Comparison of Two Fine Group Cross-section Libraries resulting from the ENDF/B-V Dosimetry File and Gas File (Version 1 and Version 2)

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Abstract

Some results are presented for the comparison of two versions of the ENDF/B-V dosimetry file.
The comparison is made for a fine group structure of the SAND-II type.

1. INTRODUCTION

The ENDF/B-V dosimetry and gas file with neutron cross-section information contains point cross-section data, resonance parameters, and prescribed interpolation schemes.
Rather complicated calculations have to be performed to obtain fine group cross-sections which can be used for neutron metrology purposes.
Probably the most simple conversion of the ENDF/B-V dosimetry file data is obtained if a fine group cross-section set is calculated.
In the latter case the weighing neutron spectrum can be approximated by a constant neutron spectrum without loss of information. A suitable fine group structure for this purpose is a SAND-II type structure with about 620 groups. The applied group structure contains 45 groups per energy decade between 10^{-10} and 1 MeV and a group width of 100 keV above 1 MeV. The maximum upper bound of the total energy range is 20 MeV for 640 groups.
The group structure applied in these calculations has been described in [1].
The ENDF/B-V files obtained from the NEA data bank (Gif-sur-Yvette, France) have been converted to the fine group cross-section values using the Fortran-IV computer program ENTOSAN [2], developed by ECN Petten.
In this report the second version of the ENDF/B-V dosimetry and gas file (TAPE531 and TAPE533) are compared with the first version.

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Table 1a. Characteristic cross-section data for the metrology tape.
The serial number is the same as the figure number of the cross-section plot.

ENDF/B-V version	reaction	code	$\langle\sigma\rangle$ (in m^2)		resonance integral (in m^2)	σ_{2200} (in m^2)		g
			Maxwell	Watt		Maxwell	point value	
0	TI47(N,P)SC47	TI47P5	5.183E-45	2.191E-30	2.085E-33	5.848E-45	2.506E-45	2.334
2	TI47(N,P)SC47	TI47P52	0.000E+00	2.191E-30	2.035E-33	0.000E+00	0.000E+00	
0	FE54(N,P)MN54	FE54P5	1.923E-43	7.875E-30	2.196E-33	2.170E-43	9.297E-44	2.334
2	FE54(N,P)MN54	FE54P52	0.000E+00	7.875E-30	2.172E-33	0.000E+00	0.000E+30	
0	NI58(N,P)CO58	NI58P5	1.417E-41	1.021E-29	2.476E-32	1.599E-41	6.851E-42	2.334
2	NI58(N,P)CO58	NI58P52	0.000E+00	1.023E-29	1.359E-31	0.000E+00	0.000E+00	
0	IN115(N,G)IN116M	IN115G5	1.502E-26	1.259E-29	3.229E-25	1.695E-26	1.663E-26	1.019
2	IN115(N,G)IN116	IN115G52	1.901E-26	1.594E-29	3.265E-25	2.146E-26	2.105E-26	1.01
0	AU197(N,G)AU198	AU197G5	8.789E-27	7.948E-30	1.562E-25	9.917E-27	9.869E-27	1.005
2	AU197(N,G)AU198	AU197G52	8.789E-27	7.948E-30	1.562E-25	9.917E-27	9.869E-27	1.00
0	TH232(N,G)TH233	TH232G5	6.545E-28	9.315E-30	8.346E-27	7.385E-28	7.402E-28	0.998
2	TH232(N,G)TH233	TH232G52	6.545E-27	9.317E-30	8.558E-27	7.385E-28	7.402E-28	0.99
2	NP237(N,F)F.P.	NP237F52	1.606E-30	1.339E-28	1.263E-28	1.813E-30	1.846E-30	0.98
0	NP237(N,F)F.P.	NP237F5	1.419E-30	1.339E-28	1.265E-28	1.601E-30	1.668E-30	0.960
0/2	PU239(N,F)F.P.	PU239F5	6.942E-26	1.790E-28	2.788E-26	7.833E-26	7.413E-26	1.057
0/2	U238(N,F)F.P.	U238F52	4.678E-34	3.003E-29	6.037E-31	5.279E-34	5.280E-34	1.00

Table 1b. Characteristic cross-section data for the gas tape.

0	3LI7-D-TOTAL	D-LI7-B5	0.	1.466E-33	0.	0.	0.	
2	3LI7-D	D-LI7-V2	0.000E+00	1.589E-33	0.000E+00	0.000E+00	0.000E+00	
0	3LI7-HE-TOTAL	HE-LI7B5	6.348E-30	2.406E-30	3.134E-30	7.163E-30	7.195E-30	0.996
2	3LI7-HE	HE-LI7V2	0.000E+00	2.037E-30	0.000E+00	0.000E+00	0.000E+00	
0	3LI7-T-TOTAL	T-LI7-B5	0.	2.399E-30	0.	0.	0.	
2	3LI7-T	T-LI7-V2	0.000E+00	2.036E-30	0.000E+00	0.000E+00	0.000E+00	
2	3LI7-H	H-LI7-V2	0.000E+00	3.523E-35	0.000E+00	0.000E+00	0.000E+00	

The comparison is made after conversion to a 640 group structure, which is standard practice in our laboratory.

2. THE CROSS-SECTION LIBRARIES

The two sets of two fine group cross-section libraries with ENDF/B-V dosimetry file information have the same group structure up to 20 MeV. The second version of the ENDF/B-V files TAPE531 and TAPE533 were received in April 1984 from the OECD.
These data were converted with aid of the program ENTOSAN. The results of this program have been compared with the fine cross-section library obtained for the original version of the two ENDF/B-V files TAPE531 and TAPE533.

