IEC-203

Status report of Subgroup 8 on Minor Actinides

Tsuneo NAKAGAWA and Hideki TAKANO
Japan Atomic Energy Research Institute

This group has not been active for recent a few years since one of coordinators was working for the other field. From the last October, he started again the work in nuclear data. Now we are making comparisons of evaluated data for ^{237}Np, ^{241}Am, ^{243}Am, ^{242}Cm, ^{243}Cm, ^{244}Cm and ^{245}Cm given in the major three evaluated nuclear data libraries; ENDF/B-VI.5, JENDL-3.2 and JEF-2.2.

Since the comparison has not yet completed, the results cannot be represented in this meeting. The following is summary of the current comparison.

Current evaluated data in the libraries

Table 1 shows the year of evaluation of data stored in the major libraries. In the last 10 years, only the data of ^{237}Np, and the data of ^{241}Am and ^{243}Am above the unresolved resonance region was reevaluated for ENDF/B-VI, and the resonance parameters of ^{237}Np for JENDL-3.2.

Comparison of cross sections

The fission and capture cross sections are compared in Figs 1 through 14. The fission cross sections of ^{237}Np, ^{241}Am and ^{243}Am were recently measured[Ya93, Ya97, Ko99] at the Research Reactor Institute of Kyoto University, Japan. Those data are shown in Figs.15 to 17.

The fission cross section of ^{237}Np given in JENDL-3.2 is larger than the other evaluations below several hundreds keV. The JENDL-3.2 data were determined so as to reproduce well the measured data of Yamanaka et al.[Ya93] as is shown in Fig. 15.

The capture cross sections of ^{237}Np are in good agreement with each other (Fig.2).

In Fig.3 for the ^{241}Am fission cross section, there are discrepancies in the energy region from several tens eV to 200 eV. The data of ENDF/B-VI is better in this case, as indicated in Fig 16 by the recent results of experiment by Yamamoto et al.[Ya97]

The capture cross section of ^{241}Am seems to have no problems from Fig. 4. However, the thermal cross section should be reexamined, because a recent experimental data is larger than the evaluated data.

The fission cross section of ^{243}Am has discrepancies below 100 keV (Fig. 5). The recent data measured by Kobayashi et al.[Ko99] are just between JENDL-3.2 and ENDF/B-VI (Fig. 17).

As for the fission cross section of ^{242}Cm (Fig. 7), the data of ENDF/B-VI and JEF-2.2 are not correct. Figure 7(2) indicates that JENDL-3.2 and BROND-2 are in good agreement with the experimental data of Alam et al.[Al88]

The fission and capture cross sections of other Cm isotopes are shown in Figs 8 to 14. They are rather discrepant than Am isotopes.

Thermal cross sections

Tables 2 and 3 are comparisons of thermal cross sections and resonance integrals of JENDL-3.2, the recommendation of Mughabghab[Mu84] and recent experimental data.

The evaluated data in JENDL-3.2 are almost consistent with the experimental data and the recommendation of Mughabghab. The largest discrepancies are found in the ^{241}Am capture cross section. Sinohara et al. measured the ^{241}Am capture cross section at JAERI by using JMTR as a neutron source. Their result of 854 barns is 40 % larger than JENDL-3.2. This large cross section is in very good agreement with 824±20 barns recommended by Belanova.[Be94] However, it is quit difficult to believe the large capture cross section, because it is larger than the total

cross section reported in 1955 ! The ^{241}Am total cross section is shown in Fig. 18.

Other cross sections

Figure 19 shows the ^{237}Np(n,2n) cross section. For this important cross section, available evaluations are quit discrepant each other.

Figure 20 is the isomeric ratio of ^{241}Am capture. ENDF/B-VI is only the available data in the evaluated nuclear data libraries. This figure compared it with experimental data and theoretical calculation made by Wisshak et al.[Wi82)] Shinohara et al. reported the ratio of 90 % at the thermal neutron energy which is completely the same as ENDF/B-VI.

Integral calculations

Takano et al.[Ta98)] made burnup calculations for the spent fuel irradiated with the PWR at Mihama, Japan. Table 4 is a comparison of C/E values. Discrepancies are found for ^{232}U, ^{238}Pu, ^{242m}Am, ^{244}Cm of JENDL-3.2, ^{238}Pu, ^{242}Pu, ^{242m}Am, ^{244}Cm of ENDF/B-VI.2, and ^{232}U, ^{236}Pu, ^{238}Pu, ^{242m}Am, ^{244}Cm of JEF-2.2. This calculation was made by using ENDF/VI.2. New calculation is being made by using ENDF/B-VI.5.

