.06		
4	0.77	.15		5.45	2.487	4.07	.40	.06			
5	.05	.23		8.2	0.159	7.87	.05				
6	0	.45	11	11.45	0	10.95	.05				
7	0	.7	11	11.7	0	10.95	.05				
8	0	2.0	11	13	0	10.95	.05				
9	0	11	11	22	0	10.95	.05				
10	0	60	11	71	0	10.92	.08				
11	0	31	12	43	0	11.91	.09				
12	0	24	15	39	0	14.90	.10				
13	1.4	6640	508	7149.4	4.2	504.14	3.86				
14	0.2	898	38	936.2	0.6	37.65	0.35				
15	0	140	11	151	0	10.93	.07				
16	0.03	252	11	263.03	0.09	11					

TABLE XI

Group	σ_f	$\sigma_{n,\gamma}$	σ_{tr}	$\nu\sigma_f$	$\sigma_{i\rightarrow i}$	$\sigma_{i\rightarrow i+1}$	$\sigma_{i\rightarrow i+2}$	$\sigma_{i\rightarrow i+3}$	$\sigma_{i\rightarrow i+4}$	$\sigma_{i\rightarrow i+5}$
					U-233					
1	1.75	0.04	4.25	5.285	1.19	0.20	0.27	0.45	0.31	0.04
2	1.83	0.06	4.5	4.941	1.53	0.18	0.50	0.35	0.05	
3	1.89	0.08	4.6	4.933	1.82	0.45	0.30	0.06		
4	1.94	0.11	5.3	4.986	2.91	0.29	0.05			
5	2.24	0.15	8.1	5.667	5.66	0.05				
6	3.5	0.42	12.5	8.785	8.54	0.04				
7	6.	0.84	16.5	15.06	9.61	0.05				
8	9.	3.	23.	22.59	10.94	0.06				
9	19.	13.	44.	47.69	11.94	0.06				
10	30.	21.	63.	75.30	11.91	0.09				
11	114.	22.	148.	286.14	11.91	0.09				
12	102.	19.	133.	256.02	11.91	0.09				
13	316.	94.	422.	793.16	11.91	0.09				
14	133.	15.	160.	333.83	11.89	0.11				
15	200.	23.	235.	502.	11.92	0.08				
16	467.	46.	525.	1172.2	12.0					

TABLE XII

Group	σ_f	$\sigma_{n,\gamma}$	σ_{tr}	$\nu\sigma_f$	ν	U-235 $\sigma_{i\to i}$	$\sigma_{i\to i+1}$	$\sigma_{i\to i+2}$	$\sigma_{i\to i+3}$	$\sigma_{i\to i+4}$	$\sigma_{i\to i+5}$
1	1.21	0.05	4.25	3.557	2.94	1.20	0.27	0.37	0.65	0.44	0.06
2	1.22	0.08	4.50	3.196	2.62	1.77	0.24	0.67	0.45	0.07	
3	1.22	0.11	4.65	3.087	2.53	2.30	0.55	0.40	0.07		
4	1.20	0.15	5.2	2.988	2.49	3.42	0.35	0.08			
5	1.43	0.23	7.9	3.518	2.46	6.16	0.08				
6	2.5	0.65	12.4	6.125	2.45	9.2	0.05				
7	4.2	1.3	15.1	10.29	2.45	9.55	0.05				
8	7.9	3.2	21.1	19.36	2.45	9.95	0.05				
9	18.7	8.5	37.2	45.815	2.45	9.95	0.05				
10	38.	20.	68.	93.1	2.45	9.95	0.05				
11	55.	35.	100.	134.75	2.45	9.95	0.05				
12	44.	40.	94.	107.8	2.45	9.95	0.05				
13	30.	9.	49.	73.5	2.45	9.95	0.05				
14	70.	10.	90.	171.5	2.45	9.95	0.05				
15	185.	39.	234.	453.25	2.45	9.96	0.04				
16	516.	95.	621.	1264.2	2.45	10.0					

TABLE XIII

						U-238					
Group	σ_t	σ_f	$\sigma_{n,\gamma}$	σ_{tr}	$\nu\sigma_f$	$\sigma_{i \to i}$	$\sigma_{i,i+1}$	$\sigma_{i,i+2}$	$\sigma_{i,i+3}$	$\sigma_{i,i+4}$	$\sigma_{i,i+5}$
1	7.53	0.616	0.02	4.00	1.725	1.254	0.33	0.46	0.79	0.53	0.07
2	7.20	0.485	0.05	4.4	1.213	1.825	0.35	0.96	0.64	0.09	
3	6.78	0.044	0.10	4.5	0.108	2.906	0.80	0.55	0.10		
4	7.56	0	0.14	5.25	0	4.53	0.50	0.08			
5	9.86	0	0.16	8.2	0	7.96	0.08				
6	13.	0	0.45	12.0	0	11.45	0.10				
7	14.	0	0.7	14.	0	13.24	0.06				
8	15.	0	2.	15.	0	12.94	0.06				
9	22.	0	11.	22.	0	10.95	0.05				
10	59.	0	50.	59.	0	8.94	0.06				
11	65.	0	56.	65.	0	8.94	0.06				
12	119.	0	110.	119.	0	8.94	0.06				
13	9.4	0	0.4	9.4	0	8.94	0.06				
14	9.55	0	0.55	9.55	0	8.94	0.06				
15	10.0	0	1.00	10.0	0	8.95	0.05				
16	11.44	0	2.44	11.44	0	9.0					

