CONF-841105--55

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MULTILEVEL ANALYSIS OF THE LOW ENERGY ^{239}Pu CROSS SECTIONS*

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CONF-841105--55

DE85 005376

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To be presented at the ANS/ENS International Meeting, Washington, D.C., November 11-16, 1984

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*Research sponsored by the Division of Reactor Research and Technology, U.S. Department of Energy, under contract DE-AC05-84OR21400 with the Martin Marietta Energy Systems, Inc.

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It is well known that the ENDF/B-V representation of the ^{239}Pu resonance region is not satisfactory: below 1 eV the cross sections are given by "smooth files" (file 3) rather than by resonance parameters. Above 1 eV the single-level formalism used in ENDF/B-V necessitates a structured file 3 contribution.[1] The present paper presents the results of an R-matrix multilevel analysis of several recent data sets[2-4] as well as of the older data.[5-7] The analysis is concerned with the region up to 30 eV, an energy region that is important for thermal reactors and for which no recent multilevel analyses had previously been available.

Most existing R-Matrix analyses are based on data more than 15 years old and extend over very limited energy regions.[8,9] The analysis presented here was done with the recently developed analysis program SAMMY which utilizes the Bayes equations rather than the usual least-square-fitting technique.[10] An advantage of using Bayes equations is that several data sets from fission, capture, absorption and transmission measurements can be included, successively in the analysis. As more information is included, the error covariance matrix elements are reduced.

Table 1 lists the Reich-Moore resonance parameters of the first 21 levels. Four bound levels were introduced to obtain a good description of the cross-section shapes at low energies.

Figure 1 shows a comparison of the fission cross section constructed from the parameters of Table 1 with recent data of Gwin et

al.[3] The agreement is good except in the valley near 9 eV. There are systematic discrepancies between data from several measurements[2,3,5,7] in that valley and it is conjectured that these discrepancies could be explained by several experimental effects which are difficult to estimate precisely (such as multiple scattering in the detector).

Figure 2 shows a comparison between the fission cross section computed from the parameters of Table 1, a recent measurement of Weston et al.,[4] and ENDF/B-V.[1] The results of our analysis describe the data of Weston et al. better than does ENDF/B-V, although the differences are mostly in the regions of low cross sections where the sensitivity of reactor calculations is relatively small.

The parameters of Table 1 were transformed into equivalent Adler-Adler type resonance parameters for use with the Chi-Psi Shape functions. (The Adler-Adler parameters and the covariance matrix of the Reich-Moore parameters may be obtained from the authors.)

In summary, recent and older data on the ^{239}Pu neutron cross sections were analysed using an R-Matrix multilevel formalism and the Bayes formula. The resulting parameters describe well the results of recent measurements in the important region below 30 eV. The computed cross sections agree well with ENDF/B-V except in the "valleys" between resonances. The multilevel parameters obviate the need of a not so smooth "file 3" background contribution.

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Table 1. Reich Moore Type Parameters for Neutron Cross Sections of ^{239}Pu

	E(eV)	Γ_γ(mV)	Γ_n(mV)	Γ_{f1}(mV)	Γ_{f2}(mV)	J
1	-2.4432E+00	3.7462E+01	8.3277E-01	-6.3903E+03	2.0437E+02	0
2	-6.6945E+00	3.1388E+01	1.4199E+01	1.9497E+02		1
3	-1.9828E+00	2.7123E+01	5.5390E-01	-9.8819E+02		1
4	-2.6046E-01	1.0076E+01	2.6916E-02	3.5192E+02		1
5	2.9786E-01	4.0150E+01	2.4775E-01	9.9006E-06	5.8688E+01	0
6	7.8297E+00	4.7240E+01	8.0142E-01	-4.9751E+01		1
7	1.0935E+01	4.4229E+01	1.8412E+00	-1.7485E+02		1
8	1.1918E+01	4.4662E+01	9.2221E-01	2.2786E+01		1
9	1.4337E+01	2.9043E+01	5.3547E-01	5.9416E+01		1
10	1.4686E+01	6.1139E+01	2.0447E+00	5.9395E+01		1
11	1.5481E+01	5.5085E+01	1.6228E+00	-2.8860E+00	5.5917E+02	0
12	1.7666E+01	4.8066E+01	1.7543E+00	-4.3558E+01		1
13	2.2253E+01	5.2207E+01	2.4199E+00	-7.9789E+01		1
14	2.3911E+01	3.0975E+01	8.2991E-02	2.6231E+01		1
15	2.6242E+01	4.7431E+01	1.4039E+00	5.9677E+01		1
16	2.7309E+01	3.6361E+01	1.0163E-01	-4.5851E+00		1
17	3.2316E+01	3.6495E+01	7.7694E-01	-4.1566E+00	-1.4234E+02	0
18	3.5472E+01	4.5772E+01	2.2503E-01	4.3745E+00		1
19	4.1423E+01	2.3265E+01	1.5823E+00	-4.5741E+00		1
20	4.1677E+01	3.9948E+01	3.2478E+00	1.6583E+01	-4.7157E+01	0
21	4.4481E+01	3.5879E+01	3.8858E+01	-9.9973E-01		1

