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THE LIPAR-5 RESONANCE PARAMETER LIBRARY

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ABSTRACT

The LIPAR-5 neutron resolved resonance parameter library has been elaborated. It contains data for 94 isotopes. The author's evaluations are included in LIPAR. Other authors' results are also included after re-evaluation. The codes used for the evaluation are described briefly. Tables of results are included for every isotope: the boundaries of the resolved resonance region, the numbers of s- and p-resonances, the thermal neutron partial cross-sections and the resonance integrals. The parameters are presented in ENDF/B-6 format. LIPAR is part of the nuclear data library of the MCU Monte Carlo code for neutron transport calculations. LIPAR was verified by comparing the benchmark experiment and Monte Carlo calculation results.

Introduction

Work began on the creation of the LIPAR (LIbrary PARameters) neutron resonance parameter library 15 years ago. Initially [Te78][1], it included parameters for 26 isotopes taken from an American evaluation [Mu73], and parameters for 7 isotopes from original work: [Ra76] ($^{153}_{63}$Eu), [Ka77] ($^{175}_{71}$Lu), [Ko74] ($^{239}_{94}$Pu), [Ko76] ($^{240}_{94}$Pu), [Sa72] ($^{233}_{92}$U and $^{235}_{92}$U) and [Ni78] ($^{238}_{92}$U).

1 The references in this article are given in a non-standard format at the request of the author.

In recent years the LIPAR library [Ab94-5, Ab93] has been constantly extended to include both parameters for new isotopes and re-evaluated parameters for isotopes already in the library. At present, the LIPAR-5 library includes resonance parameters for 94 isotopes a list of which is given in Table 1. The table also gives information on the source from which the resonance parameters were taken and the date they were entered in the LIPAR-5 library. For comparison, we also thought it useful to give information on the most widely used and complete library ENDF/B-6 [Ro91].

From Table 1 it is clear that the resonance parameters from the ENDF/B-6 evaluation were adopted without changes for only 5 nuclei, and for 12 nuclei the parameters from the compilations [Mu81] and [Mu84] were accepted. For the remaining 77 nuclei, the resonance parameters were partially or completely reviewed by the author. Not all the results of my own evaluations have been published. Table 1 includes comments on the nature of the main changes made to particular evaluations.

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Presentation format for resonance parameters in the LIPAR library

Originally, the data in the LIPAR library were notated in SOKRATOR [Ko72] format. When evaluating resonance parameters, this format has several advantages over the ENDF/B [Ro92-2] format:

(a) The resolved resonances are arranged in order of increasing resonance energy (E_0). The energy of each subsequent resonance is larger than the preceding resonance irrespective of the orbital momentum value (l) assigned to them. In the ENDF/B format, the resonances are arranged by system where $l = 0$ and $l = 1$. For evaluations this is awkward since, in the majority of cases, a specific value of l can only be attributed to resonances after analysis, e.g using the BAYES program (see below);

(b) In the SOKRATOR format, any combination of the statistical weight (g), the neutron width (Γ_n) or the reduced neutron width (Γ_n^l) is given for the resonances, depending on what the scientists performing the experiments give. In the ENDF/B format only Γ_n must be given;

(c) In the SOKRATOR format, the total resonance width (Γ), which is always equal to the sum of the partial widths (Γ_n, Γ_γ and Γ_f), need not be given.

Consequently, for the purposes of parameter evaluation the data was, as a rule, notated in the SOKRATOR format. When the evaluation was complete, the recommended parameters were converted into a format which is close to the ENDF/B format using programs specially written for that purpose (see below).

The format of LIPAR-3, which forms part of the MCU-2 package [Ma91], was determined by the processing programs in the CROSS package [Ab85], [Ab84-2]. It is similar to the ENDF/B-6 library format but not identical. Thus, in order to calculate the cross-sections at an energy point using the CROSS program and the resonance parameters from the ENDF/B-6 constants library, a series of changes must be made.

A list is given below of the main differences between the LIPAR-3 and ENDF/B-6 formats:

| |

1. The ENDF/B format does not have the start card with the four-character name of the isotope required for the CROSS package;

2. The LIPAR-3 library contains more data than ENDF/B-6:

   (a) The option is available of including the following in the calculation in the resonance region of the background: "1/v" for σ_c and σ_f and "const" for the scattering cross-section σ_e. The background is given in the form of three normalized coefficients in the file line (MF = 1, MT = 451 p/k 7). In the ENDF/B-6 format, this is available (in a more unwieldy form) via the table of cross-sections relative to energy (MF = 3; MT = 2, 18, 102 for scattering, fission and capture respectively);

   (b) The header section (MF = 1, MT = 451, p/k 8, 9, 10 ...) contains a small table (N, l, J, g, NRDI, NREG) where N is the number of the state with a given orbital momentum (l) and a compound nucleus spin (J), the statistical weight (g) and the NRDI and NREG resonance numbers for each state (l, J). Here, NRDI is the maximum number of resonances which must be taken into account when calculating cross-sections in Breit-Wigner formalism to the left and right of the resonance under consideration. (In programs which process parameters from the ENDF/B-6 library all the resonances are totalled.) The time required to calculate cross-sections from the resonance parameters is sensitive to the NRDI number. NREG is the number of resonances which must be taken into account when calculating the interference terms in Breit-Wigner formalism. The NREG value affects the calculation speed hardly at all. In some instances (W183 and W186 [Ab83]) when the interference is strong, the scattering cross-section becomes sensitive to this parameter. By varying NREG, the background in the scattering cross-section can be compensated. In the LIPAR-3 library, the NRDI and NREG parameters were used when fitting the thermal cross-sections to the experiment for some isotopes;

3. In the ENDF/B-6 format, the total cross-section can be calculated independently (and not from the balance) using the tables (MF = 3, MT = 001). Using this approach, there is a possibility of imbalance in the cross-sections in the library. The CROSS program does not accept information on this section and the total cross-section in Breit-Wigner formalism (both single level (SLBW) and multilevel (MLBW)) is obtained as the sum of the partial cross-sections (MF = 3, MT = 2, 18, 102...);

4. In the LIPAR-3 library, the numbers of realizable formalisms (LRF) are LRF = 1 for the SLBW formula, 2 or 4 for MLBW, and LRF = 5 for the calculation of the capture and fission cross-sections (LI = 6) in the Adler-Adler (A-A) approximation (for more details see [Ab84-2]). It should be noted that the A-A parameters themselves in the LIPAR-3 and ENDF/B-6 libraries differ by the normalization multiplier. The LRF values in the

ENDF/B-6 library do not coincide with LIPAR-3. Moreover, in the ENDF/B-6 library Reich-Moore (R-M) formalism is applied (LRF = 3) and there is scope for the use of other formalisms (LRF = 5 and 6).