TABLE XIV

Th-232

Group	σ_f	$\sigma_{n,\gamma}$	σ_{tr}	$\nu\sigma_f$	$\sigma_{i\to i}$	$\sigma_{i\to i+1}$	$\sigma_{i\to i+2}$	$\sigma_{i\to i+3}$	$\sigma_{i\to i+4}$	$\sigma_{i\to i+5}$
1	0.16	0.02	4.00	0.384	1.64	0.33	0.46	0.79	0.53	0.07
2	0.10	0.05	4.22	0.230	2.03	0.35	0.96	0.64	0.09	
3	0.009	0.07	4.32	0.021	2.791	0.80	0.55	0.10		
4	0.	0.13	5.04	0.	4.33	0.50	0.08			
5	0.	0.21	7.87	0.	7.58	0.08				
6	0.	0.48	13.48	0.	12.936	0.064				
7	0.	0.60	14.5	0.	13.83	0.07				
8	0.	1.9	14.5	0.	12.536	0.064				
9	0.	18.0	30.	0.	11.94	0.06				
10	0.	18.0	30.	0.	11.915	0.085				
11	0.	40.7	52.7	0.	11.906	0.094				
12	0.	0.5	12.5	0.	11.915	0.085				
13	0.	0.9	12.9	0.	11.906	0.094				
14	0.	1.5	13.5	0.	11.887	0.113				
15	0.	2.7	14.7	0.	11.926	0.074				
16	0.	7.6	19.6	0.	12.0					

TABLE XV

				H^1 ($\frac{dE}{E}$ weighting beyond group 2)							
Group	$\sigma_{tot.}$	σ_c	σ_s^{el}	σ_{tr}^{el}	σ_{tr}	$\sigma_{i\to i}$	$\sigma_{i,i+1}$	$\sigma_{i,i+2}$	$\sigma_{i,i+3}$	$\sigma_{i,i+4}$	$\sigma_{i,i+5}$
1	1.8	0	1.8	0.60	0.60	-0.84	0.769	0.239	0.239	0.144	0.049
2	2.9	0	2.9	0.97	0.97	-0.961	0.690	0.690	0.415	0.116	0.020
3	4.0	0	4.0	1.33	1.33	-1.906	1.796	1.076	0.300	0.052	0.012
4	5.5	0	5.5	1.83	1.83	-1.9375	2.827	0.781	0.132	0.022	0.0055
5	9.0	0	9.0	3.00	3.00	-1.8681	4.041	0.684	0.117	0.0216	0.0045
6	15.6	0	15.6	5.20	5.20	-2.0961	6.022	1.045	0.187	0.0296	0.0125
7	19.	0	19.0	6.33	6.33	-2.6912	7.372	1.349	0.209	0.0608	0.0304
8	20.	0.001	19.999	6.666	6.666	-2.969	7.880	1.220	0.360	0.1220	0.0520
9	20.	0.004	19.996	6.665	6.669	-2.9420	6.719	1.920	0.680	0.1920	0.0960
10	20.	0.008	19.992	6.664	6.672	-4.9798	7.757	2.719	0.780	0.2319	0.1559
11	20.	0.014	19.986	6.662	6.676	-5.4489	8.494	2.418	0.719	0.360	0.1199
12	20.4	0.025	20.375	6.792	6.817	-5.0470	7.906	2.364	1.182	0.387	--
13	20.4	0.045	20.355	6.785	6.830	-5.550	7.409	3.684	1.242	--	--
14	20.4	0.070	20.330	6.777	6.847	-6.539	9.982	3.334	--	--	--
15	20.5	0.130	20.370	6.790	6.920	-4.230	11.020	--	--	--	--
16	20.7	0.29	20.41	6.8	7.09	6.8	--	--	--	--	--

TABLE XVI

Hydrogen Anisotropic Table A ($\frac{dE}{E}$ weighting beyond group 2)

Group	"σ_{tr}"	$\sigma_{i\to i}$	$\sigma_{i\to i+1}$	$\sigma_{i\to i+2}$	$\sigma_{i\to i+3}$	$\sigma_{i\to i+4}$	$\sigma_{i\to i+5}$
1	1.45	0.01	0.769	0.239	0.239	0.144	0.049
2	2.175	0.244	0.69	0.69	0.415	0.116	0.020
3	3.3	0.064	1.796	1.076	0.300	0.052	0.012
4	4.125	0.357	2.827	0.781	0.132	0.022	0.006
5	6.75	1.881	4.041	0.684	0.117	0.022	0.005
6	11.7	4.404	6.022	1.045	0.187	0.030	0.012
7	14.25	5.229	7.372	1.349	0.209	0.061	0.030
8	15.0	5.365	7.880	1.220	0.360	0.122	0.052
9	15.0	5.389	6.719	1.920	0.680	0.192	0.096
10	15.0	3.348	7.757	2.719	0.780	0.232	0.156
11	15.0	2.875	8.494	2.418	0.719	0.360	0.120
12	15.0	3.136	7.906	2.364	1.182	0.387	
13	15.0	2.620	7.409	3.684	1.242		
14	18.0	4.730	9.90	3.30			
15	25.0	19.87	5.00				
16	45.0	44.71					
For 6 gps.							
2	2.175	0.244	0.69	0.69	0.415	0.136	
3	3.3	0.064	1.796	1.076	0.364		
4	4.125	0.357	2.827	0.941			
5	6.75	1.881	4.869				
6	11.7	11.7					

TABLE XVII

Hydrogen Anisotropic Table B ($\frac{dE}{E}$ weighting beyond group 2)

Group	$\sigma_{i\to i}$	$\sigma_{i\to i+1}$	$\sigma_{i\to i+2}$	$\sigma_{i\to i+3}$	$\sigma_{i\to i+4}$	$\sigma_{i\to i+5}$
1	0.015	0.569	0.128	0.096	0.036	0.006
2	0.128	0.511	0.397	0.148	0.020	0.001
3	0.025	1.365	0.507	0.068	0.005	0.000
4	0.181	1.849	0.248	0.016	0.001	0.000
5	1.227	2.356	0.155	0.012	0.001	0.000
6	2.86	3.372	0.248	0.019	0.001	0.000
7	3.417	4.15	0.325	0.023	0.004	0.001
8	3.517	4.444	0.310	0.051	0.010	0.002
9	3.542	3.998	0.637	0.128	0.020	0.006
10	2.18	4.964	0.987	0.158	0.028	0.011
11	1.814	5.445	0.863	0.152	0.045	0.005
12	1.915	5.076	0.896	0.268	0.028	
13	1.594	4.942	1.474	0.160		
14	4.00	6.4	0.6			
15	10.0	2.0				
16	12.0					
For 6 gps.						
2	0.128	0.511	0.397	0.148	0.021	
3	0.025	1.365	0.507	0.073		
4	0.181	1.849	0.265			
5	1.227	2.524				
6	6.50					