These kind of integral calculations will be reviewed in this subgroup.

Future plan of Subgroup 8

Above mentioned comparison of evaluated data and review of integral calculations will be completed by this summer, and the report will be finished by this autumn hopefully.

Refrences

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Wi82) Wisshak K., Wickenhauser J., Käppeler F., Reffo G., and Fabbri F.: *Nucl. Sci. Eng.*, **81**, 396 (1982).
Ya93) Yamanaka A., Kimura I., Kanazawa S., Kobayashi K., Yamamoto S., Nakagome Y., Fujita Y., and Tamai T.: *J. Nucl. Sci. Technol.*, **30**, 863 (1993).
Ya97) Yamamoto S., Kobayashi K., Miyoshi M., Kimura I., Kanno I., Shonohara N., and Fujita Y.: *Nucl Sci. Eng.*, **126**, 201 (1997).

Table 1 Year of evaluations for minor actinides

	JENDL-3.2	ENDF/B-VI.5	JEF-2.2
^{237}Np	1978	1990	1980
	1987	1991	
	1993(Res. Param. only)		
^{241}Am	1988	1988(<30keV)	1981
		1994(>30 keV)	1989
^{243}Am	1988	1988(<42 keV)	1981
		1996(>42 keV)	1984
^{242}Cm	1989	1979	1982
			1984
^{243}Cm	1989	1979	1982
			1988
^{244}Cm	1989	1978	1983
			1989
^{245}Cm	1989	1979	1982
			1988

Table 2 Thermal fission cross section and resonance integral

unit: barns

		JENDL-3.2	Mughabghab	Measurements after 1980	
^{237}Np	σ_{th}	0.025	0.0215±0.0024	0.026±0.005 0.020±0.001	Wagemans+(81) Kozharin+(86)
	RI	7.06	6.9±1.0	4.70±0.23	Kozharin+(86)
^{241}Am	σ_{th}	3.02	3.20±0.09	3.15±0.097	Yamamoto+(97)
	RI	13.9	14.4± 1.0	14.1±0.9	Dabbs+(83)
^{243}Am	σ_{th}	0.116	0.1983± 0.0043	0.0813±0.0025	Kobayashi+(99)
	RI	7.59	9± 1	3.05±0.15	Knitter+(88)
^{242}Cm	σ_{th}	5.06	< 5		
	RI	19.9	---	12.9±0.7	Alams+(88)
^{243}Cm	σ_{th}	617	617± 20		
	RI	1560	1570±100		
^{244}Cm	σ_{th}	1.04	1.04±0.20		
	RI	13.2	12.5± 2.5		
^{245}Cm	σ_{th}	2000	2145± 58		
	RI	800	840± 40		

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Table 3 Thermal capture cross section and resonance integral

unit: barns

		JENDL-3.2	Mughabghab	Measurements after 1980	
^{237}Np	σ_{th}	165	175.9±2.9	158±4 158±3	Jurova+(84) Kobayashi+(94)
	RI	661	640±50	730±30 652±24	Jurova+(84) Kobayashi+(94)
^{241}Am	σ_{th}	600	587± 12	854±58	Shinohara+(97)
	RI	1310	1425± 100		
^{243}Am	σ_{th}	78.5	75.1± 1.8		
	RI	1820	1820± 70		
^{242}Cm	σ_{th}	15.9	16± 5		
	RI	109	110± 20		
^{243}Cm	σ_{th}	130	130± 10		
	RI	199	215± 20		
^{244}Cm	σ_{th}	15.1	15.2± 1.2		
	RI	660	650± 30		
^{245}Cm	σ_{th}	346	369± 17		
	RI	110	101± 8		

