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Total Cross Section of Nd, V, In, I and Bi for 3,2 - 5,2 MeV Neutrons

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In the course of a program on total neutron cross section measurements with good resolution we have measured the total cross sections of Nd, V, In, I and Bi for neutrons of energies between 3,2 and 5,2 MeV with a resolution of about ± 30 keV. The neutrons were produced by bombarding a heavy ice target with deuterons.

For the neodimium measurements we have used neodimium oxide in powder form with a purity better than 99,6%, canned under pressure in a thin-walled brass cylinder and sealed air-tight in order to prevent the absorption of moisture. Prior to the canning and sealing the neodimium oxide was heated to ~900°C to drive off all the CO_2 or water it could have absorbed. For the vanadium measurements we have used vanadium in powder form with a purity of 99,5% canned in a air-tight thin-walled brass cylinder. The same method was used for the iodine, where we have used resublimed iodine with a purity of 99,98%. The indium (purity 99,95%) and bismuth samples (purity 99,7%) were cylinders 29,5 cm in diameter obtained by vacuum melting to prevent pinholing. In all the cases the length of the samples was chosen to have a transmission of about 50%.

In the case of neodimium the neutron cross section was obtained by substracting from the measured Nd_2O_3 cross section the oxigen cross section taking into account the hardening effects of the oxigen resonances in this range of energy. For the total cross section of the oxigen we have taken the values of Fossan et al. (1), kindly supplied to the author.

The total statistical errors of the measurements were between ± 4% and ± 5,5%, depending of the energy, for the neodimium; about ± 2% for indium and iodine and ± 2,5% for vanadium and bismuth. The mean neutron energy accuracy is ± 5 keV and the neutron energy spread ± 30 keV.

The results on neodimium were published in Ann. Real Soc. Esp. Fis. Quim. 59 A, 179 (1963) and the measurements on the other elements were sent

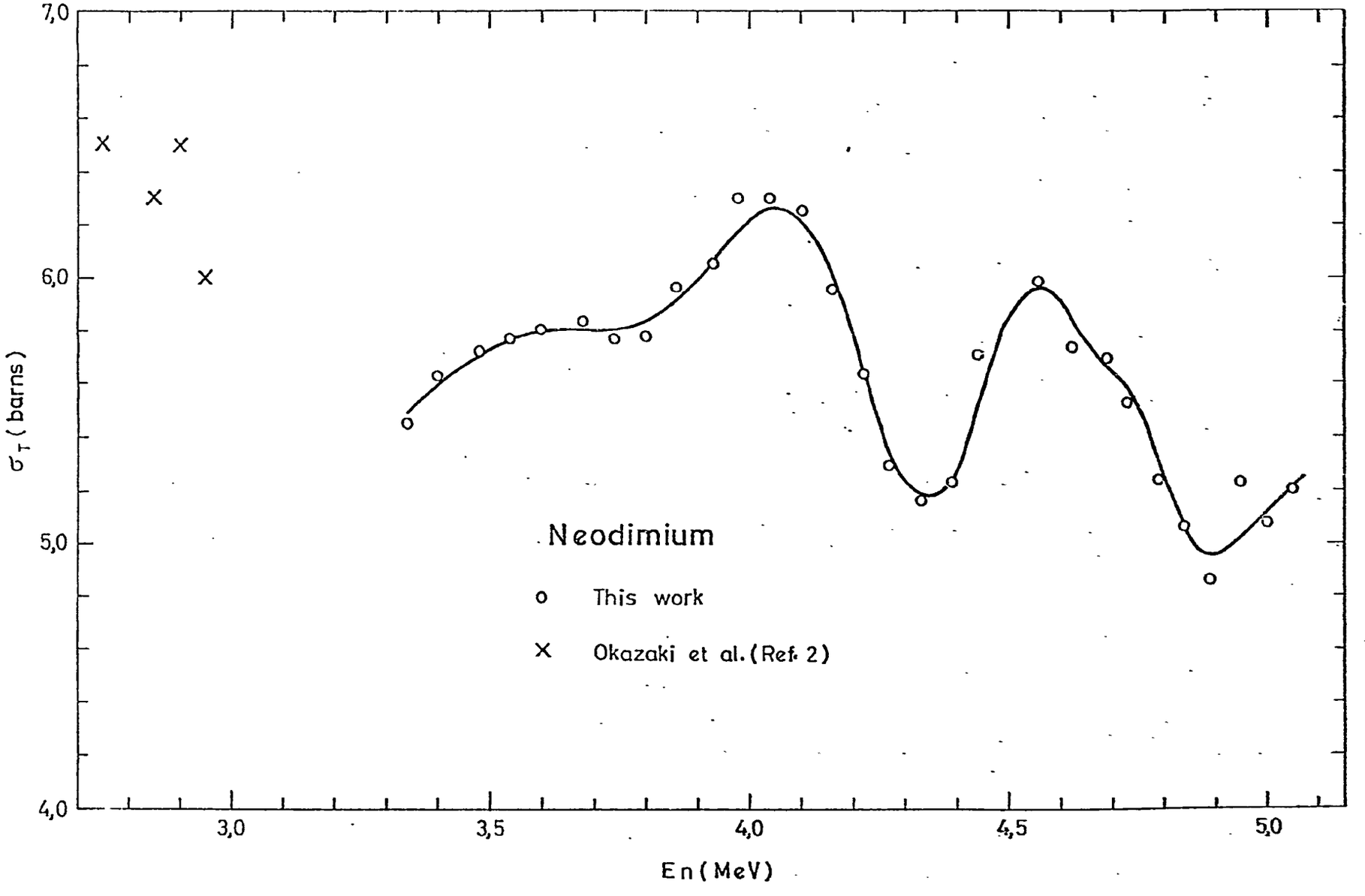
7,0
6,0
5,0
4,0
σ_T (barns)
3,0
3,5
4,0
4,5
5,0
En (MeV)
Neodimium
o This work
X Okazaki et al. (Ref. 2)