TABLE XVIII

H (χ(E) Spectrum weighting)

Group	$\sigma_{tot.}$	σ_c	σ_s^{el}	σ_{tr}^{el}	σ_{tr}	$\sigma_{i\to i}$	$\sigma_{i\to i+1}$	$\sigma_{i\to i+2}$	$\sigma_{i\to i+3}$	$\sigma_{i\to i+4}$	$\sigma_{i\to i+5}$
1	1.83	0	1.83	0.61	0.61	-0.776	0.739	0.231	0.231	0.139	0.046
2	2.85	0	2.85	0.95	0.95	-1.097	.731	.731	.439	.121	.025
3	3.95	0	3.95	1.32	1.32	-1.861	1.767	1.060	.294	.049	.011
4	5.47	0	5.47	1.82	1.82	-1.804	2.718	.752	.127	.022	.005
5	8.78	0	8.78	2.93	2.93	-1.150	3.387	.571	.100	.018	.004
6	15.6	0	15.6	5.20	5.20	-2.0961	6.022	1.045	0.187	0.0296	0.0125
7	19.	0	19.0	6.33	6.33	-2.6912	7.372	1.349	0.209	0.0608	0.0304
8	20.	0.001	19.999	6.666	6.666	-2.969	7.880	1.220	0.360	0.1220	0.0520
9	20.	0.004	19.996	6.665	6.669	-2.9420	6.719	1.920	0.680	0.1920	0.0960
10	20.	0.008	19.992	6.664	6.672	-4.9798	7.757	2.719	0.780	0.2319	0.1559
11	20.	0.014	19.986	6.662	6.676	-5.4489	8.494	2.418	0.719	0.360	0.1199
12	20.4	0.025	20.375	6.792	6.817	-5.0470	7.906	2.364	1.182	0.387	--
13	20.4	0.045	20.355	6.785	6.830	-5.550	7.409	3.684	1.242	--	--
14	20.4	0.070	20.330	6.777	6.847	-6.539	9.982	3.334	--	--	--
15	20.5	0.130	20.370	6.790	6.920	-4.230	11.020	--	--	--	--
16	20.7	0.29	20.41	6.8	7.09	6.8	--	--	--	--	--

TABLE XIX

Hydrogen Anisotropic Table A ($\chi(E)$ Spectrum Weighting)

Group	"σ_{tr}"	$\sigma_{i \to i}$	$\sigma_{i \to i+1}$	$\sigma_{i \to i+2}$	$\sigma_{i \to i+3}$	$\sigma_{i \to i+4}$	$\sigma_{i \to i+5}$
1	1.434	.048	0.739	0.231	0.231	0.139	0.046
2	2.140	.093	.731	.731	.439	.121	.025
3	3.374	.193	1.767	1.060	.294	.049	.011
4	4.103	.479	2.718	0.752	.127	.022	.005
5	6.581	2.501	3.387	.571	.100	.018	.004
6	11.7	4.404	6.022	1.045	0.187	0.030	0.012
7	14.25	5.229	7.372	1.349	0.209	0.061	0.030
8	15.0	5.365	7.880	1.220	0.360	0.122	0.052
9	15.0	5.389	6.719	1.920	0.680	0.192	0.096
10	15.0	3.348	7.757	2.719	0.780	0.232	0.156
11	15.0	2.875	8.494	2.418	0.719	0.360	0.120
12	15.0	3.136	7.906	2.364	1.182	0.387	
13	15.0	2.620	7.409	3.684	1.242		
14	18.0	4.730	9.90	3.30			
15	25.0	19.87	5.00				
16	45.0	44.71					
For 6 gps.							
2	2.175	0.244	0.69	0.69	0.415	0.136	
3	3.3	0.064	1.796	1.076	0.364		
4	4.125	0.357	2.827	0.941			
5	6.75	1.881	4.869				
6	11.7	11.7					

TABLE XX

Hydrogen Anisotropic Table B (χ(E) Spectrum Weighting)

Group	$\sigma_{i \to i}$	$\sigma_{i \to i+1}$	$\sigma_{i \to i+2}$	$\sigma_{i \to i+3}$	$\sigma_{i \to i+4}$	$\sigma_{i \to i+5}$
1	.004	.558	.127	.095	.035	.005
2	.015	.569	.426	.157	.021	.002
3	.140	1.347	.496	.066	.005	.000
4	.279	1.754	.233	.016	.001	.000
5	1.693	1.821	.127	.009	.001	.000
6	2.86	3.372	0.248	0.019	0.001	0.000
7	3.417	4.15	0.325	0.023	0.004	0.001
8	3.517	4.444	0.310	0.051	0.010	0.002
9	3.542	3.998	0.637	0.128	0.020	0.006
10	2.18	4.964	0.987	0.158	0.028	0.011
11	1.814	5.445	0.863	0.152	0.045	0.005
12	1.915	5.076	0.896	0.268	0.028	
13	1.594	4.942	1.474	0.160		
14	4.00	6.4	0.6			
15	10.0	2.0				
16	12.0					
For 6 gps.						
2	0.128	0.511	0.397	0.148	0.021	
3	0.025	1.365	0.507	0.073		
4	0.181	1.849	0.265			
5	1.227	2.524				
6	6.50					