Table 4 Comparison of C/E vales for benchmark calculations f or PWR spent fuel

isotopes	JENDL-3.2	ENDF/B-VI.2	JEF-2.2
^{232}U	0.83	0.90	0.64
^{235}U	0.98	0.98	0.98
^{236}U	0.98	0.98	0.98
^{238}U	1.00	1.00	1.00
^{237}Np	0.90	0.90	0.92
^{236}Pu	0.95	1.05	0.72
^{238}Pu	0.79	0.82	0.84
^{239}Pu	0.97	0.97	0.97
^{240}Pu	0.93	0.92	0.93
^{241}Pu	0.96	0.95	0.94
^{242}Pu	0.91	0.86	0.90
^{241}Am	0.94	0.93	0.92
^{242m}Am	0.67	0.64	0.62
^{243}Am	0.96	1.03	0.94
^{242}Cm	0.92	0.92	0.92
^{243}Cm	1.00	1.02	1.11
^{244}Cm	0.73	0.78	0.71

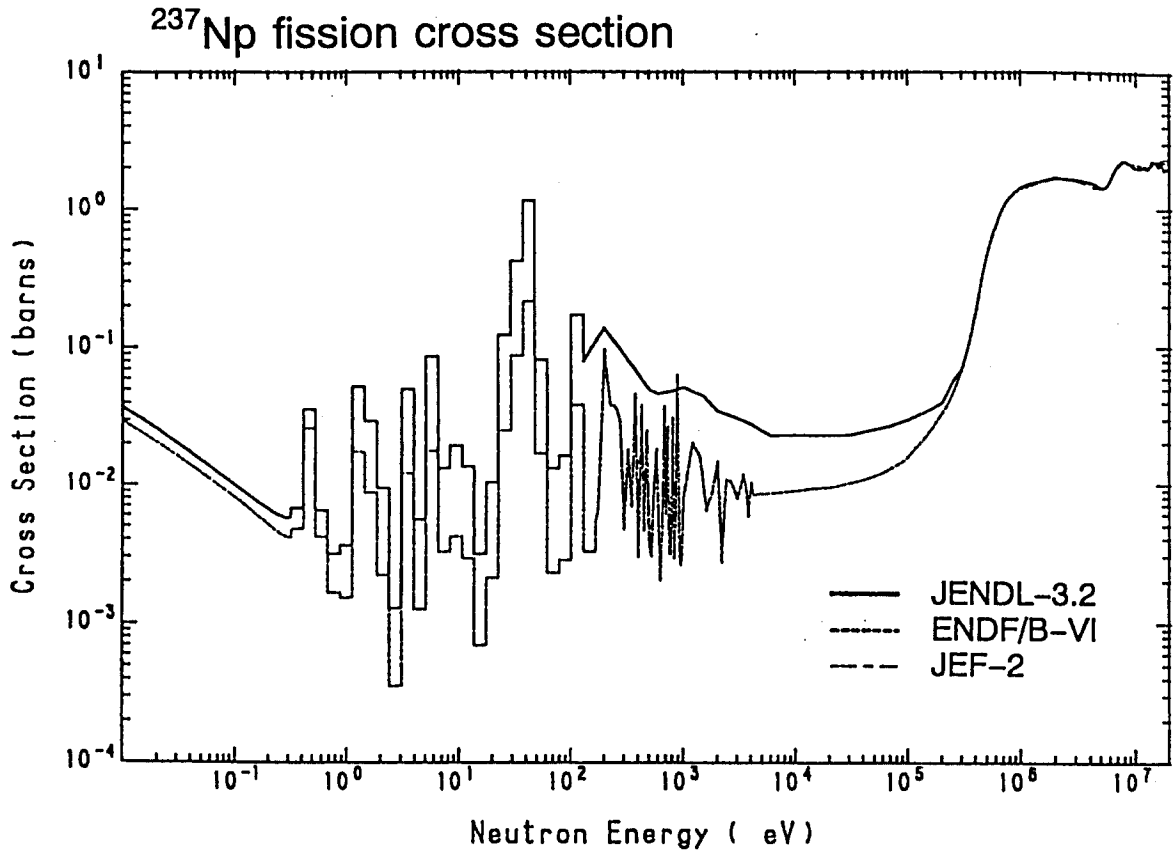
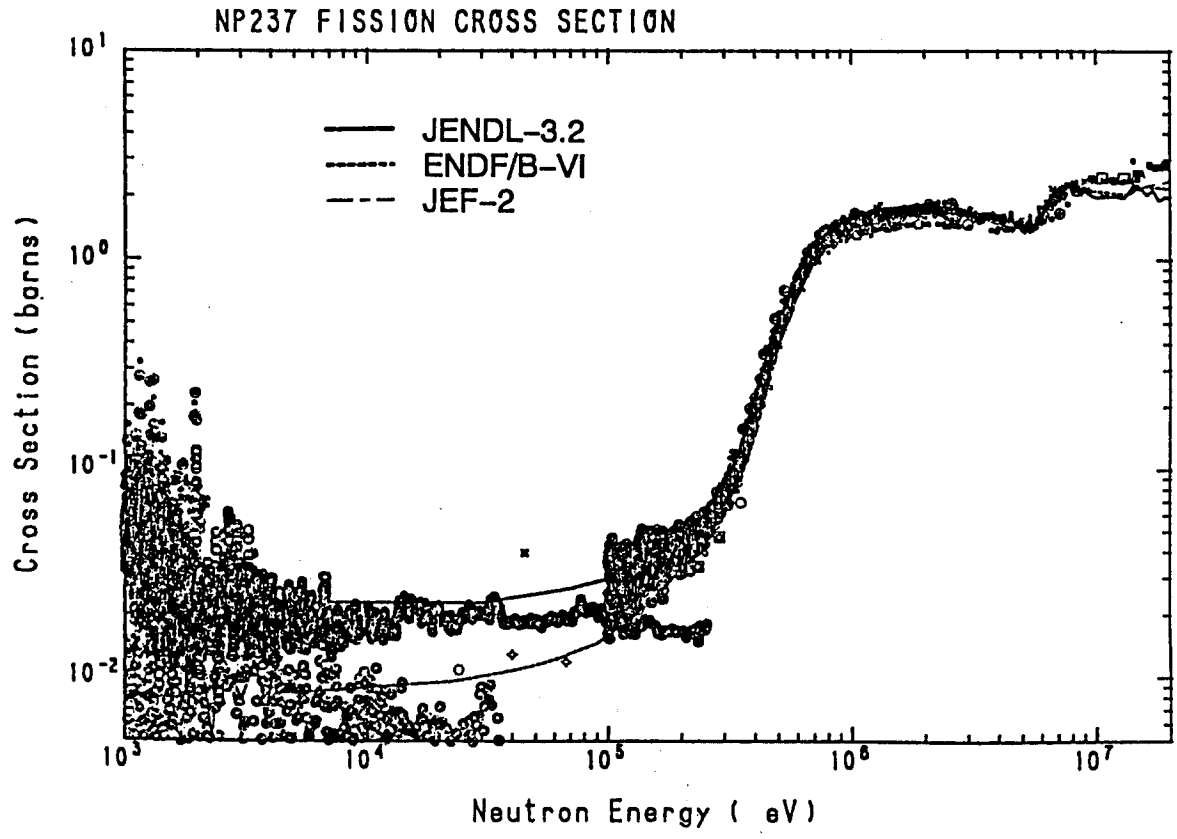