In the present version of the library (LIPAR-5), the format has been brought as close as possible to ENDF/B-6. The differences relate to the data which has been retained from LIPAR-3 which is not in ENDF/B-6. This means the start card, the information on the background, and the table of states of resolved resonances (see points 1 and 2 above). In addition, in the header section (MF = 1 and MT = 451) of the LIPAR-5 library information has been included on the EHr and Emax energies (see Section 3).

Programs for evaluating resonance parameters and calculating cross-sections

Some special programs have been written to convert the resonance parameters from one format to another. The MNSOK program converts parameters notated in SOKRATOR format into LIPAR-3 format. The TRA program converts the resonance parameters in the files of the ENDF/B-6 library into the format of the LIPAR-3 library. After conversion, the cross-sections at a given energy point can be calculated using the ENDF/B-6 files and the CROSS program. The ADLER program was written to convert Adler-Adler parameters from LIPAR-3 format to LIPAR-5 or ENDF/B-6 format. To speed up the calculation of cross-sections at a given energy point by the RAPAN program [G194], the resonance parameters are converted from ENDF/B-6 format into the internal format using the PRERAP program.

Various programs were written for our own resonance parameter evaluations and for analysing parameters taken from other evaluations. Their capabilities are outlined below.

The RESPAR program facilitates the production of tables of resonance parameters from the LIPAR library. Apart from the energy and the partial widths, the table for each resonance gives the reduced neutron widths and the resonance integrals for infinite dilution.

The AVPAR and SRPAR programs calculate the mean resonance parameters from the parameters of the resolved resonances given in the LIPAR library. The mean distance between resonances $\overline{D}$, the mean reduced widths $<\Gamma_n^l>$ and the strength functions S_l are calculated using various formulae (see, for example, [Ab86]). In addition, these programs can be used to determine the total resolution region. The mean parameters can be obtained for each state (l,j) (AVPAR program) and for a given value of l (SRPAR program).

The BAYES program identifies the orbital momentum of a resonance for given mean parameters. The resonances are divided into s- and p- resonances via a statistical test employing a probability measure which may be determined using BAYES theory [Ni75-2], [Ab87-2].

The CROSS [Ab84-2] and RAPAN [G194] programs are used to reconstruct the cross-sections at a given energy point from the resonance parameters. The CROSS program was designed to work with the LIPAR-3 library and was incorporated into the MCU-1 and MCU-2 packages [Ma91] for Monte-Carlo reactor calculations. The RAPAN program was incorporated into MCU-3 [Ab94-Ab94-4]. There are two variants of the program. RAPAN-1 is actually an equivalent of the CROSS program. It was written with a view to speeding up the calculation time. Like the CROSS program, it was written for work with the LIPAR-3 library. RAPAN-2 can be used both with the LIPAR-5 library and with data from the ENDF/B-6 library (though not always). In particular, it is capable of calculating cross-sections in the Adler-Adler approximation [LRF = 5] not only when parameters are given for the calculation of capture and fission [LI = 6], but also when parameters are given for the total cross-section as well [Li = 7]. However, the RAPAN-2 program can still not deal with resonance parameters presented in Reich-Moore formalism [LRF = 3]. It is also not capable of processing resonances with an orbital momentum in excess of 1. Therefore, for some light nuclei where resonances with l = 2 are resolved, l = 1 was assigned to the d-resonances (e.g. for MN, Zr90). This does not affect the calculation of cross-sections in the resonance region since such resonances are few and their widths ($g\Gamma_n$) are significantly smaller than the s- or p-resonances. The d-resonances partially compensate p-resonance suppression when analysing the mean parameters of the p-wave.

The following programs were developed from the CROSS or RAPAN programs:

The ACRLI program calculates cross-sections in the lower energy region (up to 5 eV). The energy points are selected automatically depending on the accuracy level required and the position of resonances with Eo < 5 eV. In this region, the program can generate the dependence of the resonance integral on the integration limits;

The GFACT program calculates cross-sections at E = 0.0253 eV and Westcott g-factors at given temperatures of the medium;

The BNABGR program calculates cross-section integrals in various assignable energy intervals and with differing integration weighting functions ($\int\sigma(E)dE$ and $\int\sigma(E)dE / E$). The program was used both to generate the BNAB group constants [Ab81-2] and when analysing the resonance parameters to compare them with the experiment in [Ab92];

The BNAB program can calculate not only the cross-section integrals from the resonance parameters (BNABGR) but also the resonance self-shielding factors relative to the temperature of the medium, and the cross-sections for dilution of a given isotope by others [Ab81-2].

There are also a series of utility programs which are useful for creating a library of resonance parameters and for working with the LIPAR library. These include the RENSOC and RENPU programs which prenumber the lines in the file, the LIPGAM program for checking the total resonance widths at given partial widths, and the SERV program for selecting a given line from the file library. The LAJ program is used to select realized states [l, J, g) of resolved resonances from the Breit-Wigner parameters in ENDF/B format (see point 2(c) of section 1). Finally, the RAPAN-2 program is used to identify negative cross-sections at resonance minimums (if they exist). They are outputted as a separate MINUS file.

All the above programs are written in FORTRAN-77 and run on a 386 and 486 PC.

The CROSS, GFACT and ACRLI programs, and some of the utility programs (MNSOC, TRA, RENSOC, RENPU, LIPGAM, SERV) were jointly written by M.S. Yudkeviech, V.V. Tebin and V.A Chistyakova. The RAPAN, ADLER and LAJ programs were written by A.E. Glushkov. I am deeply grateful to the above and also to S.M. Zakharova, M.N. Nikolaev and A.N. Tsibulya for their collaboration in the writing and operation of these programs.

Some comments on the resonance parameters from the LIPAR-5 library

The main volume of data in the library comprises the resonance parameters themselves (see, for instance, [Mu84]). In Breit-Wigner formalism, this is the resonance energy (Eo), the partial widths (Γ_n , Γ_γ, Γ_f) and the total width (Γ). In Adler-Adler formalism, this is the parameters μ, ν, G and H [Ab84-2].

Information on the number of resonances and the energy region where resonances are resolved is given in Table 2. The values included in the table are described below.

1. NAME - four-character name of isotopes in the LIPAR library. For elements with only a single isotope, or for a natural isotope mixture, this is simply the chemical symbol.

2. The table includes the numbers of resolved resonances with orbital momenta of $l = 0$ (NS), $l = 1$ (NP) and $l = 2$ (ND). The sum of these is the total number of resolved resonances in the LIPAR, ENDF/B-6 [Ro91] and BROND [Bl91] libraries. From the data in these columns it is clear that resonances with $l = 2$ were only identified for Zr90 from the ENDF/B-6 library.