TABLE XXI

Group	$\sigma_{tot.}$	σ_c	σ_s^{el}	σ_{tr}^{el}	σ_{tr}	$\sigma_{i\to i}$	$\sigma_{i\to i+1}$	$\sigma_{i\to i+2}$	$\sigma_{i\to i+3}$	$\sigma_{i\to i+4}$
				D (χ(E) Spectrum Weighting)						
1	1.903	0	1.903	1.077	1.077	0.093	0.540	0.200	0.270	0.011
2	2.543	0	2.543	1.623	1.623	0.120	0.535	0.633	0.335	
3	2.894	0	2.894	2.033	2.033	-0.073	1.142	0.964		
4	3.113	0	3.113	2.321	2.321	0.283	1.826	0.212		
5	3.287	0	3.287	2.405	2.405	1.057	1.336	0.012		
6	3.4	0	3.4	2.27	2.27	0.903	1.336	.031		
7	3.4	0	3.4	2.27	2.27	.880	1.353	.037		
8	3.4	0	3.4	2.27	2.27	.853	1.380	.037		
9	3.4	0	3.4	2.27	2.27	.859	1.234	.177		
10	3.4	0	3.4	2.27	2.27	.472	1.482	.316		
11	3.4	0	3.4	2.27	2.27	.373	1.625	.272		
12	3.4	0	3.4	2.27	2.27	.472	1.482	.309	.007	
13	3.4	0	3.4	2.27	2.27	.373	1.625	.272		
14	3.4	.0001	3.3999	2.267	2.2671	.186	1.877	.204		
15	3.4	.00016	3.39984	2.267	2.26716	.621	1.646			
16	3.4	.0004	3.3996	2.267	2.2674	2.267				
1/E Spectrum, Grps. 4 & 5										
4	3.119	0	3.119	2.473	2.473	0.319	1.903	0.251		
5	3.290	0	3.290	2.382	2.382	0.695	1.660	0.027		

TABLE XXII

D Anisotropic Table A (χ(E) Spectrum Weighting)

Group	"σ_{tr}"	$\sigma_{i\to i}$	$\sigma_{i\to i+1}$	$\sigma_{i\to i+2}$	$\sigma_{i\to i+3}$	$\sigma_{i\to i+4}$
1	1.332	.348	0.540	0.200	0.270	0.011
2	2.062	.559	.535	.633	.335	
3	2.645	.539	1.142	.964		
4	3.083	1.045	1.826	.212		
5	3.278	1.930	1.336	.012		
6	3.223	1.856	1.336	.031		
7	3.223	1.833	1.353	.037		
8	3.223	1.806	1.380	.037		
9	3.223	1.812	1.234	.177		
10	3.223	1.425	1.482	.316		
11	3.223	1.326	1.625	.272		
12	3.223	1.425	1.482	.309	.007	
13	3.223	1.326	1.625	.272		
14	3.2231	1.142	1.877	.204		
15	3.55756	1.7634	1.794			
16	4.4920	4.4916				
1/E Spectrum						
4	3.095	0.941	1.903	0.251		
5	3.269	1.582	1.660	0.027		

TABLE XXIII

D Anisotropic Table B (χ(E) Spectrum Weighting)

Group	$\sigma_{i\to i}$	$\sigma_{i\to i+1}$	$\sigma_{i\to i+2}$	$\sigma_{i\to i+3}$	$\sigma_{i\to i+4}$
1	.160	0.275	-.031	-.148	-.001
2	.398	.287	-.046	-.200	
3	.456	.508	-.352		
4	.760	.138	-.136		
5	1.091	-.210	-.008		
6	1.019	-.041	-.025		
7	1.016	-.033	-.030		
8	1.013	-.030	-.030		
9	1.014	+.051	-.112		
10	.932	+.208	-.187		
11	.898	+.228	-.173		
12	.929	.208	-.179	-.005	
13	.889	.325	-.261		
14	.823	.277	-.144		
15	.8177	.10752			
16	.8073				
1/E Spectrum					
4	0.547	0.233	-0.158		
5	0.969	-0.064	-0.018		

TABLE XXIV

Li^6

Group	$\sigma_{tot.}$	σ_c	σ_s^{in}	σ_s^{el}	σ_{tr}^{el}	σ_{tr}	$\sigma_{i\to i}$	$\sigma_{i,i+1}$	$\sigma_{i,i+2}$
1	2.00	0.11	-	1.89	0.92	1.03	0.434	0.486	
2	1.50	0.23	-	1.27	0.77	1.00	0.438	0.298	0.034
3	1.40	0.26	0	1.14	0.86	1.12	0.270	0.590	
4	1.90	0.50	0	1.40	1.20	1.70	0.702	0.498	
5	4.95	1.95	0	3.00	2.52	4.47	1.909	0.611	
6	1.75	0.85	0	0.9	0.80	1.65	0.648	0.152	
7	2.5	1.4	0	0.9	0.80	2.2	0.645	0.155	
8	5.2	4.3	0	0.9	0.80	5.1	0.642	0.158	
9	10.6	9.7	0	0.9	0.80	10.5	0.642	0.158	
10	20.8	19.9	0	0.9	0.80	20.7	0.577	0.223	
11	35.5	34.6	0	0.9	0.80	35.4	0.555	0.245	
12	61.	60.1	0	0.9	0.80	60.9	0.577	0.223	
13	110.	109.1	0	0.9	0.80	109.9	0.555	0.245	
14	172.	171.1	0	0.9	0.80	171.9	0.507	0.293	
15	310.	309.1	0	0.9	0.80	309.9	0.606	0.194	
16	838.	837.1	0	0.9	0.80	837.9	0.800		

TABLE XXV

				Li^7					
Group	$\sigma_{tot.}$	σ_c	σ_s^{in}	σ_s^{el}	σ_{tr}^{el}	σ_{tr}	$\sigma_{i \to i}$	$\sigma_{i,i+1}$	$\sigma_{i,i+2}$
1	2.19	-	-	2.19	1.10	1.10	0.43	0.67	
2	1.76	0	0.09	1.67	1.05	1.14	0.67	0.45	0.02
3	1.55	0	0.18	1.37	1.06	1.24	0.41	0.83	
4	1.27	0	0.04	1.23	1.07	1.11	0.692	0.416	0.002
5	3.50	0	0	3.50	2.99	2.99	2.37	0.62	
6	1.04	0	0	1.04	0.94	0.94	0.79	0.15	
7	1.07	0	0	1.07	0.97	0.97	0.81	0.16	
8	1.07	0	0	1.07	0.97	0.97	0.81	0.16	
9	1.07	0	0	1.07	0.97	0.97	0.81	0.16	
10	1.07	0.001	0	1.069	0.967	0.968	0.736	0.231	
11	1.07	0.001	0	1.069	0.967	0.968	0.714	0.253	
12	1.07	0.002	0	1.068	0.966	0.968	0.735	0.231	
13	1.07	0.004	0	1.066	0.965	0.969	0.712	0.253	
14	1.07	0.006	0	1.064	0.963	0.969	0.661	0.302	
15	1.07	0.012	0	1.058	0.957	0.969	0.758	0.199	
16	1.07	0.029	0	1.041	0.938	0.967	0.938		