Figure-1

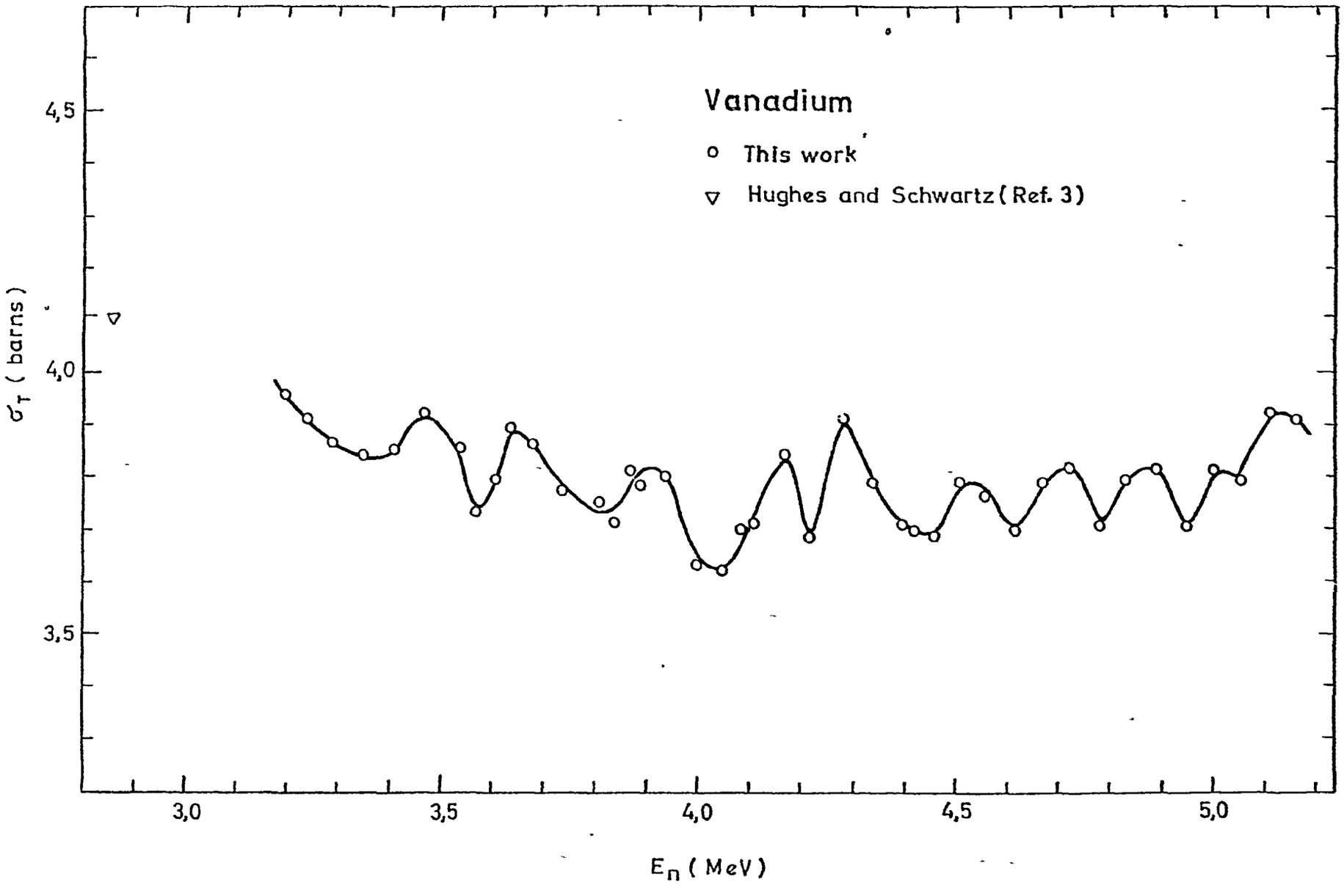
Vanadium
This work
Hughes and Schwartz (Ref. 3)
4,5
4,0
3,5
σ_T (barns)
3,0
3,5
4,0
4,5
5,0
E_n (MeV)