Fig 1 The $^{239}Pu(n,f)$ cross section below 10 eV.

1 Data of Gwin et al (Ref 3)

— Constructed with the parameters of Table 1

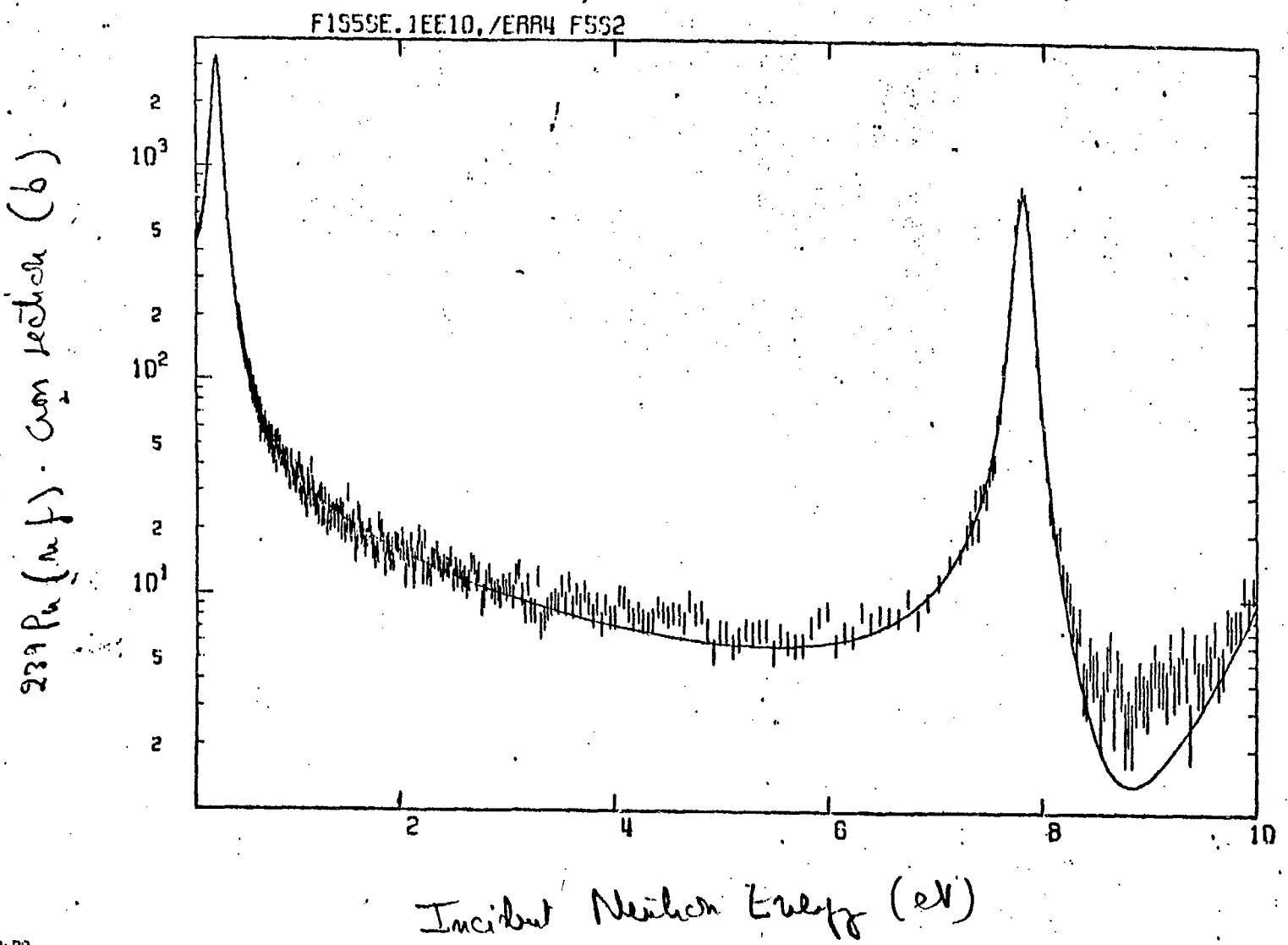

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