3. The table also gives the three energies EH, Ehr and Emax from the LIPAR library. In the third line of the file MF = 2 MT = 151 the energy region EL - EH is given where the cross-sections must be calculated from the resolved resonance parameters (sometimes adding the background from section MF = 3). The lower limit of the

range (EL) is zero, as a rule (with a few exceptions: TH32, U233, NP37, Pu39). The upper limit (EH) of the region where it is recommended that cross-sections be calculated from the parameters is somewhat underestimated in order to make it agree with the group boundaries of the BNAB 26-group system [Ab81-2] since reactor calculations above the EH limit are done using the BNAB constants where cross-section blocking is taken account of in a sub-group representation in the unresolved region. EHr is the energy above which level suppression affects the mean resonance parameters to be calculated. This is the total resonance resolution limit. Emax is the energy of the last resolved resonance. For comparison, the value from the ENDF/B-6 library is also given. It should be noted that, in ENDF/B-6, Emax ≤ EH as a rule, which in our view is not always true. Information on EHr and Emax is entered in the header section (MF = 1 MT = 141) in the LIPAR library.

4. Finally, Table 2 contains information on the formalism used in LIPAR for calculating cross-sections (see section 1).

The ways in which the parameters in the library were evaluated are not described in this paper. They have been described on various occasions in other of our publications ([Ab71], [Ni75], [Ni75-2], [Za77], [Ni78], [Ab86], etc.). A few words need to be said only about the spin of the compound nucleus J which has not been determined experimentally for the majority of resonances. Resonances with an unknown value of J were usually assigned mean values $\overline{C}$ in accordance with the table below.

Table

I, spin of target nucleus	l, orbital momentum	J, mean spin of ground-state nucleus	g, mean statistical weight
0	0	0.5	1.0
	1	1.0	1.5
0.5	0	0.5	0.5
	1	1.0	0.75
1.0	0	1.0	0.5
	1	1.3	0.6
1		1	0.5

With this approach, the error level in the neutron width obtained from the experimentally measured combination ($g\Gamma_n$) is minimal on average. The capture cross-section is thought to be correct since, as a rule, the measurable area under the capture cross-section curve remains the same. The error arises in the interference term of the scattering cross-section since the s-resonance portion with the specific values $J_1 = I - 1/2$ or $J_2 = I + 1/2$ are assigned mean values $\bar{J}$. These resonances are formally viewed as an independent system $(l, \bar{J})$ and do not interact with the (l,J_1) or (l,J_2) systems. Clearly, this is an effect of the second order of an infinitesimal. Nevertheless, where the scattering cross-section σ_e for a given nucleus is important (for instance, Zr91), each resonance was arbitrarily assigned specific values of J_1 and J_2 working from the statistical law of the proportionality of the level density to the multiplier $(2J + 1)$. The contribution of the p-wave to the scattering cross-section for the resolved resonance region is low and therefore the analogous procedure for p-resonances is not worthwhile.

As was noted in the introduction, there are not publications on all evaluated isotopes. Therefore, we thought it useful to provide short notes on the changes which were made to evaluations. The main changes made to other people's evaluations are listed in Table 1:

1. For a series of resonances, only the area under the curve $\sigma_c(E)$ was measured. In these cases, we determined the neutron width Γ from $(g\Gamma_n\Gamma_\gamma/\Gamma)$, assuming that the statistical weight g is known and the radiation width of the resonance is equal to the mean value $\overline{\Gamma_\gamma}$;

2. As was noted above, we used the BAYES program to distinguish the s- and p-resonances and assign a specific value of l to the resonances, where the mean parameters are known. Specific spins J_1 or J_2 were assigned to the s-resonances of some odd nuclei in accordance with statistical laws;

3. For the majority of nuclei, the cross-sections at E = 0.0253 eV can be evaluated fairly accurately since there are a lot of experiments in the thermal energy region. In order to compare the cross-sections calculated from the parameters with the cross-sections recommended at the thermal point [Ab81, Ab89-2, Ab89-3], in some cases it was necessary to vary the parameters of the first resonances within the limits of experimental error;

4. The parameters of the negative resonance (whose energy is lower than the bonding energy) were also changed, equally with a view to making the calculated and recommended thermal cross-sections agree with one another. In some cases, we had to evaluate the parameters of the negative resonance ourselves.

Some results of calculations using the resonance parameters from the LIPAR-5 library

We present some results of calculations performed using the above-mentioned programs.

Table 3 gives the capture cross-section σ_c^T and the scattering cross-section σ_e^T at 0.0253 eV, as well as the Westcott factors g_c which characterize the deviation of the capture cross-section from the 1/v law at 300 K. I would draw the attention of those using this library to the fact that the table gives the cross-sections for scattering on free nuclei. For oxides of rare-earth nuclei (for example, Pm [Ab84]), the cross-section for paramagnetic scattering on ions σ_{pm} must be added to σ_e (see, for instance, [Mu84], page 1).

Table 4 gives the following for fissile nuclei: the fission cross-section at 0.0253 eV σ_f^T, the Westcott factors for fission g_f and absorption (i.e. fission and capture) g_a at 300 K and, finally, the total number of secondary neutrons per single fission event ν. In Tables 3 and 4, the thermal cross-sections calculated using the parameters from the ENDF/B-6 library are also given for comparison. It should be noted that they do not always coincide with the cross-sections recommended by the authors which were evaluated from the experimental data. These differences are noted in the header sections of the ENDF/B-6 files [Ro91] where both the recommended and calculated thermal cross-sections are given.

Table 5 gives the capture resonance integrals RIC which were calculated from the parameters for nuclei with $Z < 90$. For the remaining nuclei, RIC and the fission resonance integrals RIF are given in Table 6. The integrals in the 0.5 - 1.0 eV energy region were calculated using the ACRLI program via numerical integration of the energy dependence of the cross-sections. In the 1 eV - EH region (see Table 2), the integrals were calculated using the BNABGR program, i.e. also via numerical integration of the $\sigma(E)$ curves. Finally, the capture and fission resonance integrals at infinite dilution were calculated for each resonance using the analytical formulae and the RESPAR program. The sums of these integrals by resonances in the 0.5 eV - Emax energy region are also given in Tables 5 and 6.

For some elements the parameters were evaluated for all stable isotopes. Where this is the case, Tables 3 and 5 give the thermal cross-section and resonance integral values for the natural mixture obtained by summation for the isotopes, taking into account the content of each isotope in the natural mixture.

Conclusion

Apart from creating the LIPAR-5 resonance parameter library, during the course of the analysis of the resonance parameters an archive was created in which the following information is stored on machine media.

1. Infinite dilution resonance integrals and resonance parameters for each resonance.
2. Thermal partial cross-sections and Westcott g-factors for 300 K.
3. Energy dependence of partial cross-sections in the energy region up to 5 eV.
4. Integrals $\int_{0.5}^{EGR} (\sigma(E) / E)\,dE$, where EGR varies from 0.0001 to 5 eV.