Figure-2

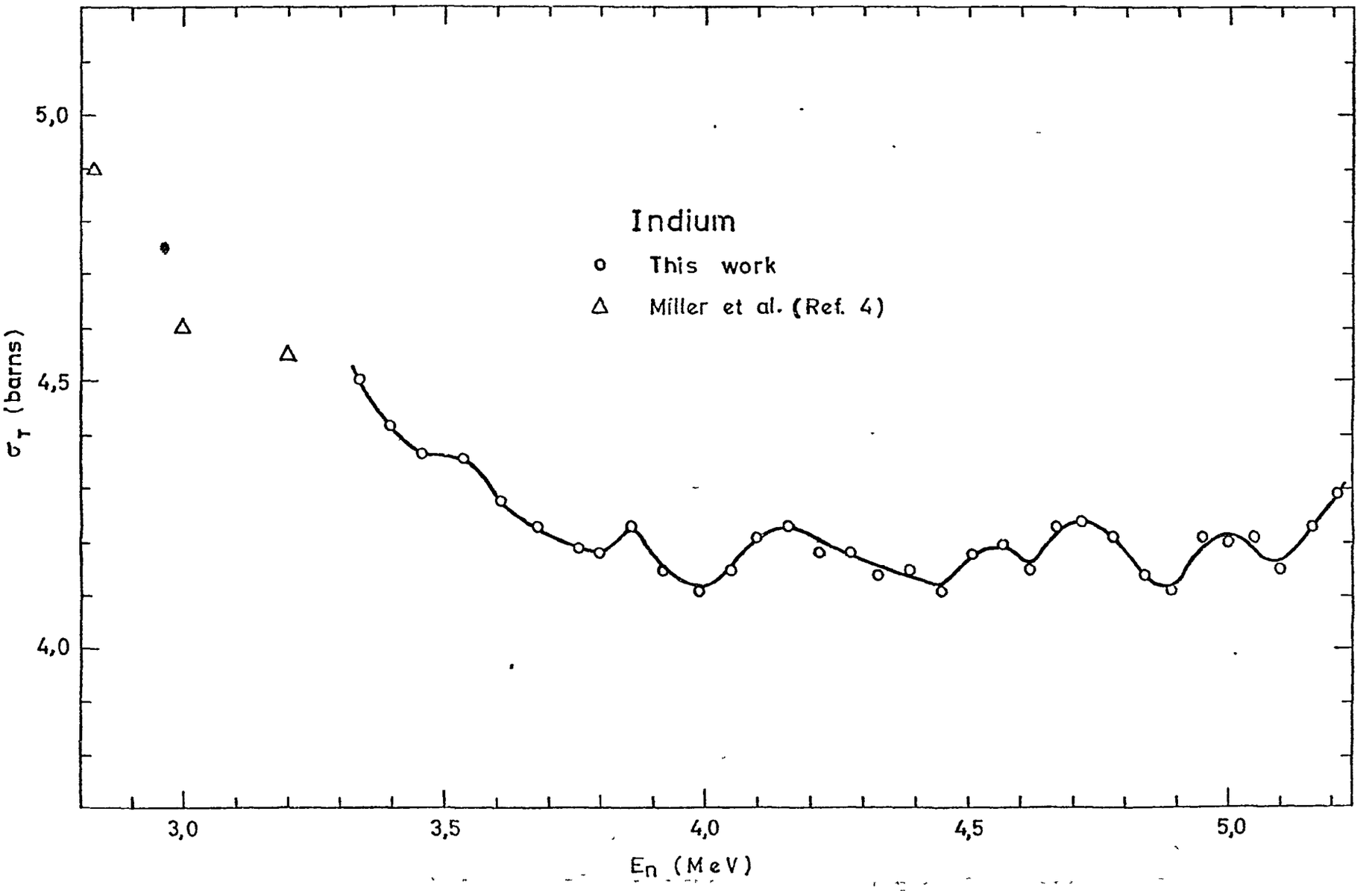
Indium
This work
Miller et al. (Ref. 4)
5,0
4,5
4,0
σ_T (barns)
3,0
3,5
4,0
4,5
5,0
En (MeV)