3.COMPARISON

With a modified version of a small utility program, SIGRATI, the ratio of the corresponding group cross-section values of the two libraries were calculated and plotted vs. energy (see figs. 1-12).
The numerator of the ratio is formed by the version 2 data and the denominator by the old version.
For the reactions which show differences also some characteristic data are presented in table 1. The Westcott g-value, listed in the last column, is calculated as the ratio of the average cross-section in a Maxwellian spectrum multiplied by $2/\sqrt{\pi}$, and the 2200 $m.s^{-1}$ point cross-section value.

4. RESULTS

The plots indicate that for 9 reactions of the metrology tape the results of the two versions were different. These reactions are:
$^{47}Ti(n,p)$, $^{54}Fe(n,p)$, $^{58}Ni(n,p)$, $^{115}In(n,\gamma)$, $^{197}Au(n,\gamma)$, $^{232}Th(n,\gamma)$, $^{237}Np(n,f)$, $^{239}Pu(n,f)$ and $^{238}U(n,\gamma)$.
Figs.5, 8 and 9 show that the differences for the reactions $^{197}Au(n,\gamma)$, $^{239}Pu(n,f)$ and $^{238}U(n,\gamma)$ are very small.
It is not completely sure that these differences are due to modifications in the ENDF/B-V tapes. They may be due to a small change in the program ENTOSAN.