This information is important for nuclei with low-lying resonances (for example, SM51, EU 51, ER67, PA31, NP37, AM41, AM2M) since, for these nuclei, the resonance integral is sensitive to the lower integration limit.

5. In the resolve resonance region, tables of the BNAB 26-group cross-sections [Ab81-2] obtained using the LIPAR-5 library, and the resonance integrals in the groups.

6. The mean reduced neutron widths calculated using various formulae, the mean distances between resonances, the strength functions. All these values are given relative to the energy up to which the parameters were averaged.

7. Results for identification of the orbital momenta (l) of specific resonances. The identification was carried out using the Bayes theorem.

Work on the LIPAR library will continue. As new experimental data and evaluations appear, and following verification via benchmark experiments, the parameters can be corrected. In addition, resonance parameters may be required for new isotopes and these must be included in the library. Therefore, the library will continue to be improved and expanded.

The LIPAR library and the BNAB library form part of the constants library in the MCU program package ([Ab94]-[Ab94-4]) for reactor calculations.

We expect that LIPAR will be used to obtain BNAB group cross-sections in the resolved resonance region.

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Table 1

Content of the LIPAR-5 library

N	NAME	Isotope	Main source	LIPAR changes	Date	ENDF/B-6 Laboratory	Date
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	MN	25-MN- 55	Mu81	(2)	NOV87	JAERI.ORNL	MAR88
2	CO	27-CO- 59	Mu81	(1) (2)	NOV87	ANL	JUL89
3	ZR90	40-ZR- 90	Mu81	(1) (5)	NOV87	SAI,BNL	APR76
4	ZR91	40-ZR- 91	Mu81	(1) (2)	NOV87	SAI,BNL	APR76
5	ZR92	40-ZR- 92	Mu81	(1)	NOV87	HEDL	APR74
6	ZR94	40-ZR- 94	Mu81	(1) (2)	NOV87	SAI,BNL	APR76
7	ZR96	40-ZR- 96	Mu81	(2)	NOV87	SAI,BNL	APR76
8	NB	41-NB- 93	ENDF/B-6		JAN93	ANL,LLL	MAR90
9	RH	45-RH-103	Mu81	(1) (2)	NOV87	HEDL,BAW	NOV78
10	AG07	47-AG-107	Mu81		JAN88	BNL,HEDL	JUN83
11	AG09	47-AG-109	Mu81		JAN88	BNL,HEDL	JUN83
12	CD13	48-CD-113	Mu81		NOV87	BNL,HEDL	NOV78
13	IN15	49-IN-115	Mu81		JAN92	HEDL,ANL	MAR90
14	XE35	54-XE-135	Mu81	(3)	NOV87	BNW,HEDL	APR74
15	CS	55-CS-133	MU81		NOV87	HEDL,BNL	NOV78
16	CS34	55-CS-134	MU81		NOV87	ORNL,HEDL	DEC88
17	ND42	60-ND-142	Mu81	(1) (2)	NOV93	HEDL	APR74
18	ND43	60-ND-143	Mu81	(2) (3)	NOV93	HEDL,BNL	FEB80
19	ND44	60-ND-144	Mu81	(2)	NOV93	HEDL	FEB80
20	ND45	60-ND-145	Mu81	(1) (2)	NOV93	HEDL,BNL	FEB80
21	ND46	60-ND-146	Mu81	(1) (2)	NOV93	HEDL,BNL	FEB80
22	ND47	60-ND-147	Mu81		NOV93	ORNL,HEDL	DEC88
23	ND48	60-ND-148	Mu81	(1) (2)	NOV93	HEDL,BNL	FEB80
24	ND50	60-ND-150	Mu81		NOV93	HEDL,BNL	FEB80
25	PM47	61-PM-147	Ab84		JAN87	ORNL,HEDL	APR89
26	PM8M	61-PM-148M	Ab84		JAN87	HEDL	APR74
27	SM47	62-SM-147	Ab86	Ab88 (5)	JAN93	ORNL,HEDL	APR89
28	SM49	62-SM-149	Ab86	Ab88 (5)	JAN93	HEDL,BNW	NOV78
29	SM50	62-SM-150	Ab84		JAN87	HEDL	APR74
30	SM51	62-SM-151	Ab84		JAN87	ORNL,HEDL	MAR89
31	SM52	62-SM-152	Ab84	(5)	JAN93	HEDL,BNL	FEB80

Table 1 (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
32	SM54	62-SM-154	Ab84		JAN87	HEDL	APR74
33	EU51	63-EU-151	Mu73	(2)	JAN87	LANL	APR86
34	EU53	63-EU-153	Mu73	(2) (6)	JAN87	LANL	APR86
35	GD52	64-GD-152	Ab87	Ab89	DEC87	BNL	JAN77
36	GD54	64-GD-154	Ab87	Ab89	DEC87	BNL	JAN77
37	GD55	64-GD-155	Ab87	Ab89	DEC87	BNL	JAN77
38	GD56	64-GD-156	Ab87	Ab89	DEC87	BNL	JAN77
39	GD57	64-GD-157	Ab87	Ab89	DEC87	BNL	JAN77
40	GD58	64-GD-158	Ab87	Ab89	DEC87	BNL	JAN77
41	GD60	64-GD-160	Ab87	Ab89 (5)	DEC93	BNL	JAN77
42	DY56	66-DY-156	Mu84		JAN94		
43	DY58	66-DY-158	Mu84	(3)	JAN94		
44	DY60	66-DY-160	Mu84		JAN94	HEDL	APR74
45	DY61	66-DY-161	Mu84	(2) (3)	JAN94	HEDL	APR74
46	DY62	66-DY-162	Mu84		JAN94	HEDL	APR74
47	DY63	66-DY-163	Mu84	(2)	JAN94	HEDL	APR74
48	DY64	66-DY-164	Mu84	(2)	JAN94	BNW	JUN67
49	ER62	68-ER-162	Za77		NOV87		
50	ER64	68-ER-164	Za77		NOV87		
51	ER66	68-ER-166	Za77	(6)	NOV87	ORNL, HEDL	DEC88
52	ER67	68-ER-167	Za77		NOV87	ORNL, HEDL	DEC88
53	ER68	68-ER-168	Za77	(6)	NOV87		
54	ER70	68-ER-170	Mu84		NOV87		
55	LU75	71-LU-175	Ka77	(3)	NOV87	BNW	JUN67
56	LU76	71-LU-176	Mu73	(4)	NOV87	BNW	JUN67
57	HF74	72-HF-174	Ab93-2		JAN93	SAI	APR76
58	HF76	72-HF-176	Ab93-2		JAN93	SAI	APR76
59	HF77	72-HF-177	Ab93-2		JAN93	SAI	APR76
60	HF78	72-HF-178	Ab93-2		JAN93	SAI	APR76
61	HF79	72-HF-179	Ab93-2		JAN93	SAI	APR76
62	HF80	72-HF-180	Ab93-2		JAN93	SAI	APR76
63	W180	74-W -180	Ab83		NOV87		
64	W182	74-W -182	Ab83	(2)	NOV87	LANL, ANL	DEC80
65	W183	74-W -183	Ab83	(6)	NOV93	LANL, ANL	DEC80
66	W184	74-W -184	Ab83	(6)	NOV87	LANL, ANL	DEC80