Figure-3

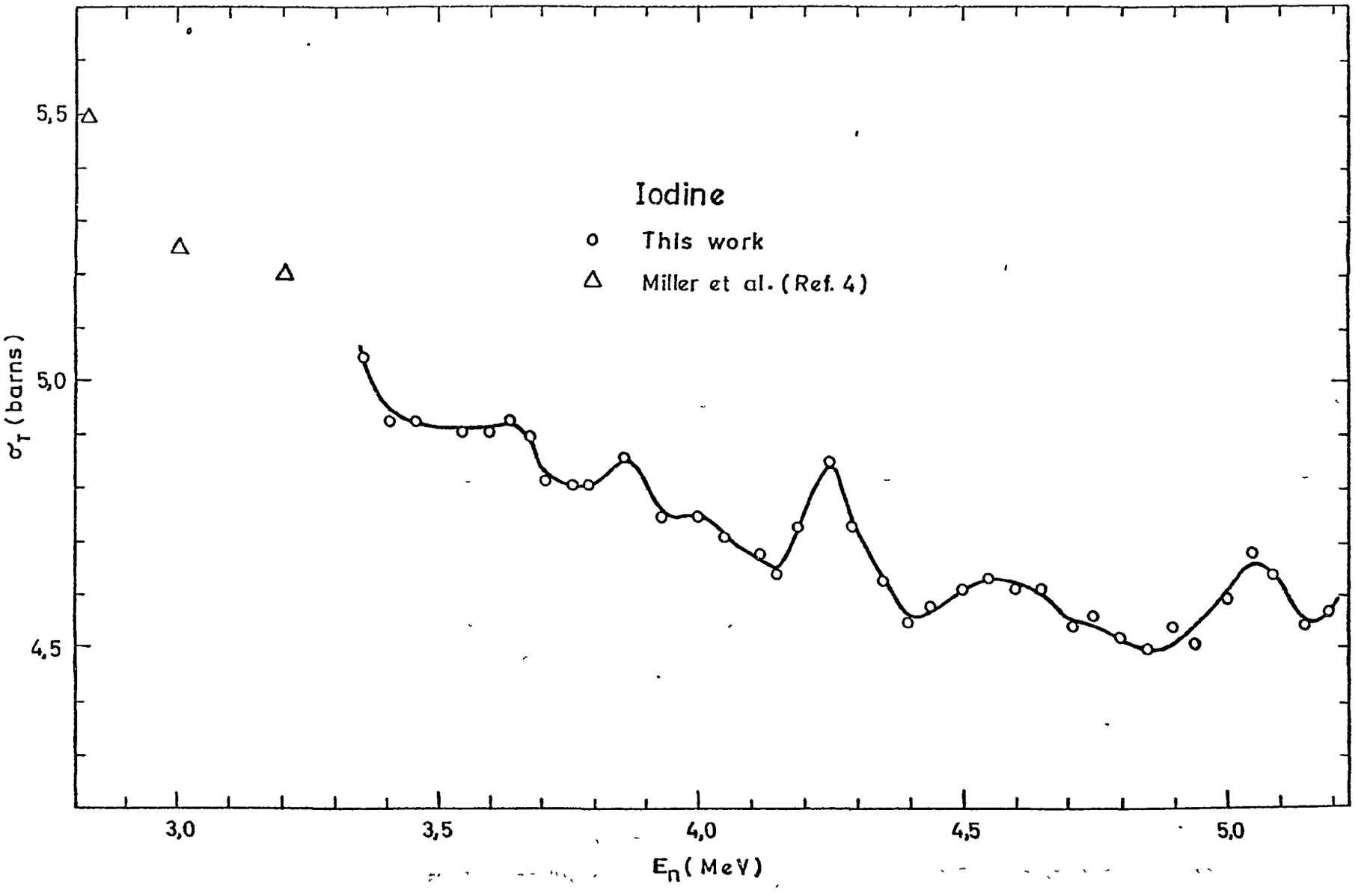
Iodine
o This work
Δ Miller et al. (Ref. 4)
5,5
5,0
4,5
σ_T (barns)
3,0
3,5
4,0
4,5
5,0
E_n (MeV)