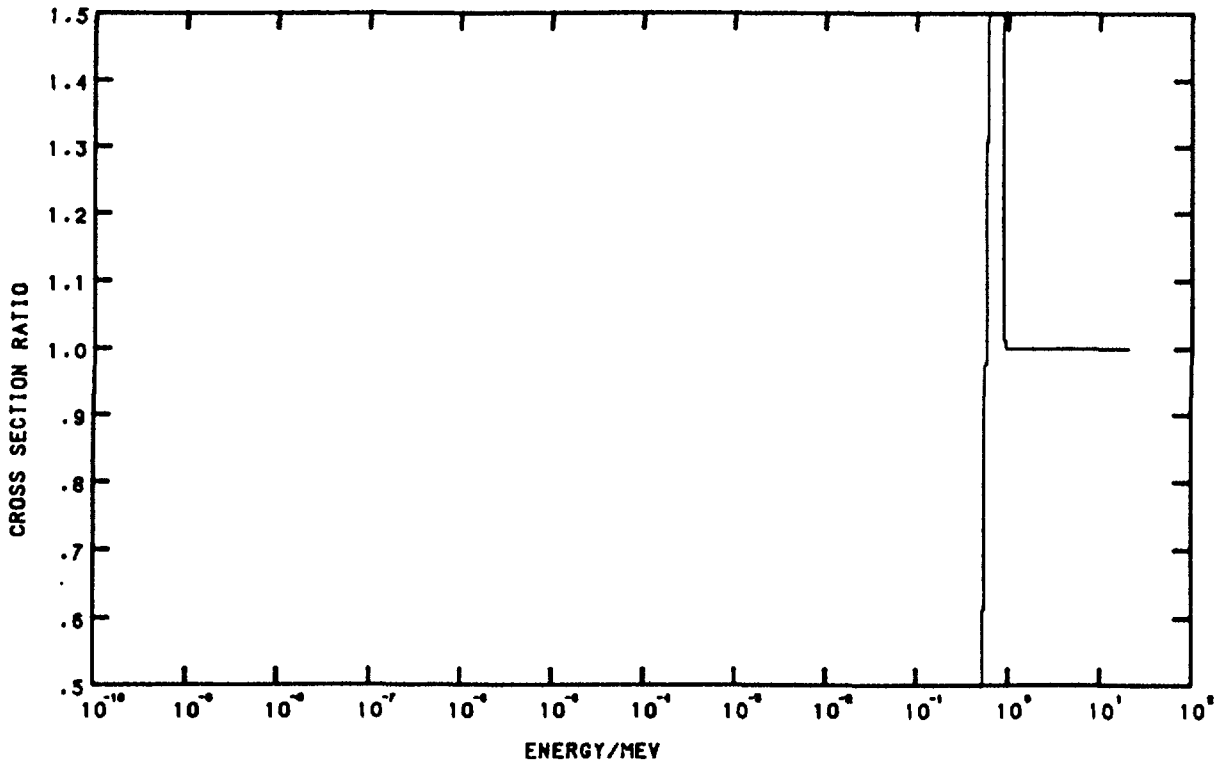

Fig.1. CROSS SECTION RATIO FOR THE REACTION TI47(N,P)SC47

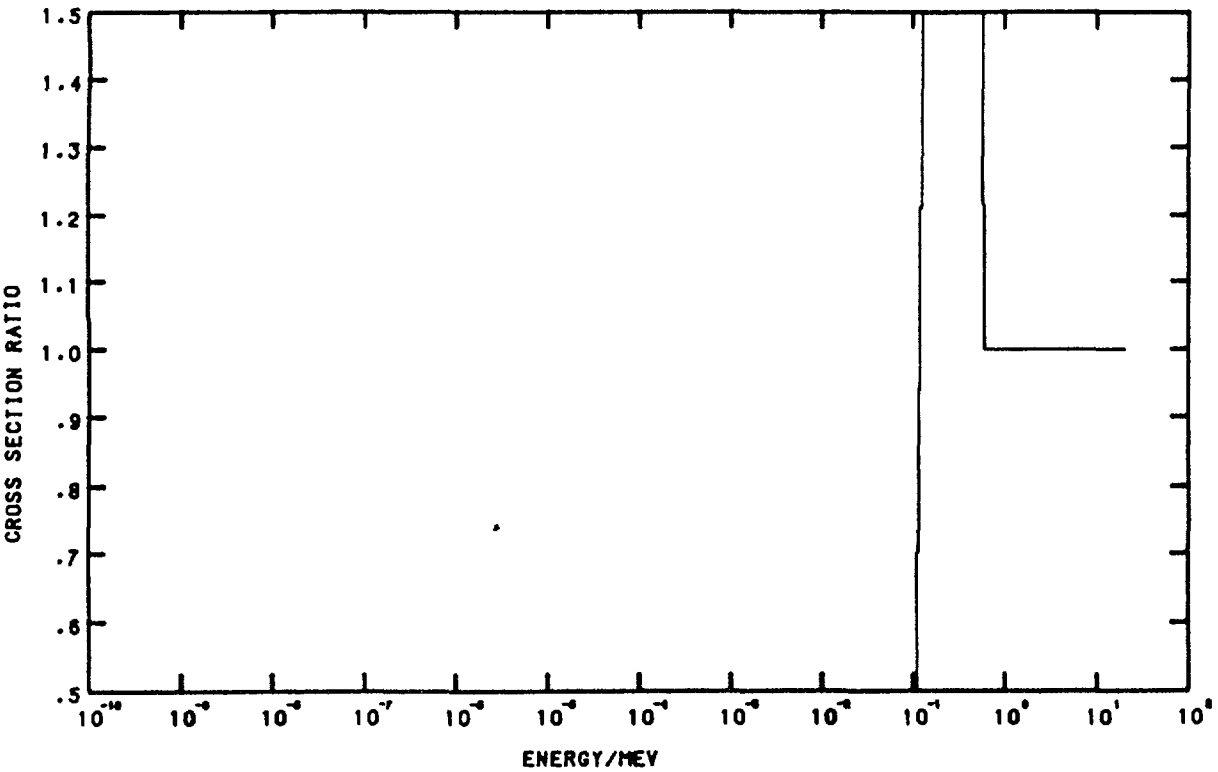

Fig.2. CROSS SECTION RATIO FOR THE REACTION FE54(N,P)MN54

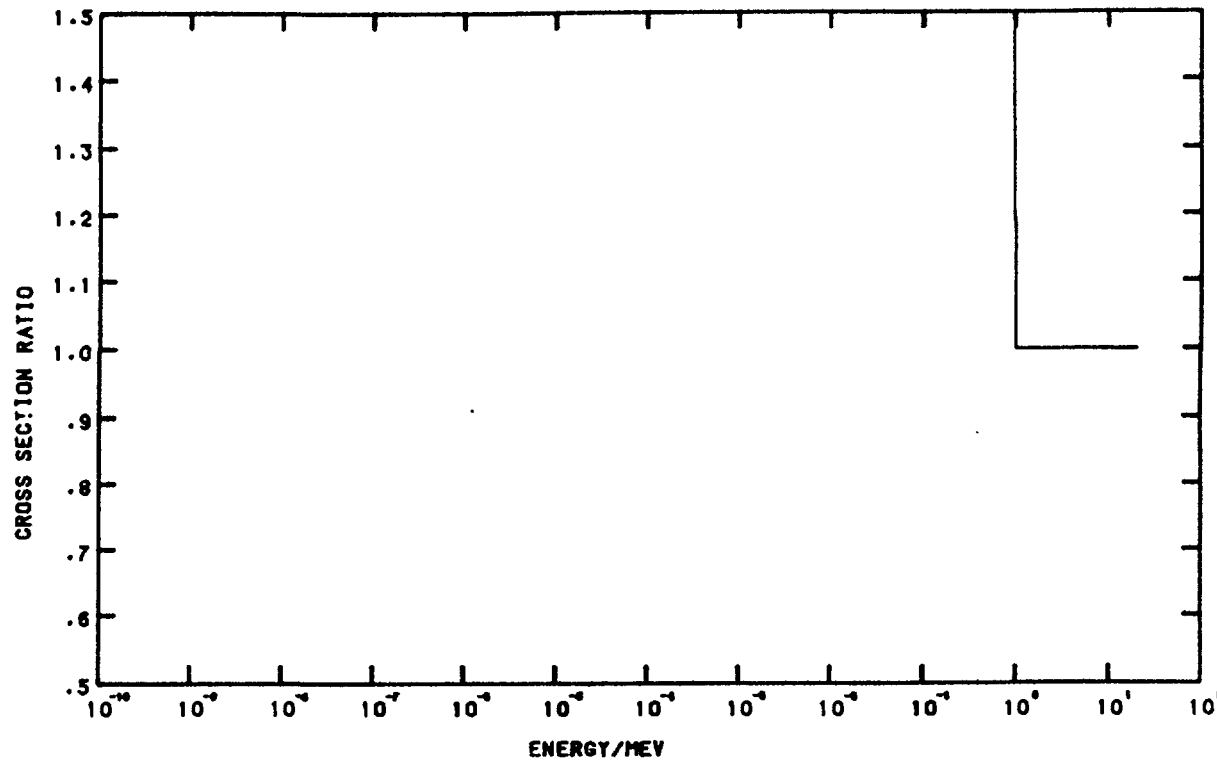