Table 1 (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
67	W186	74-W -186	Ab83	(6)	NOV93	LANL, ANL	DEC80
68	AU	79-AU-197	ENDF/B-6		DEC92	LANL	JAN84
69	TH29	90-TH-229	Ab81		OCT90		
70	TH30	90-TH-230	Ab81		SEP90	HEDL	NOV77
71	TH32	90-TH-232	ENDF/B-6		JAN93	BNL, ANL	DEC77
72	PA31	91-PA-231	Ab81		OCT90	HEDL	NOV77
73	PA33	91-PA-233	ENDF/B-6	(6)	JAN93	GA, BNL, LANL	MAY78
74	U232	92-U -232	ENDF/B-6	(4)	JAN93	HEDL	NOV77
75	U233	92-U -233	ENDF/B-6		JAN93	LANL, ORNL	DEC78
76	U234	92-U -234	Ab81		OCT90	BNL, GGA	JUL78
77	U235	92-U -235	Ab90		MAR92	ORNL, LANL	APR89
78	U236	92-U -236		(6)	DEC93	HEDL	OCT89
79	U238	92-U -238	Ab81	(6)	NOV87	ORNL, LANL	NOV89
80	NP37	93-NP-237	ENDF/B-6		JAN93	LANL	APR90
81	PU38	94-PU-238	Ab89-1	Ab92	OCT91	HEDL, AI	APR78
82	PU39	94-PU-239	Ab89-1	Ab92	OCT91	LANL	APR89
83	PU40	94-PU-240	ENDF/B-6	(6)	JAN93	ORNL	AUG86
84	PU41	94-PU-241	Ab89-1	Ab92	OCT91	ORNL	OCT88
85	PU42	94-PU-242	Ab89-1	Ab92	OCT91	HEDL, SRL	OCT78
86	AM41	95-AM-241	Mu84	(6)	JAN91	CNDC	FEB88
87	AM2M	95-AM-242M	Br84	(6)	JAN91	HEDL, SRL	APR78
88	AM43	95-AM-243	Ab81		SEP90	ORNL, HEDL	OCT88
89	CM42	96-CM-242	Ab81		OCT90	HEDL, SRL	APR78
90	CM44	96-CM-244	Ab81		OCT90	HEDL, SRL	APR78
91	CM45	96-CM-245	Ab81		OCT90	SRL, LLNL	JAN79
92	CM46	96-CM-246	Ab81		OCT90	BNL, SRL	JUL76
93	CM47	96-CM-247	Mu84	(4)	JAN92	BNL, SRL	JUL76
94	CM48	96-CM-248	Ab81		OCT90	HEDL, SRL	APR78

Notes: (1) The neutron widths of some resonances were determined from $(g\Gamma_n\Gamma_\gamma/\Gamma)$ when Γ_γ and g were evaluated by the author; (2) The orbital momenta ($l = 0$, $l = 1$) were identified or the spins of the compound nuclei (J) assigned to resonances with $l = 0$; (3) In order to make the calculated data agree with the recommended thermal cross-sections, the parameters of the first resonances were varied within the limits of experimental error; (4) A negative resonance was assigned or its parameters were changed; (5) Background added; (6) Other changes.

Table 2

Some characteristics of the resonance parameters

N	NAME	Number of Resonances (NS+NP+ND)			EH, eV	EHr, eV	Emax, eV		Formalism
		LIPAR	ENDF/B-6	BROND	LIPAR		LIPAR	ENDF/B-6	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	MN	73+99	52+97	-	100000.	70000.	207700.	111760.	MLBW
2	CO	25+41	117	-	21500.	21500.	29943.	119400.	MLBW
3	ZR90	27+108	34+84+5	28+60	21500.	21500.	300900.	300900.	MLBW
4	ZR91	36+80	36+58	48+92	10000.	10000.	25280.	24240.	MLBW
5	ZR92	16+85	16+63	32+54	1000.	700.	120000.	120000.	MLBW
6	ZR94	23+50	23+48	22+46	46500.	70000.	89350.	89350.	MLBW
7	ZR96	9+21	9+21	5+11	21500.	50000.	95927.	95927.	MLBW
8	NB	148+46	(1)	99+100	465.0	5500.	7331.	7331.	SLBW
9	RH	106+157	59+60	66+102	2150.	2150.	4191.	1487.	MLBW
10	AG07	92+41	74	-	1000.	1200.	2698.	2659.	MLBW
11	AG09	109+32	83	81+12	1000.	1000.	2683.	2506.	MLBW
12	CD13	37	12	-	215.	300.	2241.	291.56	MLBW
13	IN15	160+73	89+50	-	1000.	1000.	2003.7	998.	MLBW
14	XE35	1	-	-	1.		0.08418		SLBW
15	CS	162+5	123	-	2150.	2500.	3500.	2492.	SLBW
16	CS34	8	7	-	100.	100.	171.	171.	MLBW
17	ND42	34+47	5+12	-	10000.	11000.	31050.	5982.	MLBW
18	ND43	122+27	18	65	4650.	5000.	5503.	576.2	MLBW
19	ND44	37+33	19	-	10000.	12000.	19407.	9735.	MLBW
20	ND45	213	79	115	2150.	2500.	4637.	1448.	MLBW
21	ND46	47+44	18	-	10000.	10000.	17323.	4047.	MLBW
22	ND47	8	8	-	21.5	33.3	33.3	33.3	MLBW
23	ND48	78+47	11+1	-	4650.	8000.	11924.	871.9	MLBW
24	ND50	79	15	-	4650.	8000.	13844.	1861.9	MLBW
25	PM47	45	40	45	100.	100.	316.5	316.5	MLBW
26	PM8M	2	1	-	1.		0.56	0.169	MLBW
27	SM47	213	141	106	465.	700.	1988.	1050.	MLBW
28	SM49	161	30	70	100.	120.	519.6	99.	MLBW
29	SM50	23	12	23	465.	500.	1563.	556.	MLBW
30	SM51	123	121	76	100.	110.	295.7	295.7	MLBW
31	SM52	91	57	31	2150.	3500.	5100.	2985.5	MLBW