Fig. 1(1) ^{237}Np fission cross section



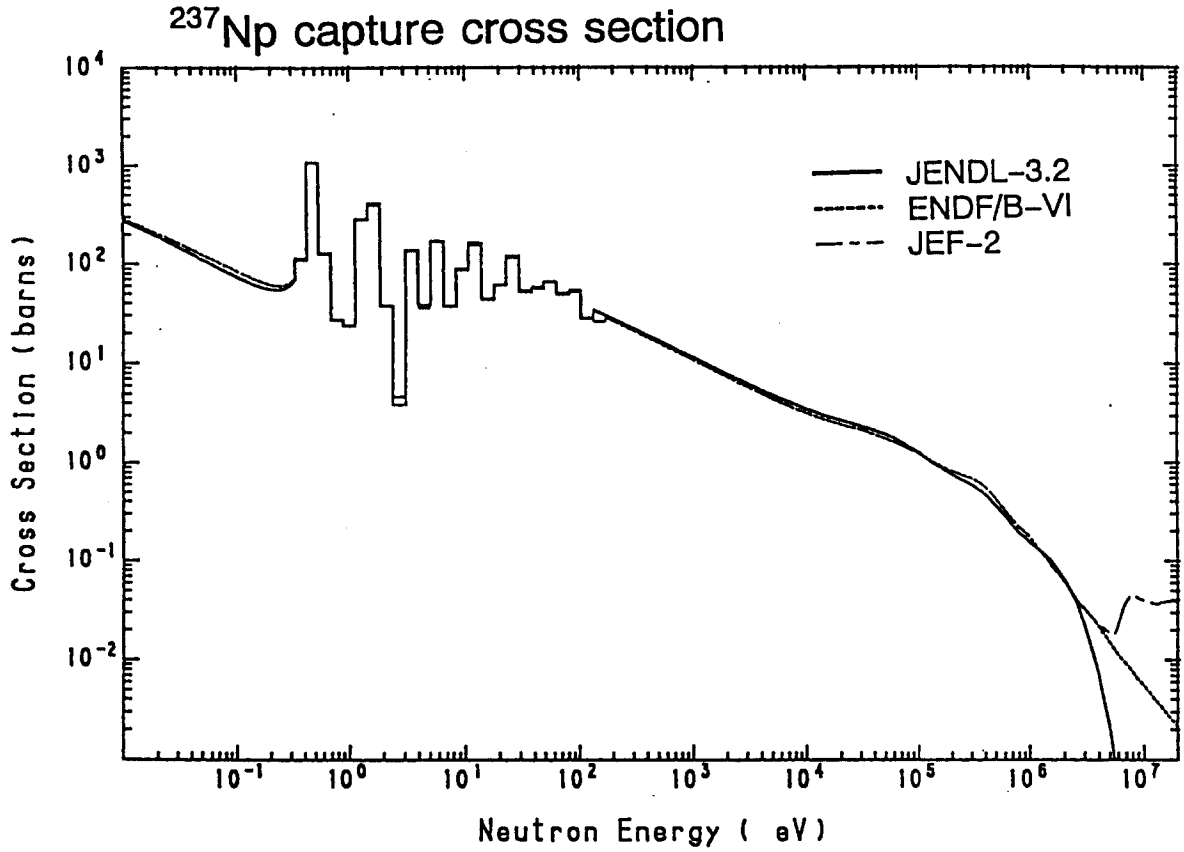


Fig. 2(1) ^{237}Np capture cross section