Fig.3. CROSS SECTION RATIO FOR THE REACTION NI58(N,P)CO58

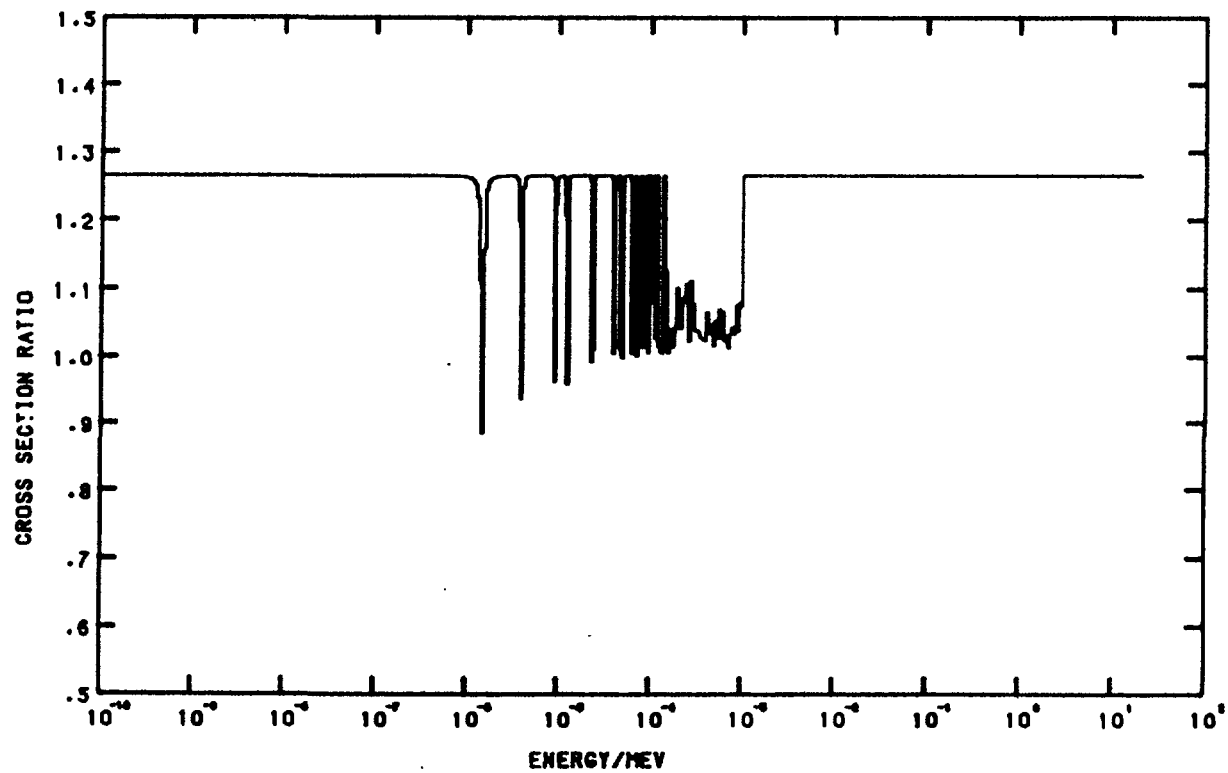

Fig.4. CROSS SECTION RATIO FOR THE REACTION IN115(N,G)IN116M

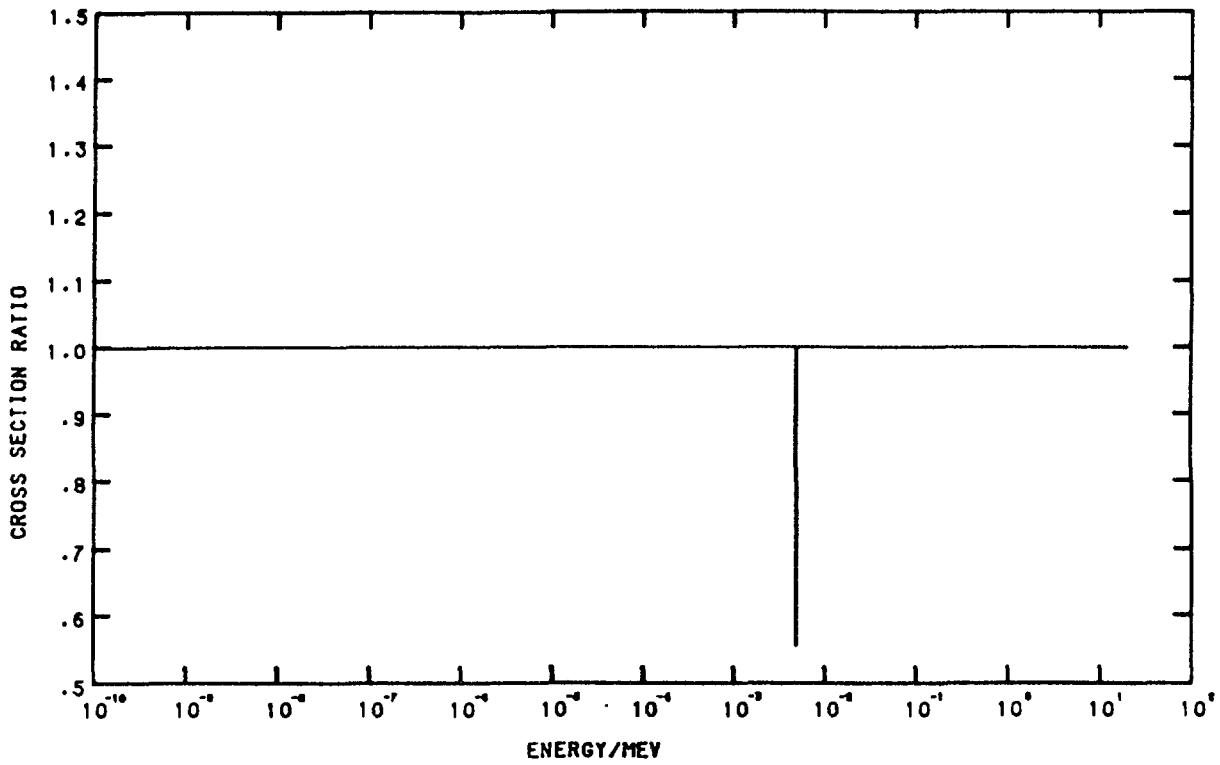