TABLE XXVI

			5^B (natural)				
Group	σ_t	σ_c	σ_s^{el}	σ_{tr}^{el}	σ_{tr}	$\sigma_{i \to i}$	$\sigma_{i \to i+1}$
1	1.6	0.04	1.56	1.48	1.52	0.81	0.67
2	1.9	0.06	1.84	1.73	1.79	1.31	0.42
3	2.4	0.04	2.36	2.10	2.14	1.22	0.88
4	2.8	0.08	2.72	2.19	2.27	1.69	0.50
5	3.6	0.27	3.33	2.89	3.16	2.51	0.38
6	4.31	0.61	3.7	3.47	4.08	3.11	0.36
7	5.2	1.5	3.7	3.47	4.97	3.10	0.37
8	7.1	3.4	3.7	3.47	6.87	3.09	0.38
9	11.7	8.0	3.7	3.47	11.47	3.09	0.38
10	20.1	16.4	3.7	3.47	19.87	2.94	0.53
11	32.7	29	3.7	3.47	32.47	2.89	0.58
12	55.7	52	3.7	3.47	55.47	2.94	0.53
13	95.7	92	3.7	3.47	95.47	2.89	0.58
14	154.7	151	3.7	3.47	154.47	2.77	0.70
15	276.7	273	3.7	3.47	276.47	3.01	0.46
16	673	669.3	3.7	3.47	672.77	3.47	--

TABLE XXVII

Be^9

Group	σ_t	σ_c	σ_s^{el}	$\sigma_{n,2n}$	σ_{tr}^{el}	σ_{tr}	$\sigma_{i,i}$	$\sigma_{i,i+1}$	$\sigma_{i,i+2}$
1	2.1	0.041	1.709	0.35	0.90	1.291	0.432	0.818	0.35
2	2.2	0.032	2.048	0.12	1.323	1.475	0.934	0.509	0.12
3	3.0	0	3.0	0	2.38	2.38	1.173	1.207	
4	3.7	0	3.7	0	3.31	3.31	2.397	0.913	
5	4.5	0	4.5	0	3.94	3.94	3.306	0.634	
6	5.6	0	5.6	0	5.18	5.18	4.525	0.655	
7	5.7	0	5.7	0	5.28	5.28	4.60	0.68	
8	5.8	0	5.8	0	5.37	5.37	4.66	0.71	
9	5.85	0	5.85	0	5.42	5.42	4.71	0.71	
10	5.9	0	5.9	0	5.46	5.46	4.45	1.01	
11	5.9	0	5.9	0	5.46	5.46	4.35	1.11	
12	5.9	0	5.9	0	5.46	5.46	4.45	1.01	
13	5.9	0.001	5.899	0	5.46	5.46	4.349	1.11	
14	5.9	0.002	5.898	0	5.46	5.46	4.128	1.33	
15	5.9	0.004	5.896	0	5.46	5.46	4.576	0.88	
16	6.01	0.009	6.00	0	5.56	5.569	5.56		

TABLE XXVIII

Group	σ_t	σ_c	C^{12} σ_s^{el}	σ_{tr}	$\sigma_{i,i}$	$\sigma_{i,i+1}$
1	1.65	0	1.65	1.23	0.715	0.515
2	1.9	0	1.9	1.42	1.106	0.314
3	2.5	0	2.5	2.26	1.404	0.856
4	3.1	0	3.1	2.93	2.326	0.604
5	3.8	0	3.8	3.59	3.157	0.433
6	4.5	0	4.5	4.25	3.849	0.401
7	4.7	0	4.7	4.44	4.012	0.428
8	4.6	0	4.6	4.34	3.912	0.428
9	4.6	0	4.6	4.34	3.912	0.428
10	4.6	0	4.6	4.34	3.737	0.603
11	4.6	0	4.6	4.34	3.678	0.662
12	4.7	0	4.7	4.44	3.824	0.616
13	4.7	0	4.7	4.44	3.763	0.677
14	4.7	0	4.7	4.44	3.627	0.813
15	4.7	0.001	4.699	4.44	3.903	0.536
16	4.7	0.003	4.697	4.44	4.437	

TABLE XXIX

			$_7N$				
Group	σ_t	σ_c	σ_s^{el}	σ_{tr}^{el}	σ_{tr}	$\sigma_{i\rightarrow i}$	$\sigma_{i\rightarrow i+1}$
1	1.68	0.25	1.43	0.72	0.97	0.39	0.33
2	1.82	0.11	1.71	1.37	1.48	1.01	0.36
3	1.92	0.04	1.88	1.65	1.69	1.20	0.45
4	2.28	0.04	2.24	2.13	2.17	1.78	0.35
5	3.46	0.002	3.458	3.292	3.294	3.122	0.17
6	5.71	0.002	5.708	5.434	5.436	4.994	0.44
7	7.73	0.004	7.726	7.355	7.359	6.745	0.61
8	8.50	0.008	8.492	8.084	8.092	7.404	0.68
9	8.92	0.019	8.901	8.474	8.493	7.764	0.71
10	9.80	0.04	9.76	9.29	9.33	8.18	1.11
11	10.07	0.07	10.0	9.52	9.59	8.28	1.24
12	10.12	0.12	10.0	9.52	9.64	8.38	1.14
13	10.22	0.22	10.0	9.52	9.74	8.28	1.24
14	10.36	0.36	10.0	9.52	9.88	8.03	1.49
15	10.64	0.64	10.0	9.52	10.16	8.53	0.99
16	11.67	1.67	10.0	9.52	11.19	9.52	--

