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ON THE METHODOLOGY OF THE INTERCOMPARISON OF TND EVALUATIONS

S. Yiftah, M. Caner and Y. Gur

Contributed Paper submitted at the Second IAEA Advisory
Group Meeting on Transactinium Isotope Nuclear Data
2-5 May 1979, Cadarache, France

Israel Atomic Energy Commission
Soreq Nuclear Research Centre

March 1979

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I. INTRODUCTION

During the First IAEA Advisory Group Meeting on Transactinium Nuclear Data in Karlsruhe, November 1975,the authors presented as a summary of their paper* the following four (out of a total of nine) conclusions:

- In general, it is advisable that two separate evaluations be done of each nuclide, these two to be critically compared and analysed in various ways, in order to discover inconsistent and discrepant data and to improve future evaluations.

- Comparative critical analysis of different nuclear data files and evaluations should be sponsored by the IAEA for the benefit of all users.

- At the present stage of nuclear technology and applications on one hand, and the relatively important world-wide nuclear data measurement programs on the other, it is reasonable to consider, in general, that the half-life of a good reliable nuclear data evaluation should not be more than three years. All evaluations should be checked for revisions or complete reevaluation - at least at three-year intervals.

- All evaluations should contain at least rough estimates of the uncertainties in the recommended data. These estimates should be included in the "General information" section of evaluated data files.

Today, we have several evaluations of the same nuclide, performed independently by different groups, both within and outside the framework of the IAEA TND Coordinated Research Program, and one should try to specify the methodology of the intercomparison.

II. LEVELS OF INTERCOMPARISON

Given two independent complete nuclear data evaluations of the same nuclide, the questions and problems that come to mind immediately are the following:

(1) Are the evaluations based on the same body of experimental information? In other words, does one of the evaluations use experimental data not available to the other group?

*IAEA-186, III, 165 (1976)

(2) Assuming that the energy range is subdivided, as usual, into thermal, resolved resonances, unresolved resonances and fast, what are the theoretical methods used to calculate the different nuclear data in the four ranges?

(3) Are the parameters of the different nuclear models (spherical optical model, deformed optical model, statistical model, one-humped and two-humped fission model) used in the calculations identical or different?

(4) What are the differences in recommended data in the four energy ranges? It is useful to have both tabular and graphical display of the differences.

(5) Importance of the differences in recommended data for different applications. Here we enter into the area of sensitivity analysis.

(6) Testing of the recommended data using benchmarks. Intercomparison between different evaluations and experimental benchmarks, if these exist. At this stage one has also to process the evaluated data to be used as input to computation models. One should be careful to use identical procedures if one wants to draw conclusions relevant to the evaluated data intercomparison.

(7) Detailed analysis to discover the reasons of the differences in evaluated data and feedback to the evaluators for checking and improving the evaluations.

It is clear from the above that a detailed intercomparison of evaluations can be a multi-levelled exercise of considerable detail, not all stages of which can be always performed. It is also clear that a detailed intercomparison can be a rich source for improving considerably the nuclear data used for the different applications.

<u>The four levels of intercomparison are therefore</u>:

(a) Comparison of the <u>input</u> to the evaluation: Measured data, nuclear models, model parameters, nuclides used as models for systematic judgement.

(b) Tabular and graphical intercomparison of recommended data. Intercomparison of uncertainties.

(c) Importance of differences and sensitivity analysis. Testing of the evaluations against benchmarks, either experimental benchmarks or detailed model calculation used as benchmark.

(d) Analysis of differences and feedback to evaluators. Recommendations for measurements.

III. SOME PRELIMINARY EXAMPLES

The following preliminary examples of intercomparison are given for illustrative purposes only.

a) Cm-244. Two complete evaluations of Cm-244 have been completed in the framework of the IAEA TND Coordinated Research Programme and submitted to the IAEA by the Japanese group[(1)] and the Israeli group[(2)].
The recommended thermal cross sections and optical model parameters of the two evaluations are intercompared in tables 1 and 2. Figure 1 compares graphically the total fission, capture, elastic, inelastic, (n,2n) and (n,3n) cross sections as function of energy.