Table 2 (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
32	SM54	36	18	28	2150.	3000.	5075.	2106.9	MLBW
33	EU51	105	92	-	46.5	60.	98.6	98.61	MLBW
34	EU53	71	72	73	46.5	70.	96.9	97.22	MLBW
35	GD52	19	18	22 (2)	100.	215.	231.	231.	MLBW
36	GD54	48	49	48 (2)	215.	215.	985.5	985.5	MLBW
37	GD55	92	92	92 (2)	46.5	100.	183.3	183.3	MLBW
38	GD56	88	30	105(2)	1000.	1000.	2226.5	1427.	MLBW
39	GD57	60	56	56 (2)	215.	300.	306.4	306.4	MLBW
40	GD58	90+6	93	96 (2)	2150.	4000.	9979.8	9979.8	MLBW
41	GD60	39+5	44	57 (2)	2150.	5000.	9662.4	9662.4	MLBW
42	DY56	19	-	-	46.5	55.0	90.9		MLBW
43	DY58	4	-	-	46.5	86.	86.		MLBW
44	DY60	66	3	-	1000.	1000.	1994.3	20.5	MLBW
45	DY61	254	27	-	100.	150.	996.2	66.4	MLBW
46	DY62	142	8	-	4650.	5000.	15814.	409.	MLBW
47	DY63	116	60	-	465.	500.	996.6	483.	MLBW
48	DY64	78+39	2	-	4650.	8250.	21151.	145.5	MLBW
49	ER62	18	-	18	46.5	70.	228.5		MLBW
50	ER64	17	-	18	215.	230.	750.2		MLBW
51	ER66	175	56	175	1000.	4650.	9485.	2128.9	MLBW
52	ER67	272	113	272	465.	500.	1686.	518.9	MLBW
53	ER68	105+25	-	106+24	2150.	1000.	14600.		MLBW
54	ER70	95+30	-	96+30	4650.	4650.	23690.		MLBW
55	LU75	53	17	-	100.	120.	195.8	60.	MLBW
56	LU76	20	21	-	21.5	30.	45.2	46.7	MLBW
57	HF74	11	10	-	215.	211.	211.	211.	MLBW
58	HF76	23	22	-	1000.	580.	1068.	1068.	MLBW
59	HF77	180	99	-	465.	200.	696.6	298.6	MLBW
60	HF78	25	25	-	2150.	1300.	2090.	2090.	MLBW
61	HF79	78	49	-	1000.	280.	1010.	431.9	MLBW
62	HF80	15	31	-	2150.	1000.	2405.	11350.	MLBW
63	W180	9	-	-	215.	90.	614.		MLBW
64	W182	148+14	69	159+3	10000.	4650.	13253.	4492.	MLBW
65	W183	101+1	50	102	465.	900.	2444.	760.	MLBW
66	W184	132+12	38	140+4	4650.	3000.	16450.	2621.	MLBW
67	W186	112+11	40	121+2	2150.	2650.	17340.	3158.	MLBW

Table 2 (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
68	AU	263	(1)	263	2150.	2300.	4827.	4827.	MLBW
69	TH29	12	-	-	4.65	9.15	9.15		SLBW
70	TH30	23	22	-	215.	250.	294.	248	MLBW
71	TH32	243+192	(1)	240+112	2150.(3)	3900.	3997.6	3997.6	MLBW
72	PA31	119	31	-	21.5	30.	99.	14.1	SLBW
73	PA33	34	34	-	21.5	21.5	36.2	36.2	SLBW
74	U232	13	(1)	-	46.5	50.0	52.48	52.48	MLBW
75	U233	83	(1)	178	46.5(3)	62.7	62.7	62.7	A-A
76	U234	118	119	-	465.	900.	1468.1	1492.2	MLBW
77	U235	143	(2)	205(4)	100.	100.	101.1		A-A
78	U236	191	82+35	73	2150.	2150.	4106.2	1495.2	MLBW
79	U238	248+232	(2)	249	2150.	1500.	5756.	16400.	MLBW
80	NP37	249	(1)	-	100.(3)	120.	232.8	232.8	SLBW
81	PU38	56	16	56	465.	250.	518.	192.	MLBW
82	PU39	260.	(2)	260	465.(3)	300.	658.3	1000.	MLBW
83	PU40	268	(1)	70	1000.	1400.	5692.	5692.	MLBW
84	PU41	86	(2)	93	100.	100.	100.1	400.	A-A
85	PU42	132	68	70	1000.	1300.	3836.	977.9	MLBW
86	AM41	187	195	189	46.5	75.	149.1	149.1	SLBW
87	AM2M	48	6	48	10.	10.	19.7	3.25	SLBW
88	AM43	220	220	220	215.	100.	249.7	249.7	SLBW
89	CM42	13	13	10	100.	160.	265.	265.	MLBW
90	CM44	65	38	38	465.	530.	971.5	520.6	MLBW
91	CM45	41	39	-	46.5	46.5	60.	60.	SLBW
92	CM46	9	10	-	215.	300.	313.4	381.1	MLBW
93	CM47	35	39	-	46.5	33.	60.	60.	SLBW
94	CM48	47	47	-	1000.	1300.	2391.	2391.	MLBW

Notes: (1) The resonance parameters are taken from the ENDF/B-6 files; (2) Reich-Moore formalism; (3) The lower limit of the resonance region is not zero; (4) Single-level Breit-Wigner formalism and alternating background. The numbers of (s+p+d)-resonances (i.e. l = 0, 1, 2) in the various libraries are given in columns 3, 4 and 5. The upper limits of the resonance region, where it is recommended that cross-sections be calculated from the parameters (EH) and where resonance suppression is significant (Ehr), are given in columns 6 and 7. Column 9 gives the energy of the last resonance Emax.

Table 3

Westcott factors and thermal cross-sections

N	NAME	σ_c^T , barn LIPAR	σ_c^T , barn ENDF/B-6	g_c LIPAR	σ_e^T , barn LIPAR	σ_e^T , barn ENDF/B-6
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1	MN	13.3	13.42	1.0000	2.40	2.15
2	CO	37.2	37.2	1.0001	5.98	5.97
	ZR	0.193			5.8	
3	ZR90	0.011	0.011	1.0000	5.05	5.3
4	ZR91	1.247	1.187	1.0000	10.4	10.8
5	ZR92	0.226	0.219	0.9998	4.87	5.22
6	ZR94	0.048	0.049	1.0000	6.14	6.52
7	ZR96	0.023	0.023	1.0003	6.27	6.67
8	NB	1.155	1.155	1.0015	6.34	6.34
9	RH	146.2	146.3	1.0230	3.36	4.66
	AG	63.2			4.98	
10	AG07	37.6	37.6	0.9980	7.35	7.42
11	AG09	90.7	90.7	1.0050	2.42	2.23
12	CD13	20640.	19915.	1.3377	27.0	21.7
13	IN15	202.1	210.7	1.0193	2.46	2.27
14	XE35	2681000.	2636300.	1.0392	301100.	295680.
15	CS	29.1	29.6	1.0024	4.09	4.96
16	CS34	139.7	139.7	0.9982	23.7	25.4
	ND	48.8			15.7	
17	ND42	18.6	18.7	0.9986	7.93	4.57
18	ND43	319.3	325.1	0.9961	80.0	68.9
19	ND44	3.58	3.60	1.0000	1.02	-4.56
20	ND45	41.9	42.0	0.9998	17.9	0.89
21	ND46	1.40	1.40	0.9999	9.50	1.70
22	ND47	440.7	440.	0.9952	82.3	84.2
23	ND48	2.50	2.50	1.0001	3.66	-0.30
24	ND50	1.20	1.20	0.9997	3.55	3.85
25	PM47	183.1	168.6	0.9951	6.71	21.3
26	PM8M	11030.	10633.	1.4647	21.8	32.9
27	SM47	56.7	57.14	0.9942	3.8	38.8
28	SM49	39420.	39311.	1.7088	163.	136.
29	SM50	108.2	102.0	0.9936	10.3	6.99