Figure-4

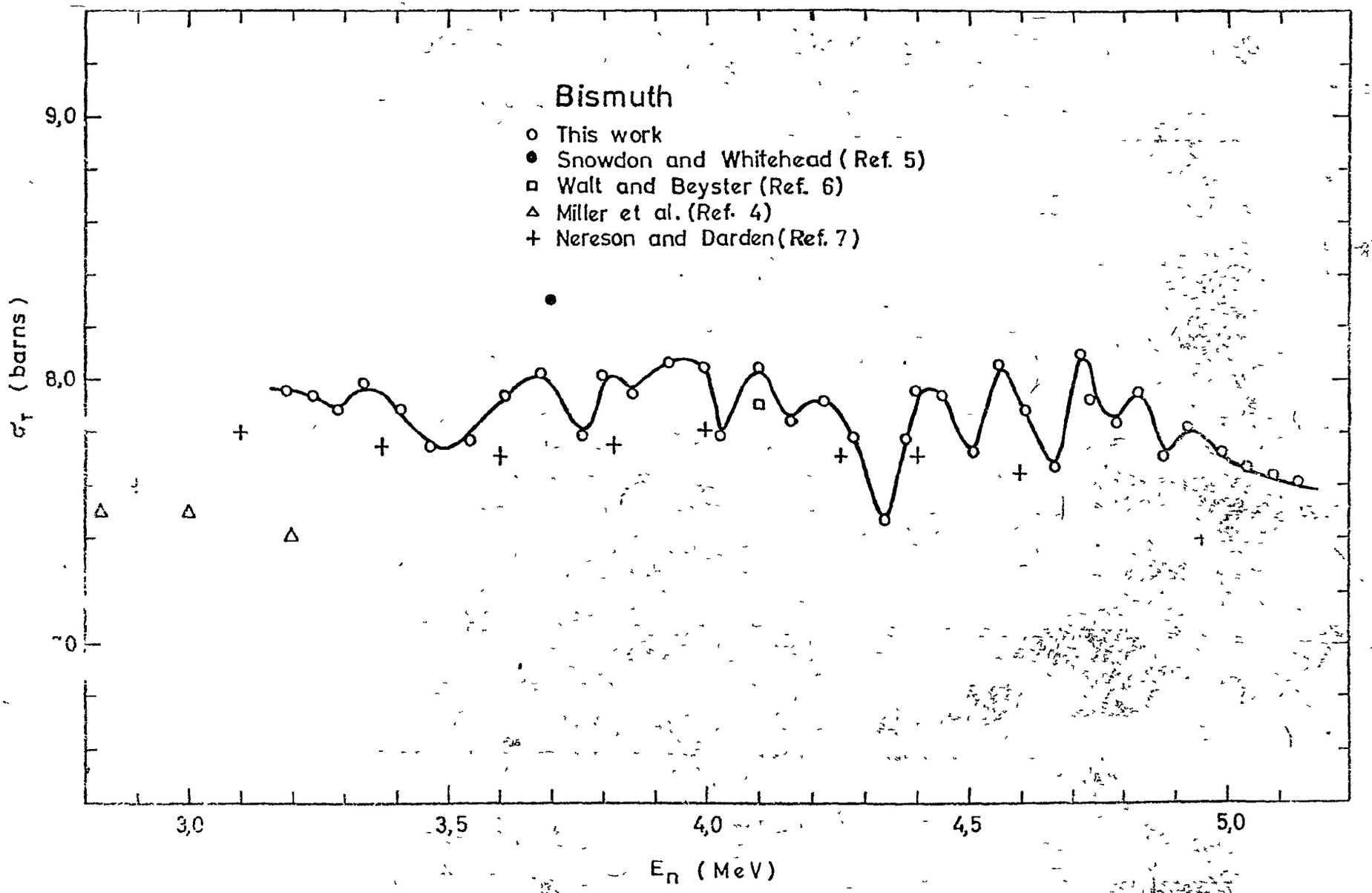
Bismuth
o This work
● Snowdon and Whitehead (Ref. 5)
□ Walt and Beyster (Ref. 6)
△ Miller et al. (Ref. 4)
+ Nereson and Darden (Ref. 7)
9,0
8,0
~0
σ_T (barns)
3,0
3,5
4,0
4,5
5,0
E_n (MeV)

Figure-5

to Nuclear Physics, being accepted for publication. They appeared also in the J.E.N. unpublished inner reports. MF/9 (Oct. 1963) MF/11 (Apr. 1964) and MF/12 (Sept. 1964).

In figures 1-5 are given the results of the measurements together with previously published values. The agreement with ours seems good.