TABLE 1

Cm-244 thermal cross sections (barns) compared

	Fuketa et al.[(1)]	Caner and Yiftah[(2)]
σ_n	6.76	8.4
σ_f	1.18	1.0 ± 0.2
σ_γ	14.48	11.3 ± 1.8
σ_T	22.42	20.7

TABLE 2

Spherical optical model parameters compared

	Fuketa et al.[(1)]	Caner and Yiftah[(2-3)] (Np-237, Cm-244)
V_{RE} (MeV)	40.5+ 0.5E	42
V_{IM} (MeV)	$8.2+0.5\sqrt{E}$	8
V_{SR} (MeV)	7.0	7.5
a (fm)	0.47	0.47
b (fm)	0.47	1.5
R_o (fm)	1.32	1.3

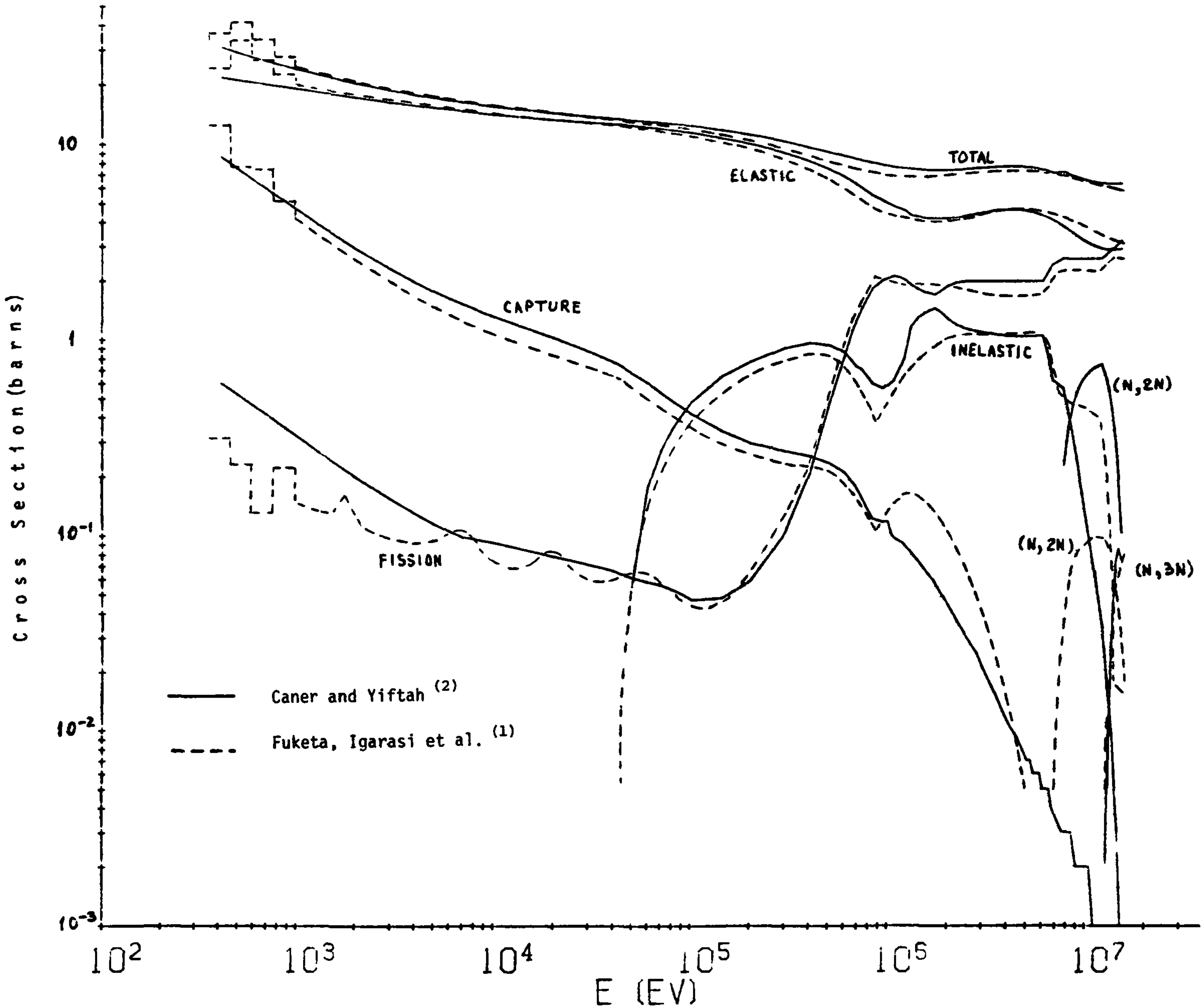

Fig. 1

Cm-244 cross sections compared

b) Pu-241. The thermal cross sections recommended by the Italian group [4] are compared in table 3 with those recommended by the Israeli group[5].