Fig.5. CROSS SECTION RATIO FOR THE REACTION AU197(N,G)AU198

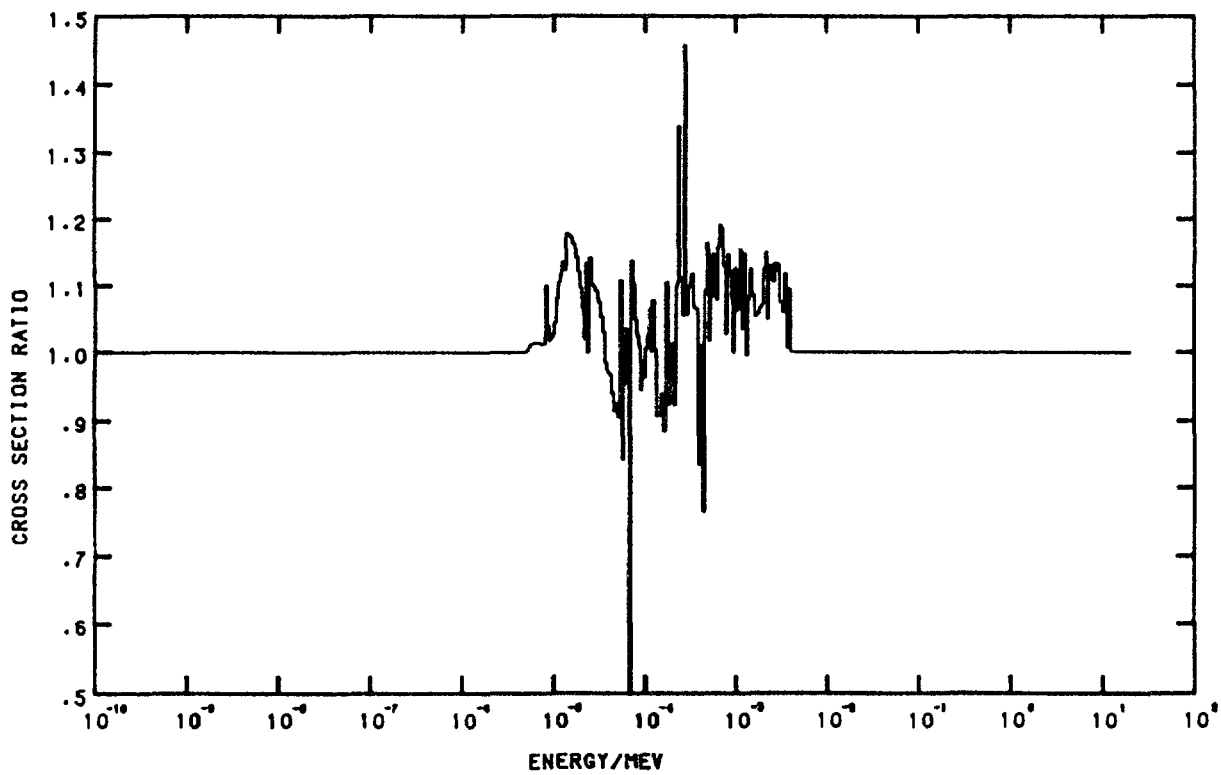

Fig.6. CROSS SECTION RATIO FOR THE REACTION TH232(N,G)TH233

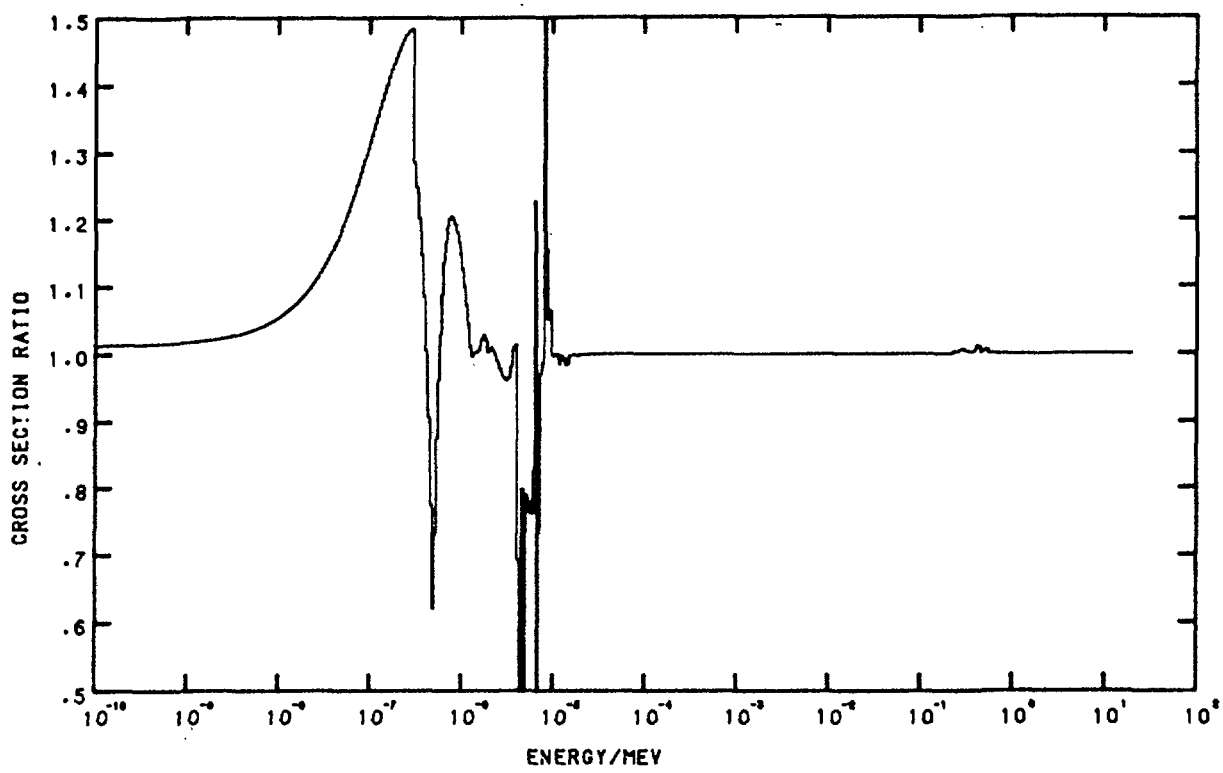

Fig.7. CROSS SECTION RATIO FOR THE REACTION NP237(N.F)F.P.