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Phys. Rev. 89, 775 (1953)

Nuclear Shell Effects in the (n,2n) Cross Sections at 14 MeV

F. Manero

A compilation of all the reported experimental data, till March 1965, on the total (n,2n) reaction cross section at approximately 14 MeV neutron has been made.

Weighted means have been obtained for each isotope, which were plotted versus Z and N = A-Z to investigate the possible existence of a shell effect, similar to the reported for the total (n,α) and (n,p) reaction cross sections (1). It was found that for about the lower half part of the Z and N range marked proton and neutron shell and subshell effects are present being less clear these effects for the upper half, due in part to the scarcity of data. The results of this study will be submitted to the "International Conference on the Study of Nuclear Structure with Neutrons" that will be held at Antwerp, July 1965.

REFERENCES

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A. Chatterjee. Nucl. Phys. 60, 273 (1964)

On the Level Scheme of Th^{231}

R. Gaeta and M.A. Vigón

To obtain a more coherent level scheme of Th^{231} than the existing till now, the decay of U^{235} has been investigated. From the data obtained on α and γ spectra, γ-γ coincidences and Vorovov results on α-γ coincidences a decay scheme could be deduced.

The measurements on the α spectrum of U^{235} have been made with a high resolution semiconductor spectrometer. The thickness of the normally used samples was 10-20 $\mu gr/cm^2$ but to determine the intensity of some lines thickness of 40-60 $\mu gr/cm^2$ were required. The results are listed in Table I where only the peaks identified in at least seven of ten independent spectra have been given. 19 of these lines had not been previously reported (1).

The gamma spectrum has been obtained with an scintillation spectrometer. Samples of 60 $\mu gr/cm^2$ were used for the low energy region to decrease the interference of the K_x radiation of uranium. The measurements on the high energy region were performed with 5g of uranile nitrate free from Th and Pa. The obtained results are given in Table II. 13 of the observed lines had not been previously identified (2).

The γ-γ coincidences have been observed with a conventional spectrometer and the corresponding results are given in Table III. The clearly observed coincidences are marked with a cross and the dubious ones with an interrogation point. The only observed coincidences till now were the 200 - (100, 144, 184) keV and the 74 - (110, 220) keV (3).

The rough scheme is given in fig. 1 and the proposed assignements in fig. 2. Below 400 keV, there remain only two unclassified levels, namely the 84 keV and the 325 keV ones, both of very low intensity. There is a system of levels above 400 keV, probably due to rotational bands of β and γ vibrational states. More experimental data are however necessary to attempt a classification in this region.

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Table I

Energy (keV)	Level (keV)	Intensity (%)
4592 ± 3	0	1,2
4579 ± 3	13	1,8
4559 ± 3	33	2,5
4550 ± 3	42	1,7
4537 ± 10	55	< 0,5
4522 ± 3	70	< 1,0
4510 ± 10	82	< 0,5
4496 ± 3	96	1,4
4478 ± 3	114	1,6
4438 ± 3	154	2,1
4424 ± 5	168	1,8
4411 ± 5	181	2,3
4394 ± 3	198	53 ± 1,3
4368 ± 5	224	6,1
4362 ± 3	230	12,3
4339 ± 5	253	< 1,0
4319 ± 3	273	3,5
4289 ± 10	303	< 0,5
4267 ± 10	325	< 0,3
4240 ± 10	352	< 0,5
4210 ± 3	380	6,2
4184 ± 3	408	1,3
4164 ± 10	428	< 0,5
4140 ± 3	452	1,0
4131 ± 10	461	< 0,5
4091 ± 10	501	
4069 ± 10	523	
3977 ± 10	615	
3945 ± 10	647	
3892 ± 20	700	
3835 ± 20	757	
3769 ± 20	825	

Table II

Energy (keV)	Intensity (%)
46 ± 4	< 1
78 ± 4	< 1
97 ± 4	< 1
109 ± 4	4,9
115 ± 4	< 1
144 ± 2	11,3
151 ± 4	< 1
184 ± 2	54,9 ± 1,5
196 ± 4	4,5
285 ± 5	10^{-3}
350 ± 5	6×10^{-3}
430 ± 5	10^{-3}
510 ± 5	3×10^{-3}
620 ± 10	2×10^{-3}
670 ± 10	6×10^{-3}
760 ± 10	10^{-3}
1010 ± 20	10^{-4}

Table III

	L_x	50	70	75	77	92	109	134	144	154	173	184	196
L_x			x			x			x	x	?	x	
50							x	?			?	x	?
75					x	x	x						?
109		x	x	x		x							x
144			x			x							x
184		?	?										x
196			x			x	x	?	x		?	x	