TABLE 3

Pu-241 thermal cross sections (barns) compared

	Menapace et al.[4] Reich-Moore (Table 4,Ref.4)	Menapace et al.[4] Corrected (p.11,Ref.4)	Caner and Yiftah[5]
σ_f	490.72	1000.72	1011.7
σ_γ	148.07	368.07	364.8
σ_n	7.92	7.92	9.9
σ_T	646.71	1376.71	1386.4

c) Pu-242. The thermal cross sections and resonance parameters recommended by the Italian group[6] are compared in tables 4 and 5 with those recommended by the Israeli group[7].

TABLE 4

Pu-242 thermal cross sections (barns) compared

	Menapace et al.[6]	Caner and Yiftah[7]
σ_n	12.4	8.3 ± 1.4
σ_γ	18.5	18.5 ± 1
σ_f	0.001	0
σ_T	30.9	26.8 ± 1

TABLE 5

Pu-242 resonance parameters compared

	Menapace et al.[6]	Caner and Yiftah[7]
Resolved resonance range (eV)	-13; 2.7-1286	2.6-495
$\langle D\rangle_{obs.}$ (eV)	15	13.7 ± 1.2
$S_o(\times10^{-4})$	1.15	1.17 ± 0.23
$S_1(\times10^{-4})$	2.7	0.62
$\langle\Gamma_\gamma\rangle$ (meV)	25	28 ± 1
σ_{pot} (b)	11.6	12.2

Figures 2,3, 4 and 5 compare, respectively, the $\sigma_{n'}$, σ_{2n}, σ_n and σ_γ of the French group[8] (1979) and the Israeli group[7] (1973).