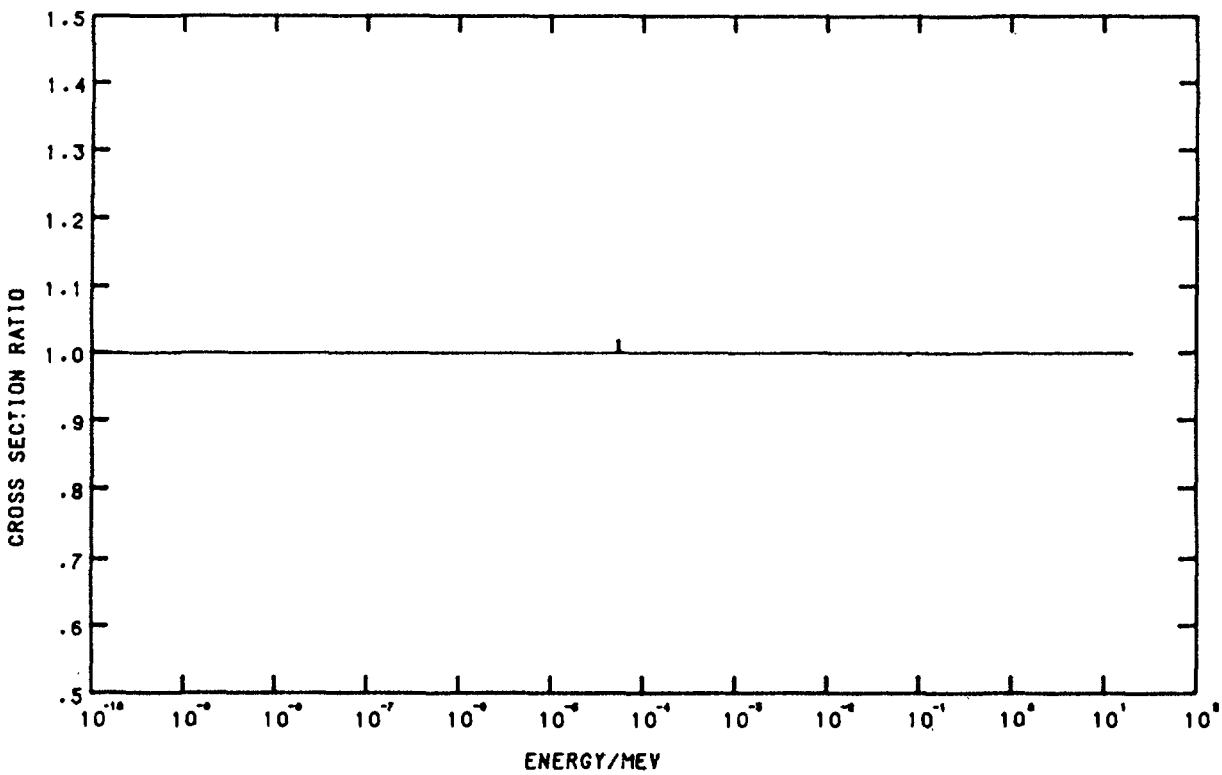

Fig.8. CROSS SECTION RATIO FOR THE REACTION PU239(N.F)F.P.