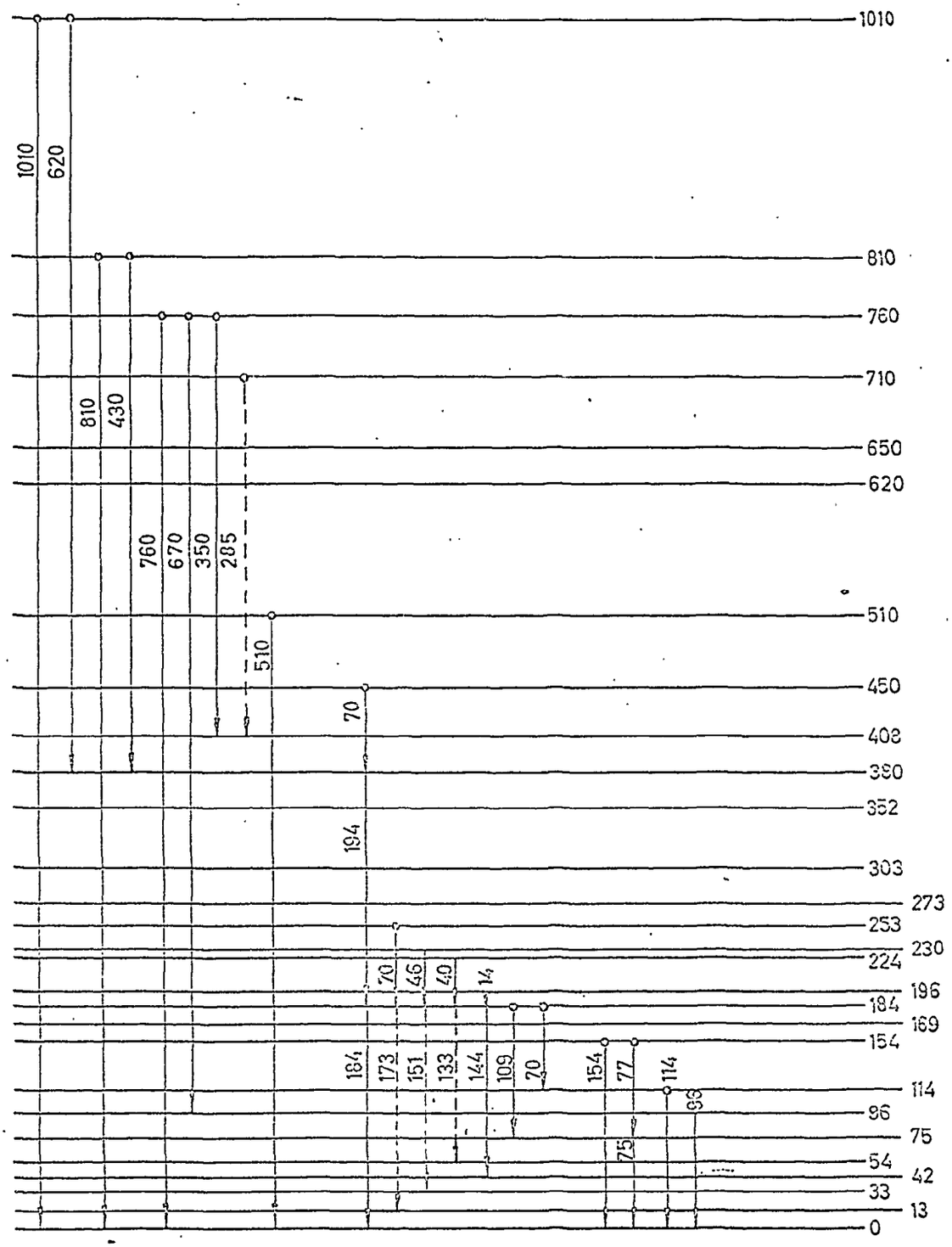
1010
810
760
710
650
620
510
450
408
380
352
303
273
253
230
224
196
184
169
154
114
96
75
54
42
33
13
0
1010
620
810
430
760
670
350
285
510
70
194
70
46
40
14
184
173
151
133
144
109
70
154
77
114
96
75