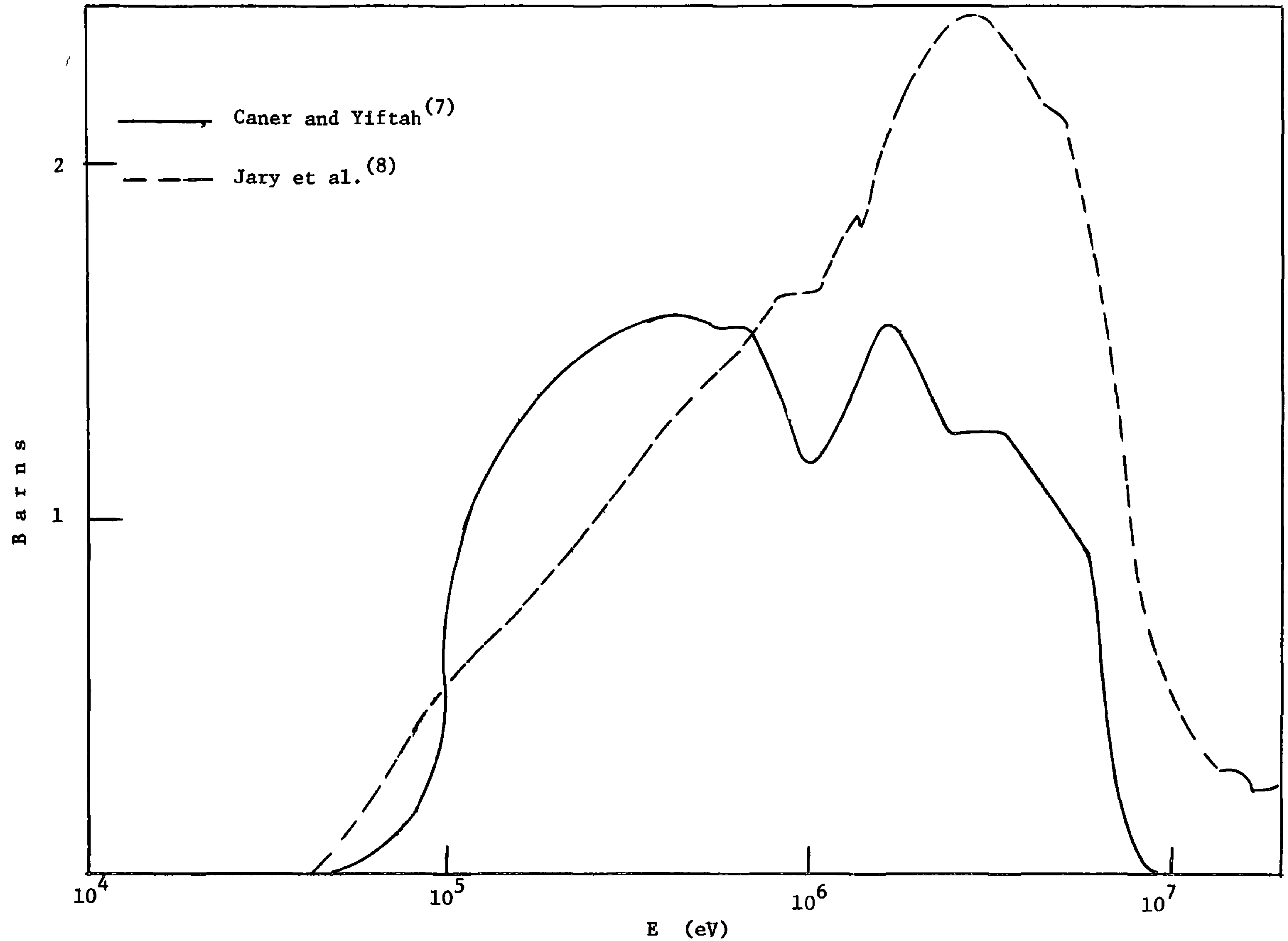

Fig. 2

^{242}Pu (n,n')