Table 3 (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
30	SM51	15160.	15232.	0.9256	34.4	43.4
31	SM52	201.5	206.1	1.0032	7.49	2.16
32	SM54	8.30	5.50	0.9996	13.6	3.25
	EU	4481.			7.62	
33	EU51	9208.	9204.	0.9311	7.72	6.30
34	EU53	312.	312.	0.9801	7.68	9.00
	GD	48780.			169.3	
35	GD52	732.	14.42	0.9783	17.0	3.07
36	GD54	84.9	85.9	0.9923	6.0	10.5
37	GD55	60710.	60710.	0.8446	58.6	58.7
38	GD56	1.77	1.71	1.0005	5.20	5.62
39	GD57	253500.	254300.	0.8527	1005.	1012.
40	GD58	2.16	2.00	1.0005	3.53	3.29
41	GD60	0.770	0.764	1.0000	3.63	3.62
	DY	941.8			96.6	
42	DY56	33.1	-	1.0082	4.10	-
43	DY58	42.6	-	0.9888	6.68	-
44	DY60	57.0	61.0	1.0058	5.14	1.95
45	DY61	600.	585.	0.9900	16.4	24.3
46	DY62	193.8	199.2	1.0047	0.005	-1.33
47	DY63	124.1	134.4	1.0112	3.39	1.82
48	DY64	2653.	2520.	0.9875	329.	369.
	ER	157.9			7.27	
49	ER62	29.05	-	0.8825	5.31	-
50	ER64	2.47	-	1.0020	8.53	-
51	ER66	19.93	19.62	0.9995	11.95	15.83
52	ER67	652.8	657.1	1.0707	1.19	1.27
53	ER68	2.79	-	0.9999	8.12	-
54	ER70	5.84	-	1.0002	4.44	-
	LU	83.7			6.70	
55	LU75	23.0	25.9	0.9971	5.96	5.27
56	LU76	2347.	1952.	1.6375	34.1	3.04
	HF	104.7			10.3	
57	HF74	562.	388.	0.9780	15.0	4.19
58	HF76	23.5	41.9	1.0029	5.54	3.59
59	HF77	373.5	377.3	1.0199	0.020	-4.36

Table 3 (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
60	HF78	84.0	74.4	1.0029	4.45	-1.56
61	HF79	42.2	45.5	0.9960	6.99	4.55
62	HF80 W	12.9 18.4	13.2	0.9995	22.2 3.61	19.0
63	W180	3.46	-	1.0015	5.33	-
64	W182	20.95	20.55	1.0027	3.44	11.82
65	W183	10.1	10.0	1.0006	3.33	3.41
66	W184	1.66	1.75	1.0000	6.48	4.29
67	W186	38.2	37.46	1.0014	0.81	0.24
68	AU	98.7	98.7	1.0049	6.84	6.84
69	TH29	54.2	-	1.0431	10.4	-
70	TH30	23.4	23.1	1.0129	7.24	5.91
71	TH32	7.40	7.4	0.9982	12.95	12.95
72	PA31	202.5	227.0	1.0201	10.1	8.52
73	PA33	39.0	41.5	0.9767	8.70	8.34
74	U232	74.9	72.6	0.9713	11.1	7.55
75	U233	45.8	45.8	1.0265	12.6	12.6
76	U234	100.9	103.1	0.9894	19.3	12.3
77	U235	98.7	98.8	0.9815	14.1	15.5
78	U236	5.09	5.13	1.0022	10.6	8.82
79	U238	2.709	2.710	1.0019	7.8	9.38
80	NP37	181.0	181.0	0.9914	14.7	14.7
81	PU38	544.	561.	0.9557	21.4	20.3
82	PU39	271.0	271.1	1.151	7.41	8.0
83	PU40	289.5	287.5	1.0273	1.40	0.95
84	PU41	361.0	363.	1.0384	11.3	11.2
85	PU42	18.6	19.2	1.0097	8.20	7.73
86	AM41	609.4	619.	1.0098	14.3	11.3
87	AM2M	1411.	1343.	1.1159	6.07	5.84
88	AM43	81.4	75.1	1.0123	5.30	8.54
89	CM42	16.1	16.87	0.9949	11.5	10.8
90	CM44	13.6	10.37	1.0011	8.52	6.98
91	CM45	365.	342.	0.9501	11.8	8,89
92	CM46	1.31	1.30	1.0055	11.1	9.68
93	CM47	59.5	58.2	1.0021	8.83	8.40
94	CM48	2.92	2.44	1.0017	6.59	6.14

Table 4

Fission characteristics in the thermal region

N	NAME	ν		σ_f^T , barn		g_f	g_a
		LIPAR	ENDF/B-6	LIPAR	ENDF/B-6	LIPAR	LIPAR
69	TH29	2.100	-	31.57	-	1.0248	1.0364
72	PA31	2.29	2.29	0.012	0.010	1.0266	1.0201
74	U232	2.47	3.13 (*)	76.5	77.1	0.9764	0.9739
75	U233	2.4947	2.4947	528.4	528.4	0.9966	0.9990
76	U234	2.352	2.352	0.643	0.464	0.9883	0.9893
77	U235	2.432	2.432	584.0	584.3	0.9804	0.9805
78	U236	2.374	2.317	0.067	0.047	1.0018	1.0022
79	U238	-	2.492	-	0.00005	-	-
80	NP37	2.6358	2.6358	0.018	0.018	0.9845	0.9914
81	PU38	2.905	2.895	17.2	17.0	0.9579	0.9558
82	PU39	$\nu(E)$	$\nu(E)$	746.0	747.5	1.0504	1.0771
83	PU40	2.803	2.803	0.0631	0.0640	1.0249	1.0273
84	PU41	2.945	2.9453	1012.	1012.	1.0470	1.0447
85	PU42	2.756	2.81	0.0022	0.0010	1.0067	1.0097
86	AM41	3.21	3.2235	3.21	3.14	1.0153	1.0098
87	AM2M	3.264	3.264	6598.	6622.	1.1101	1.1112
88	AM43	-	3.22	-	0.074	-	-
89	CM42	-	3.44	-	3.02	-	-
90	CM44	3.46	3.46	1.006	0.604	0.9982	1.0009
91	CM45	3.72	3.6059	2110.	2219.	0.9548	0.9541
92	CM46	3.66	3.48	0.015	0.063	1.0053	1.0055
93	CM47	3.80	3.58	80.7	83.4	0.9948	0.9979
94	CM48	3.83	3.49	0.37	0.087	0.9983	1.0013

Note: (*) - In LIPAR ν is derived from the systematics and in ENDF/B-6 from a single experiment.