TABLE XXX

				O^{16}				
Group	$\sigma_{tot.}$	σ_c	σ_s^{in}	σ_s^{el}	σ_{tr}^{el}	σ_{tr}	$\sigma_{i,i}$	$\sigma_{i,i+1}$
1	1.9	0.040	0	1.86	1.29	1.33	0.866	0.424
2	1.7	0	0	1.7	1.18	1.18	0.989	0.191
3	4.5	0	0	4.5	3.23	3.23	2.328	0.902
4	4.5	0	0	4.5	3.63	3.63	3.074	0.556
5	3.8	0	0	3.8	3.71	3.71	3.373	0.337
6	3.4	0	0	3.4	3.26	3.26	3.029	0.231
7	3.7	0	0	3.7	3.55	3.55	3.295	0.255
8	3.8	0	0	3.8	3.64	3.64	3.370	0.270
9	3.8	0	0	3.8	3.64	3.64	3.370	0.270
10	3.8	0	0	3.8	3.64	3.64	3.260	0.380
11	3.8	0	0	3.8	3.64	3.64	3.226	0.414
12	3.8	0	0	3.8	3.64	3.64	3.260	0.380
13	3.8	0	0	3.8	3.64	3.64	3.226	0.414
14	3.8	0	0	3.8	3.64	3.64	3.142	0.498
15	3.8	0	0	3.8	3.64	3.64	3.309	0.331
16	3.8	0.0002	0	3.7998	3.641	3.6412	3.641	--

TABLE XXXI

Group	σ_t	σ_c	σ_s^{in}	σ_s^{el}	σ_{tr}^{el}	F^{19} σ_{tr}	$\sigma_{i,i}$	$\sigma_{i,i+1}$	$\sigma_{i,i+2}$	$\sigma_{i,i+3}$
1	1.9	0.10	0.4	1.4	0.9	1.4	0.88	0.42		
2	2.4	0	0.9	1.5	1.0	1.9	1.28	0.32	0.21	0.09
3	2.5	0	1.0	1.5	1.09	2.09	1.41	0.68		
4	4.0	0.0002	1.6	2.4	1.60	3.2002	2.14	1.06		
5	5.3	0.0002	1.8	3.5	2.81	4.6102	3.953	0.65	0.007	
6	4.2	0	0	4.2	3.78	3.78	3.53	0.25		
7	3.7	0	0	3.7	3.57	3.57	3.36	0.21		
8	3.7	0	0	3.7	3.57	3.57	3.35	0.22		
9	3.6	0	0	3.6	3.47	3.47	3.25	0.22		
10	3.4	0	0	3.4	3.28	3.28	2.99	0.29		
11	3.1	0	0	3.1	2.99	2.99	2.71	0.28		
12	3.3	0	0	3.3	3.18	3.18	2.90	0.28		
13	3.4	0.001	0	3.339	3.28	3.281	2.97	0.31		
14	3.4	0.002	0	3.338	3.28	3.282	2.91	0.37		
15	3.6	0.004	0	3.596	3.47	3.474	3.21	0.26		
16	3.6	0.008	0	3.592	3.46	3.468	3.46			

TABLE XXXII

					Na^{23}					
Group	$\sigma_{tot.}$	σ_c	σ_s^{in}	σ_s^{el}	σ_{tr}^{el}	σ_{tr}	$\sigma_{i\to i}$	$\sigma_{i\to i+1}$	$\sigma_{i\to i+2}$	$\sigma_{i\to i+3}$
1	2.3	0.030	0.143	2.127	1.434	1.607	1.137	0.440		
2	2.5	0	0.963	1.537	1.297	2.260	1.704	0.556		
3	3.2	0.0002	0.869	2.3308	2.121	2.9902	1.799	1.191		
4	3.2	0.0005	0.420	2.78	2.70	3.1194	2.4709	0.604	0.036	0.008
5	3.2	0.0009	0	3.20	3.11	3.1072	2.9113	0.195	(1×10^{-8})	
6	4.0	0.001	0	4.0	3.88	3.884	3.695	0.188		
7	6.28	0.001	0	6.27	6.088	6.089	5.787	0.301		
8	4.69	0.001	0	4.68	4.544	4.545	4.310	0.234		
9	3.10	0.005	0	3.095	3.005	3.010	2.850	0.155		
10	3.10	0.011	0	3.089	2.999	3.010	2.783	0.216		
11	3.12	0.018	0	3.102	3.012	3.030	2.776	0.236		
12	3.16	0.032	0	3.128	3.037	3.069	2.818	0.219		
13	3.19	0.057	0	3.133	3.042	3.099	2.804	0.238		
14	3.30	0.10	0	3.20	3.11	3.21	2.816	0.294		
15	3.44	0.19	0	3.25	3.16	3.35	2.962	0.198		
16	3.85	0.447	0	3.4	3.3	3.747	3.30			

TABLE XXXIII

					Al^{27}					
Group	$\sigma_{tot.}$	σ_c	σ_s^{in}	σ_s^{el}	σ_{tr}^{el}	σ_{tr}	$\sigma_{i,i}$	$\sigma_{i,i+1}$	$\sigma_{i,i+2}$	$\sigma_{i,i+3}$
1	2.4	0.0159	0.7	1.68	1.09	1.8059	1.10	0.56	0.10	0.03
2	2.94	0.00035	0.3	2.64	1.722	2.02235	1.662	0.23	0.11	0.02
3	2.97	0.00038	0.2	2.77	1.94	2.14038	1.61	0.38	0.14	0.01
4	3.63	0.0007	0	3.63	2.72	2.7207	2.47	0.25		
5	3.33	0.002	0	3.33	2.83	2.832	2.69	0.14	($\sigma_{2\to 6}$ = 0.0009)	
6	1.5	0.005	0	1.50	1.43	1.435	1.36	0.07		
7	1.5	0.002	0	1.498	1.461	1.463	1.398	0.063		
8	1.4	0.001	0	1.399	1.364	1.365	1.304	0.060		
9	1.4	0.003	0	1.397	1.363	1.366	1.303	0.060		
10	1.4	0.006	0	1.394	1.360	1.366	1.276	0.084		
11	1.4	0.010	0	1.390	1.356	1.366	1.264	0.092		
12	1.42	0.017	0	1.403	1.368	1.385	1.284	0.084		
13	1.45	0.03	0	1.42	1.38	1.41	1.286	0.094		
14	1.5	0.05	0	1.45	1.41	1.46	1.295	0.115		
15	1.5	0.08	0	1.42	1.38	1.46	1.306	0.074		
16	1.6	0.20	0	1.4	1.36	1.56	1.36	--		