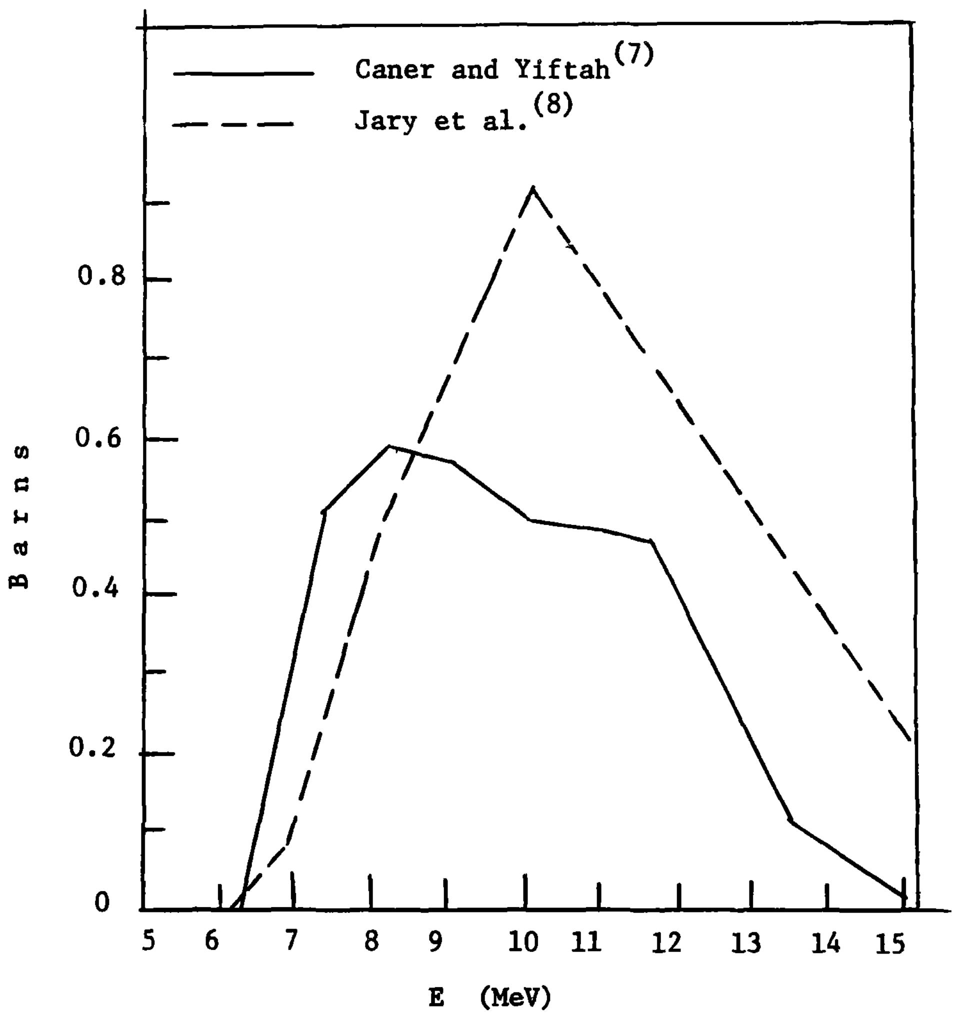

Fig. 3

^{242}Pu(n,2n) cross sections

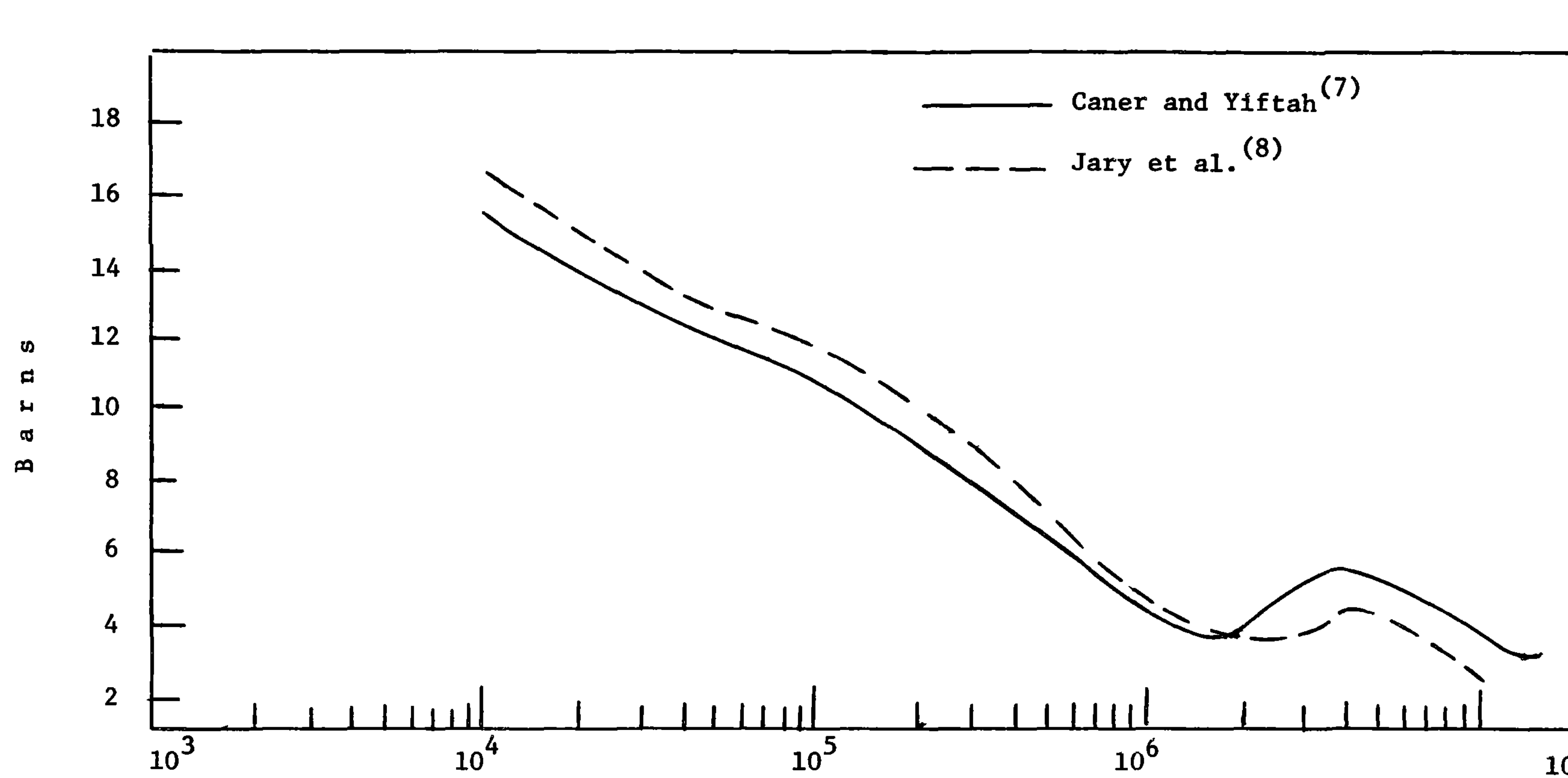

Fig. 4

^{242}Pu elastic scattering cross sections

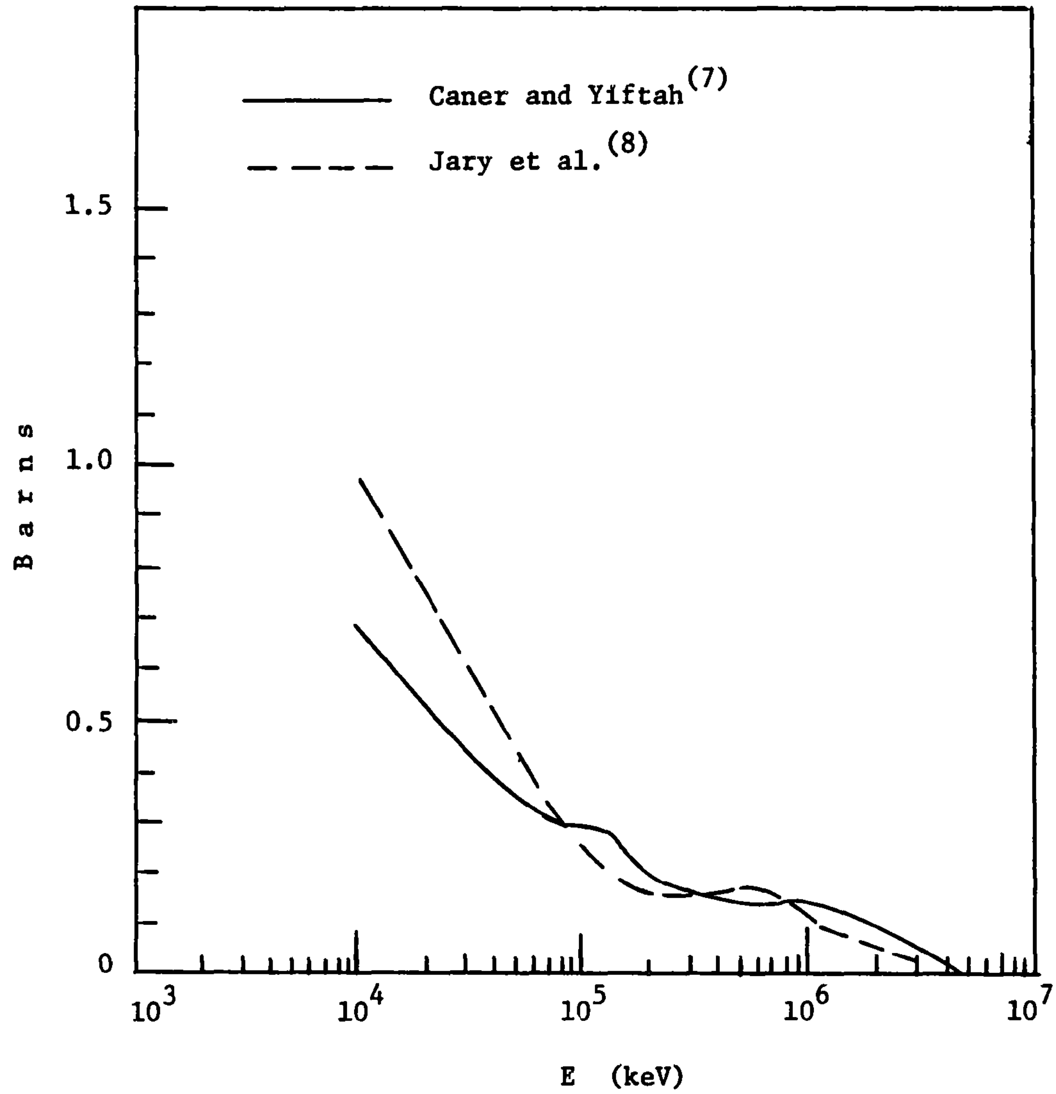

Fig. 5

$^{242}Pu(n,\gamma)$ cross sections

REFERENCES

1. T. Fuketa, S. Igarasi et al., Evaluation of Neutron Data of Am-243 and Cm-244, Progress Report to IAEA (Oct. 1978).

2. M. Caner and S. Yiftah, Cm-244 neutron data evaluation, IA-1353, Final Report submitted to IAEA (March 1979).

3. M. Caner, S. Wechsler and S. Yiftah, Evaluation of Np-237 Microscopic Neutron Data, IA-1346 (Dec. 1977).

4. E. Menapace, M. Motta and A. Ventura, Evaluation of Pu-241 Neutron Cross Sections in the Resonance Region, Report submitted to IAEA (1978).

5. M. Caner and S. Yiftah, Nuclear Data Evaluation for Pu-241, IA-1276 (May 1973).

6. E. Menapace, M. Motta and A. Ventura, Pu-242 Evaluation in Resolved Resonance Region, Report submitted to IAEA (1978).

7. M. Caner and S. Yiftah, Nuclear Data Evaluation for Pu-242, IA-1275 (Feb. 1973).

8. J. Jary, Ch. Lagrange, C. Philis and J. Salvy, INDC(FR) 32/L (Feb. 1979).