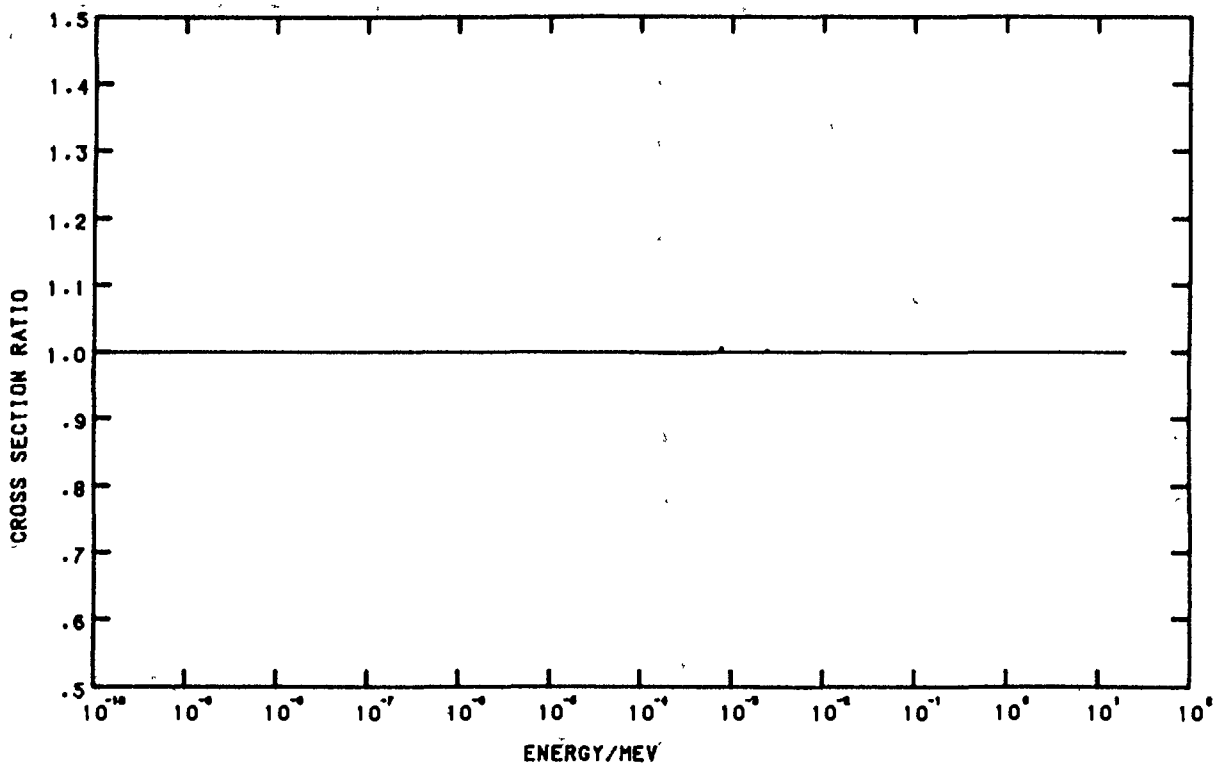

Fig.9. CROSS SECTION RATIO FOR THE REACTION U238(N,G)U239

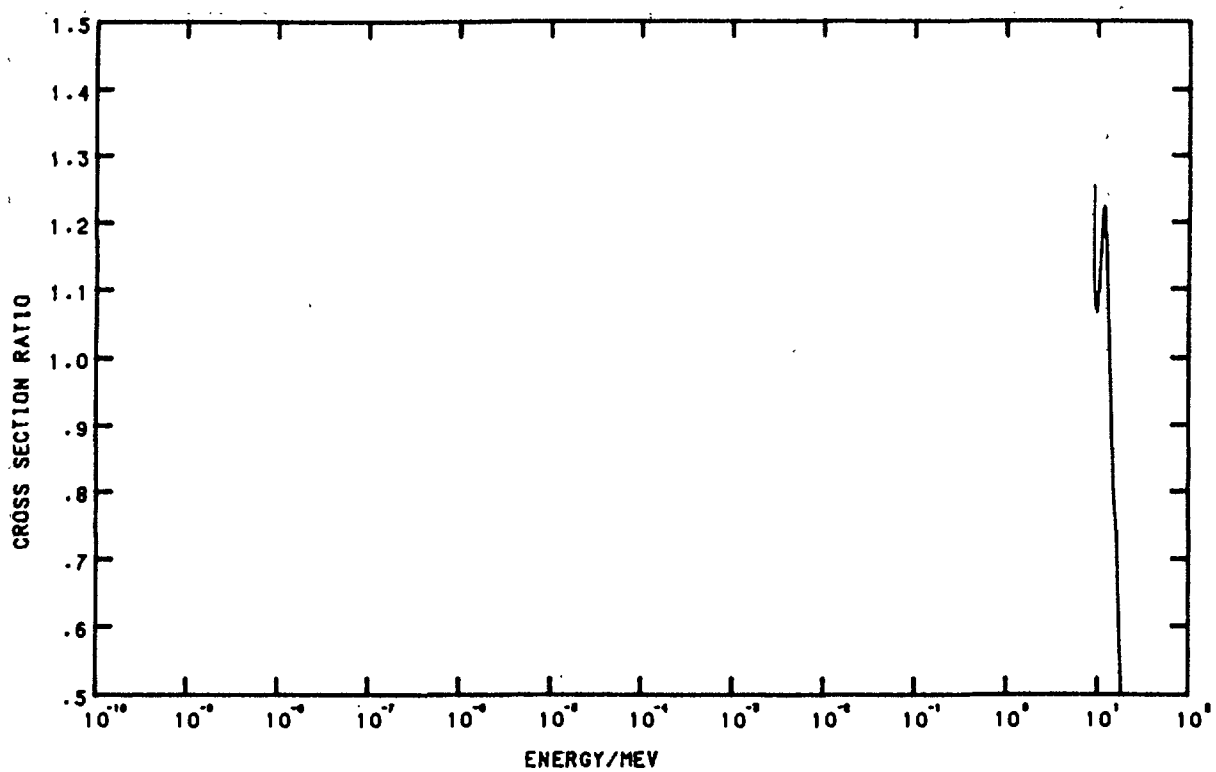

Fig.10. CROSS SECTION RATIO FOR THE REACTION 3LI7-D-TOTAL

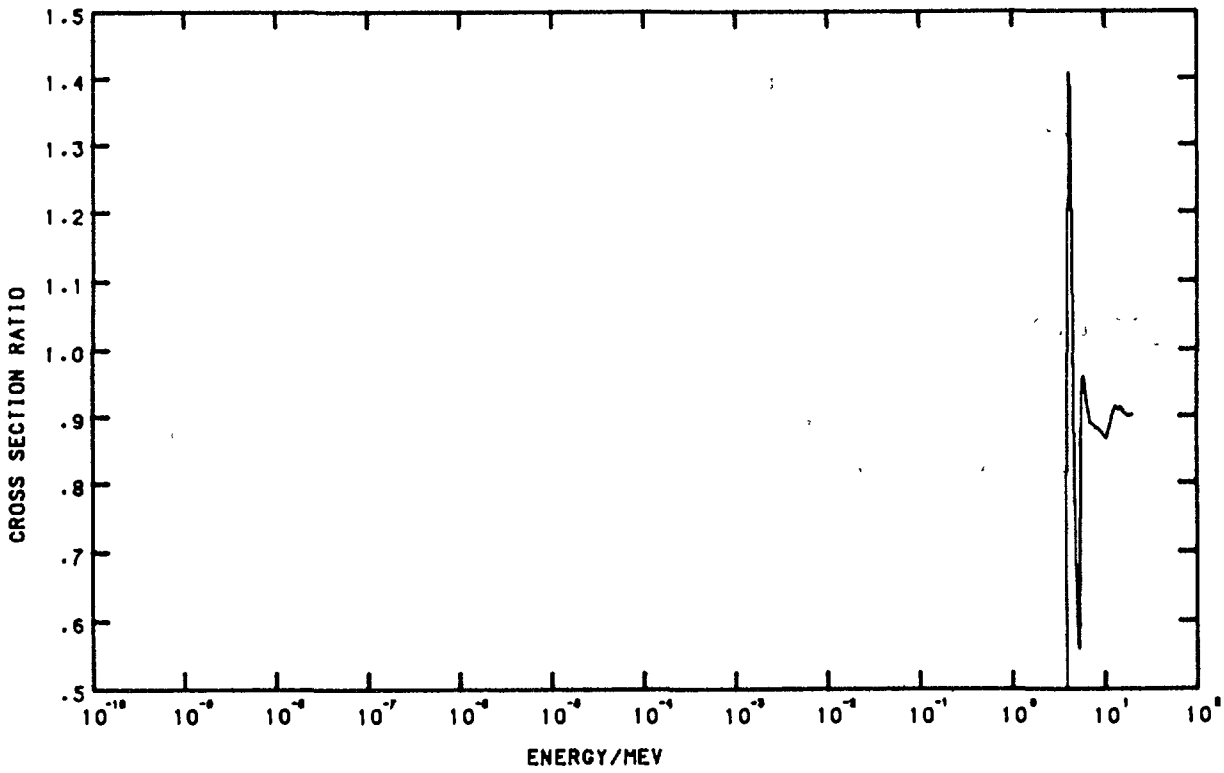

Fig.11. CROSS SECTION RATIO FOR THE REACTION 3LI7-HE-TOTAL

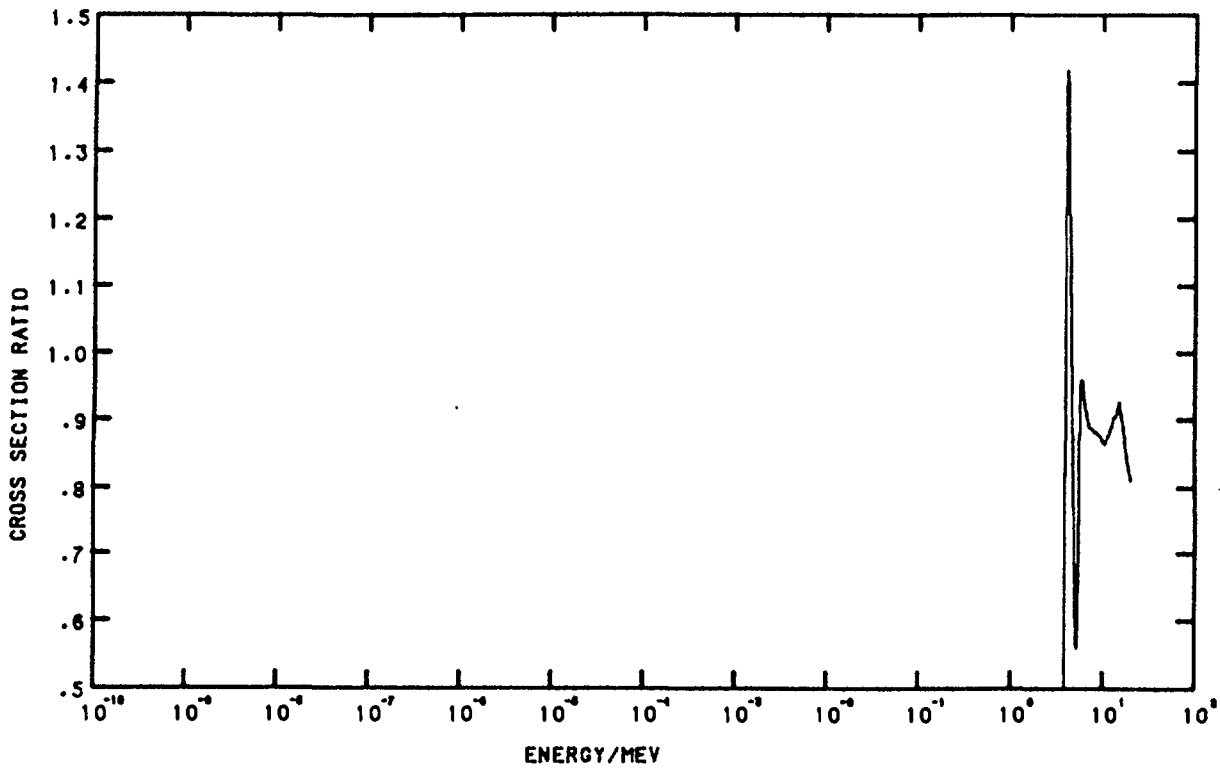

Fig.12. CROSS SECTION RATIO FOR THE REACTION 3LI7-T-TOTAL

For the gas tape differences between the original and the second version were found for the reactions: $^{7}_{3}Li(n,d)$, $^{7}_{3}Li(n,\alpha)$ and $^{7}_{3}Li(n,total)$.
In the second version also the reaction $^{7}_{3}Li(n,p)$ is present.
Ratios for the differences in the cross-section are shown in figs.10...12.
In table 1 the characteristic cross-section data are shown.

5. REFERENCES

[1] Simons, R.L., and McElroy, W.N.: "Evaluated reference cross-section library",
BNWL-1312 (Richland, May 1970).

[2] Rieffe, H.Ch., Nolthenius, H.J., and Zijp, W.L.:
"ENTOSAN. A program for the calculation of fine group cross section values from ENDF/B data",
ECN-93 (Petten, April 1981).