TABLE XXXIV

Group	σ_t	σ_a	^{17}Cl σ_s^{el}	σ_{tr}^{el}	σ_{tr}	$\sigma_{i\to i}$	$\sigma_{i\to i+1}$
1	2.95	0.06	2.89	1.59	1.65	1.417	0.173
2	2.97	0	2.97	1.66	1.66	1.557	.103
3	2.40	0	2.40	1.52	1.52	1.368	.152
4	2.30	0	2.30	1.66	1.66	1.586	.074
5	2.30	0	2.30	2.02	2.02	1.992	.028
6	3.47	0	3.47	3.40	3.40	3.291	.109
7	1.80	0	1.80	1.77	1.77	1.713	.057
8	1.95	0.002	1.95	1.91	1.912	1.846	.064
9	4.36	0.05	4.31	4.23	4.28	4.047	.183
10	10.01	0.39	9.62	9.44	9.83	8.997	.443
11	13.78	0.98	12.8	12.56	13.54	11.915	.645
12	17.40	2.10	15.3	15.01	17.11	14.306	.704
13	19.52	3.82	15.7	15.40	19.22	14.609	.791
14	22.77	6.77	16.0	15.70	22.47	14.732	.968
15	28.3	12.1	16.0	15.70	27.80	15.052	.648
16	46	30	16.0	15.70	45.7	15.7	--

TABLE XXXV

			^{19}K				
Group	$\sigma_{tot.}$	σ_c	σ_s^{el}	σ_{tr}^{el}	σ_{tr}	$\sigma_{i\to i}$	$\sigma_{i\to i+1}$
1	3.1	0	3.1	2.11	2.11	1.795	0.315
2	3.2	0	3.2	2.22	2.22	2.071	0.149
3	2.3	0	2.3	1.69	1.69	1.495	0.195
4	2.15	0	2.15	1.84	1.84	1.724	0.116
5	2.0	0	2.0	1.97	1.97	1.898	0.072
6	1.90	0.001	1.899	1.866	1.867	1.813	0.053
7	1.45	0.003	1.447	1.422	1.425	1.380	0.042
8	1.55	0.008	1.542	1.515	1.523	1.470	0.045
9	1.73	0.017	1.713	1.683	1.700	1.633	0.050
10	1.90	0.038	1.862	1.830	1.868	1.752	0.078
11	2.0	0.068	1.932	1.898	1.966	1.809	0.089
12	2.15	0.12	2.03	1.99	2.11	1.905	0.085
13	2.3	0.21	2.09	2.05	2.26	1.954	0.096
14	2.4	0.36	2.04	2.00	2.36	1.888	0.112
15	2.7	0.61	2.09	2.05	2.66	1.975	0.075
16	4.04	1.75	2.29	2.25	4.00	2.25	

TABLE XXXVI

$_{26}Fe$

Group	σ_t	σ_c	σ_s^{el}	σ_s^{in}	σ_{tr}^{el}	σ_{tr}	$\sigma_{i\rightarrow i}$	$\sigma_{i\rightarrow i+1}$	$\sigma_{i\rightarrow i+2}$	$\sigma_{i\rightarrow i+3}$
1	3.5	0.007	2.243	1.25	0.99	2.247	1.44	0.5	0.2	0.1
2	2.9	0.005	2.05	0.845	1.35	2.20	1.495	0.4	0.2	0.1
3	2.34	0.010	1.89	0.44	1.51	1.96	1.47	0.23	0.23	0.02
4	2.85	0.010	2.84	0	2.28	2.29	2.157	0.123	(1×10^{-8})	
5	2.7	0.010	2.69	0	2.43	2.44	2.359	0.071		
6	2.34	0.010	2.33	0	2.22	2.23	2.17	0.05		
7	5.75	0.010	5.74	0	5.64	5.65	5.52	0.120		
8	7.2	0.011	7.189	0	7.103	7.114	6.952	0.151		
9	11.1	0.027	11.073	0	10.941	10.968	10.708	0.233		
10	11.5	0.055	11.445	0	11.309	11.364	10.977	0.332		
11	11.5	0.098	11.402	0	11.266	11.364	10.901	0.365		
12	11.5	0.17	11.33	0	11.20	11.37	10.871	0.329		
13	11.5	0.31	11.19	0	11.06	11.37	10.702	0.358		
14	11.5	0.51	10.99	0	10.86	11.37	10.431	0.429		
15	11.7	0.91	10.79	0	10.66	11.57	10.390	0.270		
16	13.2	2.24	10.96	0	10.8	13.04	10.8	--		

TABLE XXXVII

$_{28}Ni$

Group	σ_t	σ_c	σ_s^{in}	σ_s^{el}	σ_{tr}^{el}	σ_{tr}	$\sigma_{i\to i}$	$\sigma_{i\to i+1}$	$\sigma_{i\to i+2}$	$\sigma_{i\to i+3}$
1	3.4	0.27	1.15	1.98	0.87	2.29	1.22	0.5	0.2	0.1
2	3.2	0.10	0.72	2.38	1.52	2.34	1.64	0.3	0.2	0.1
3	3.2	0.01	0.1	3.09	2.42	2.53	2.22	0.25	0.05	
4	3.1	0.01	0	3.05	2.44	2.45	2.34	0.10		
5	3.8	0.01	0	3.74	3.37	3.38	3.29	0.08		
6	5.4	0.02	0	5.42	5.15	5.17	5.05	0.10		
7	14.8	0.38	0	14.42	14.2	14.58	13.91	0.29		
8	15.9	0.04	0	15.82	15.64	15.68	15.32	0.32		
9	16.9	0.05	0	16.82	16.63	16.68	16.30	0.33		
10	16.9	0.10	0	16.82	16.63	16.73	16.16	0.47		
11	17.5	0.18	0	17.32	17.12	17.30	16.59	0.53		
12	17.5	0.31	0	17.19	17.00	17.31	16.52	0.48		
13	17.7	0.56	0	17.14	16.95	17.51	16.42	0.53		
14	18.4	0.94	0	17.46	17.26	18.20	16.62	0.64		
15	19.2	1.6	0	17.60	17.40	19.00	16.97	0.43		
16	21.4	4.6	0	16.8	16.61	21.21	16.61	—		