Fig. 1

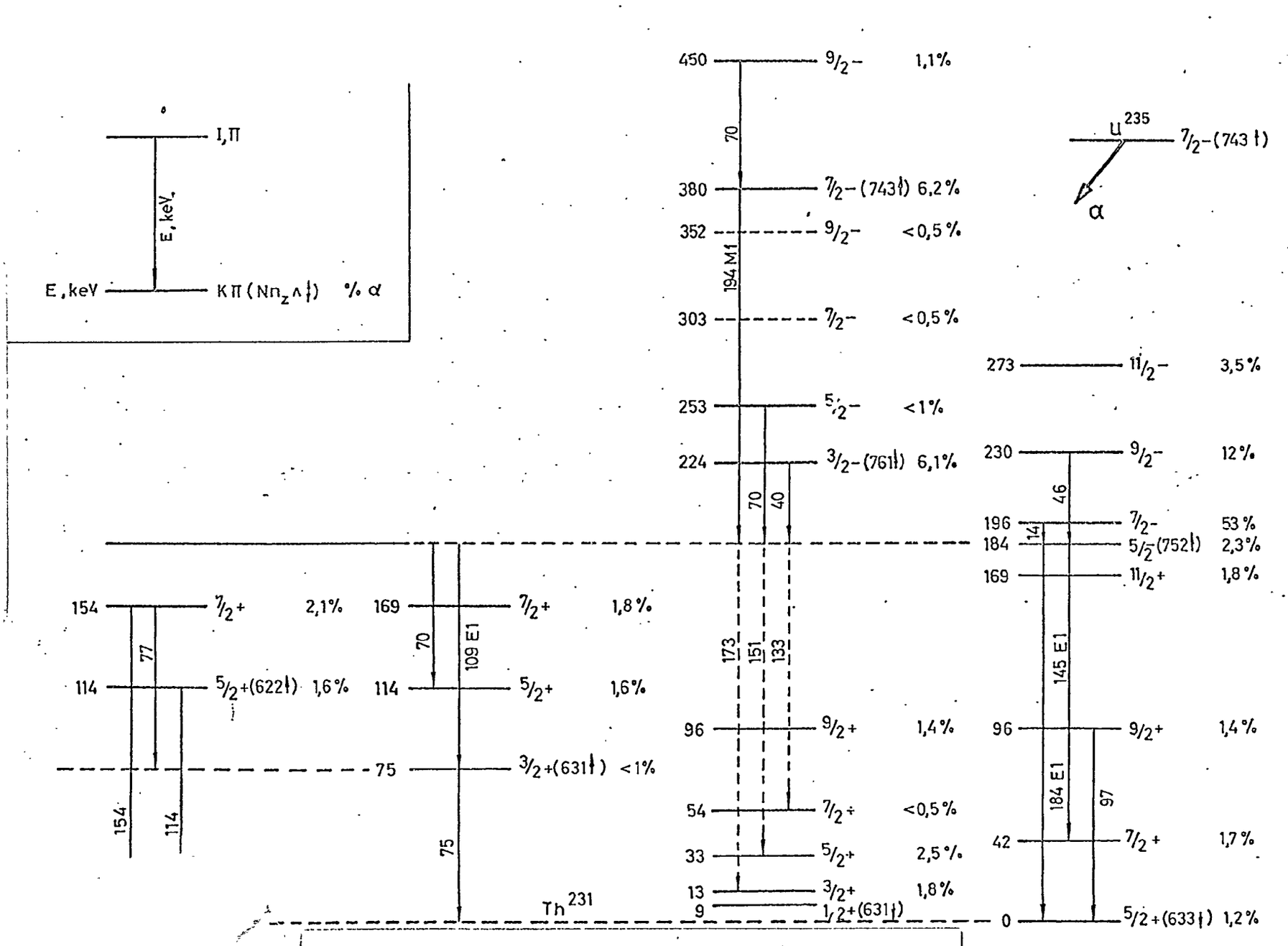
I,Π
E, keV
E, keV
KΠ(Nn_z Λ↓) % α
450 9/2− 1,1%
70
380 7/2−(743↑) 6,2%
352 9/2− <0,5%
194 M1
303 7/2− <0,5%
253 5/2− <1%
224 3/2−(761↑) 6,1%
70
40
173
151
133
96 9/2+ 1,4%
54 7/2+ <0,5%
33 5/2+ 2,5%
13 3/2+ 1,8%
9 1/2+(631↑)
0 5/2+(633↑) 1,2%
154 7/2+ 2,1%
77
114 5/2+(622↑) 1,6%
154
114
75 3/2+(631↑) <1%
169 7/2+ 1,8%
70
109 E1
114 5/2+ 1,6%
75
Th231
U235
7/2−(743↑)
α
273 11/2− 3,5%
230 9/2− 12%
46
196 7/2− 53%
14
184 5/2−(752↑) 2,3%
169 11/2+ 1,8%
145 E1
96 9/2+ 1,4%
184 E1
97
42 7/2+ 1,7%

Fig. 2