Table 5

Capture resonance integrals (RIC) for nuclei with Z < 90

N	NAME	$\int \sigma_c du$, barn		Σ(RIC), barn
		(0.5-1.)eV	(1.-EH)eV	(0.5<E0<Emax) eV
(1)	(2)	(3)	(4)	(5)
1	MN	1.76	12.82	8.64
2	CO	4.9	69.3	58.0
	ZR	0.025	0.902	
3	ZR90	0.001	0.152	0.149
4	ZR91	0.164	4.658	4.296
5	ZR92	0.030	0.584	0.523
6	ZR94	0.006	0.253	0.239
7	ZR96	0.003	5.648	5.642
8	NB	0.160	8.920	8.196
9	RH	122.	908.	1039.
	AG	9.95	748.6	
10	AG07	4.46	95.85	89.93
11	AG09	15.9	1451.	1435.
12	CD13	314.0	74.41	28.45
13	IN15	109.	3107.	3206.
14	XE35	-	-	-
15	CS	4.4	431.0	425.2
16	CS34	16.8	37.5	15.1
	ND	5.44	34.0	
17	ND42	2.27	3.72	0.43
18	ND43	34.4	92.5	55.5
19	ND44	0.47	3.79	2.75
20	ND45	5.50	222.7	214.1
21	ND46	0.18	2.34	1.94
22	ND47	45.5	360.5	340.9
23	ND48	0.33	19.1	18.3
24	ND50	0.16	15.1	14.8
25	PM47	21.4	2108.	2088.
26	PM8M	905.3	-	2618.
27	SM47	6.14	715.	709.
28	SM49	2157.	1198.	3282.
29	SM50	10.4	323.7	313.6
30	SM51	428.0	2969.	3259.
31	SM52	31.7	2926.	2882.
32	SM54	1.07	34.09	32.14
	EU	745.5	1426.	
33	EU51	1531.	1585.	1656.

Table 5 (continued)

(1)	(2)	(3)	(4)	(5)
34	EU53	23.6	1281.	1273.
	GD	49.2	319.8	
35	GD52	36.3	450.	432.
36	GD54	7.64	198.0	191.4
37	GD55	75.4	1362.	1349.
38	GD56	0.24	102.0	101.5
39	GD57	240.5	470.8	420.5
40	GD58	0.29	67.09	66.5
41	GD60	0.10	7.27	7.03
	DY	92.6	1309.	
42	DY56	7.43	871.3	873.8
43	DY58	3.31	117.8	126.6
44	DY60	12.0	1090.	1085.
45	DY61	51.1	1007.	973.4
46	DY62	33.3	2711.	2676.
47	DY63	41.0	1434.	1459.
48	DY64	191.3	150.9	25.1
	ER	369.9	348.8	
49	ER62	1.39	411.5	409.4
50	ER64	0.36	123.3	122.9
51	ER66	2.56	104.8	100.3
52	ER67	1611.	1276.	2600.
53	ER68	0.37	39.20	38.46
54	ER70	0.78	56.23	54.44
	LU	4.43	557.4	
55	LU75	3.03	551.6	548.6
56	LU76	56.7	771.7	752.3
	HF	90.0	1908.	
57	HF74	27.5	298.8	286.3
58	HF76	3.64	889.4	879.4
59	HF77	456.2	6729.	7177.
60	HF78	13.0	1900.	1880.
61	HF79	5.13	553.6	514.9
62	HF80	1.66	31.8	28.0
	W	2.7	360.2	
63	W180	0.49	208.8	208.0
64	W182	3.28	594.8	590.6
65	W183	1.4	347.5	345.0
66	W184	0.22	15.4	14.91
67	W186	5.4	521.2	510.5
68	AU	17.3	1542.	1525.

Table 6

Capture (RIC) and fission (RIF) resonance integrals for nuclei with Z ≥ 90

N	NAME	$\int\sigma_c du$ (.5-1.)	$\int\sigma_c du$ (1.-EH)	Σ(RIC) (0.5-Emax)	$\int\sigma_f du$ (.5-1.)	$\int\sigma_f du$ (1.-EH)	Σ(RIF) (0.5-Emax)
69	TH29	482.	331.	866.	127.	308.	446.
70	TH30	10.0	955.4	963.0	-	-	-
71	TH32	0.85	82.8	81.02	-	-	-
72	PA31	114.	330.7	357.7	0.023	0.008	0.013
73	PA33	12.9	696.2	707.0	-	-	-
74	U232	3.56	279.3	276.6	4.83	318.4	313.6
75	U233	6.73	118.6	-	86.2	578.9	-
76	U234	8.20	604.5	598.6	0.048	0.745	0.712
77	U235	4.72	106.7	-	43.5	171.9	-
78	U236	0.776	338.5	337.6	0.010	4.064	4.053
79	U238	0.400	276.5	275.9	-	-	-
80	NP37	115.1	500.4	498.8	0.0034	0.1195	0.1193
81	PU38	11.9	126.2	122.0	0.46	15.06	14.75
82	PU39	23.5	147.0	144.2	58.5	216.	194.0
83	PU40	935.	7549.	8521.	0.186	2.29	2.476
84	PU41	13.8	168.5	-	22.7	468.6	-
85	PU42	4.44	1111.	1111.	0.0005	0.230	0.230
86	AM41	532.	818.	1403.	1.71	5.35	7.16
87	AM2M	106.	102.	210.	615.	675.	1452.
88	AM43	59.2	1624.	1677.	-	-	-
89	CM42	1.64	97.89	96.96	-	-	-
90	CM44	1.94	613.4	610.8	0.12	19.1	18.96
91	CM45	12.8	83.3	91.1	142.	568.	726.
92	CM46	0.24	98.2	98.0	0.003	1.14	1.14
93	CM47	27.0	492.9	517.5	25.1	505.3	525.4
94	CM48	0.42	264.5	263.8	0.045	2.765	2.701

Note: The integration limits are given in eV and the resonance integrals in barns.

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