TABLE XXXVIII

$_{40}Zr$

Group	$\sigma_{tot.}$	σ_c	σ_s^{el}	σ_s^{in}	σ_{tr}^{el}	σ_{tr}	$\sigma_{i\to i}$	$\sigma_{i\to i+1}$	$\sigma_{i\to i+2}$	$\sigma_{i\to i+3}$
1	4.0	0.003	2.44	1.56	1.04	2.60	1.497	0.6	0.3	0.2
2	4.6	0.005	3.73	0.87	2.23	3.10	2.395	0.4	0.2	0.1
3	5.9	0.007	5.66	0.23	3.60	3.84	3.343	0.30	0.15	0.04
4	7.8	0.012	7.79	0	6.20	6.21	5.978	0.22		
5	8.0	0.015	7.99	0	7.20	7.21	7.060	0.135		
6	8.0	0.015	7.99	0	7.90	7.91	7.788	0.107		
7	7.7	0.015	7.685	0	7.629	7.644	7.533	0.096		
8	6.6	0.015	6.585	0	6.537	6.552	6.453	0.084		
9	6.4	0.015	6.385	0	6.338	6.353	6.257	0.081		
10	6.2	0.015	6.185	0	6.140	6.155	6.028	0.112		
11	6.2	0.015	6.185	0	6.140	6.155	6.018	0.122		
12	6.2	0.015	6.185	0	6.140	6.155	6.029	0.111		
13	6.2	0.022	6.178	0	6.133	6.155	6.011	0.122		
14	6.2	0.036	6.164	0	6.119	6.155	5.973	0.146		
15	6.2	0.065	6.135	0	6.090	6.155	5.994	0.096		
16	6.2	0.159	6.041	0	5.997	6.156	5.997			

TABLE XXXIX

$_{41}Nb$

ΔE	Group	$\sigma_{tot.}$	σ_c	σ_s^{in}	σ_s^{el}	σ_{tr}	$\sigma_{i\to i}$	$\sigma_{i\to i+1}$	$\sigma_{i\to i+2}$	$\sigma_{i\to i+3}$
3 Mev-∞	1	3.9	0.01	1.4	2.5	2.4	1.39	0.5	0.3	0.2
1.4-3 Mev	2	4.9	0.02	0.9	4.0	2.9	2.13	0.4	0.25	0.1
0.9-1.4 Mev	3	6.4	0.04	0.2	6.2	3.9	3.46	0.30	0.1	
0.4-0.9	4	7.8	0.05	0.	7.8	6.2	5.95	0.20		
0.1-0.4	5	8.8	0.08	0.	8.7	8.2	7.99	0.13		
17-110 Kev	6	8.0	0.4	0.	7.6	8.0	7.50	0.10		
3-17	7	7.2	1.2	0.	6.0	7.2	5.92	0.08		
0.55-3	8	8.6	2.6	0.	6.0	8.6	5.92	0.08		
100-550 ev	9	8.8	2.8	0.	6.0	8.8	5.92	0.08		
30-100	10	6.4	0.4	0.	6.0	6.4	5.90	0.10		
10-30	11	6.0	0.02	0.	6.0	6.0	5.88	0.10		
3-10	12	6.0	0.04	0.	6.0	6.0	5.86	0.10		
1-3	13	6.1	0.06	0.	6.0	6.1	5.93	0.11		
0.4-1	14	6.1	0.10	0.	6.0	6.1	5.86	0.14		
0.1-0.4	15	6.4	0.37	0.	6.0	6.4	5.94	0.09		
Th.	16	7.0	1.02	0.	6.0	7.0	5.98			

TABLE XL

$_{42}$Mo

ΔE	Group	$\sigma_{tot.}$	σ_c	σ_s^{in}	σ_s^{el}	σ_{tr}	$\sigma_{i\to i}$	$\sigma_{i\to i+1}$	$\sigma_{i\to i+2}$	$\sigma_{i\to i+3}$
3 Mev-∞	1	3.9	0.01	1.4	2.5	2.4	1.39	0.5	0.3	0.2
1.4-3 Mev	2	4.9	0.02	0.9	4.0	2.9	2.13	0.4	0.25	0.1
0.9-1.4 Mev	3	6.4	0.04	0.2	6.2	3.9	3.46	0.3	0.1	
0.4-0.9	4	7.8	0.07	0.	7.8	6.2	5.93	0.20		
0.1-0.4	5	8.8	0.09	0.	8.7	8.2	7.98	0.13		
17-110 Kev	6	8.0	0.17	0.	7.8	7.9	7.63	0.10		
3-17	7	7.1	0.4	0.	6.7	7.1	6.62	0.08		
0.55-3	8	8.1	1.5	0.	6.6	8.05	6.47	0.08		
100-550 ev	9	9.2	2.9	0.	6.3	9.16	6.18	0.08		
30-100	10	19.4	13.4	0.	6.0	19.36	5.86	0.10		
10-30	11	5.6	0.05	0.	5.55	5.56	5.41	0.10		
3-10	12	5.7	0.08	0.	5.62	5.66	5.48	0.10		
1-3	13	6.0	0.15	0.	5.85	5.96	5.70	0.11		
0.4-1	14	6.5	0.25	0.	6.25	6.46	6.07	0.14		
0.1-0.4	15	6.7	0.90	0.	5.80	6.66	5.67	0.09		
Th.	16	7.6	2.50	0.	5.10	7.56	5.06			