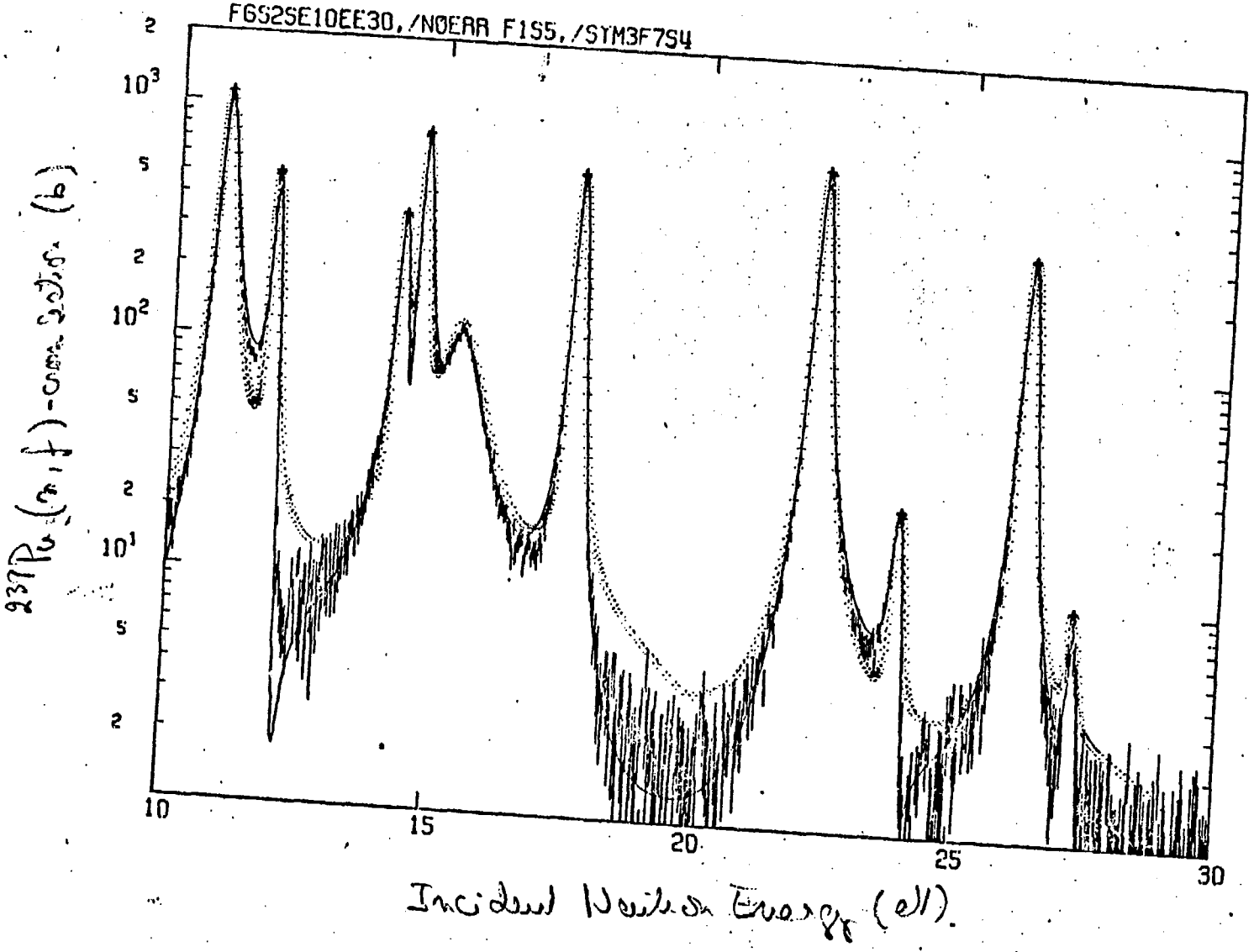
Fig 2 The $^{237}Pu(n,f)$-cross-section between 10 and 30 eV

||| Data : Weston and Todd (ref 4)

— Constructed from parameters of Todd

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