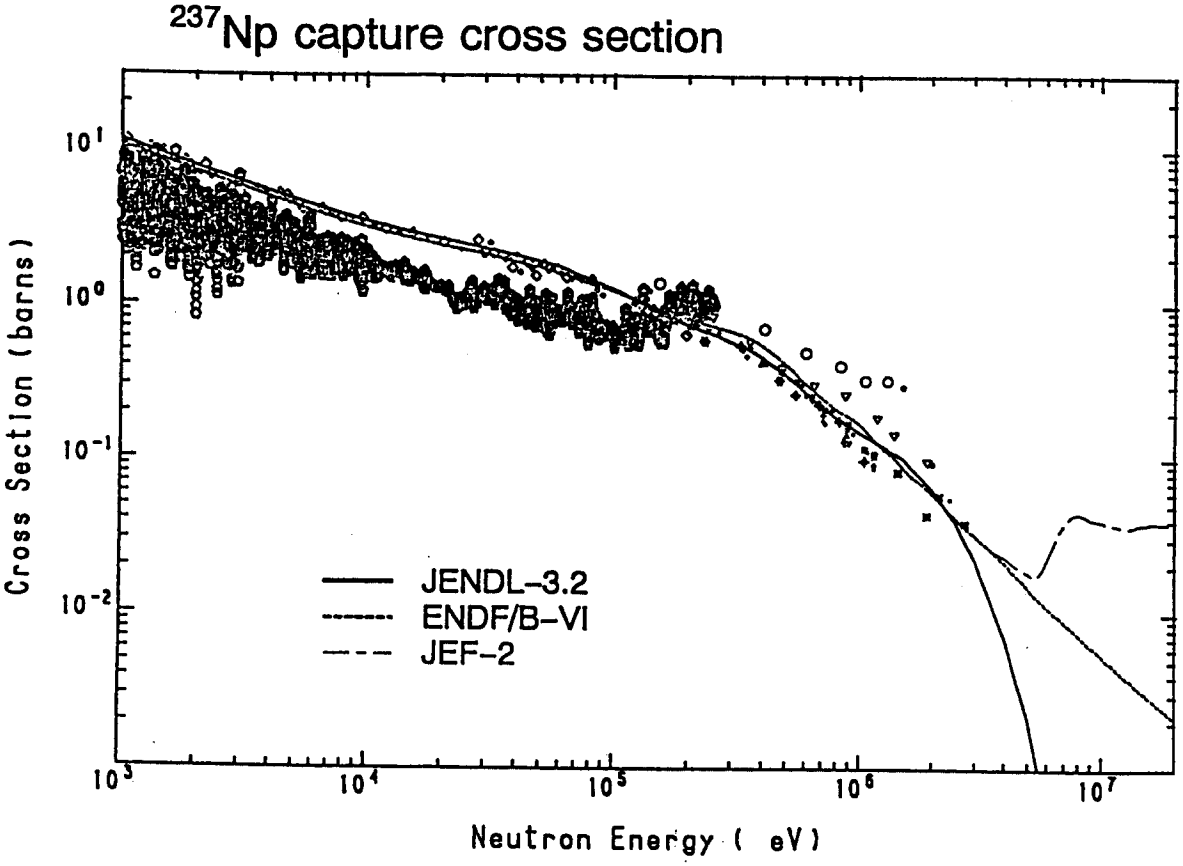


Fig. 2(2) ^{237}Np capture cross section

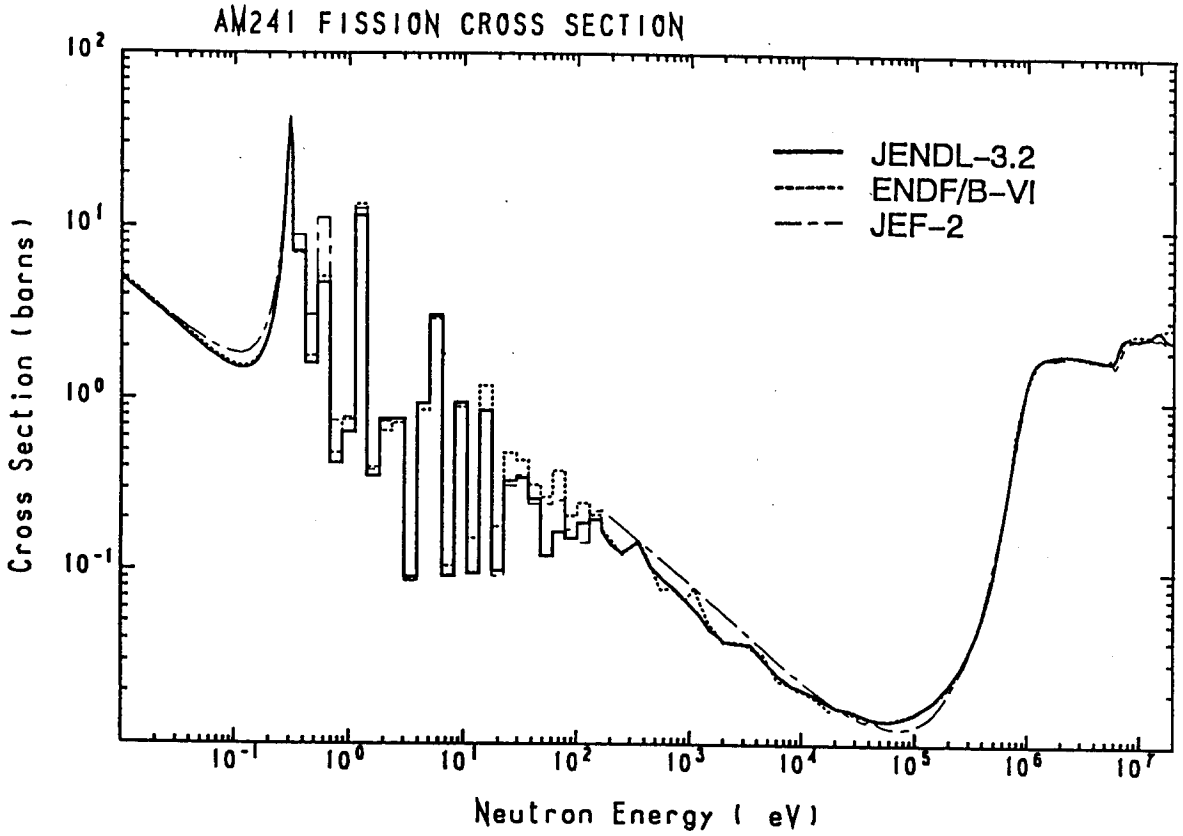
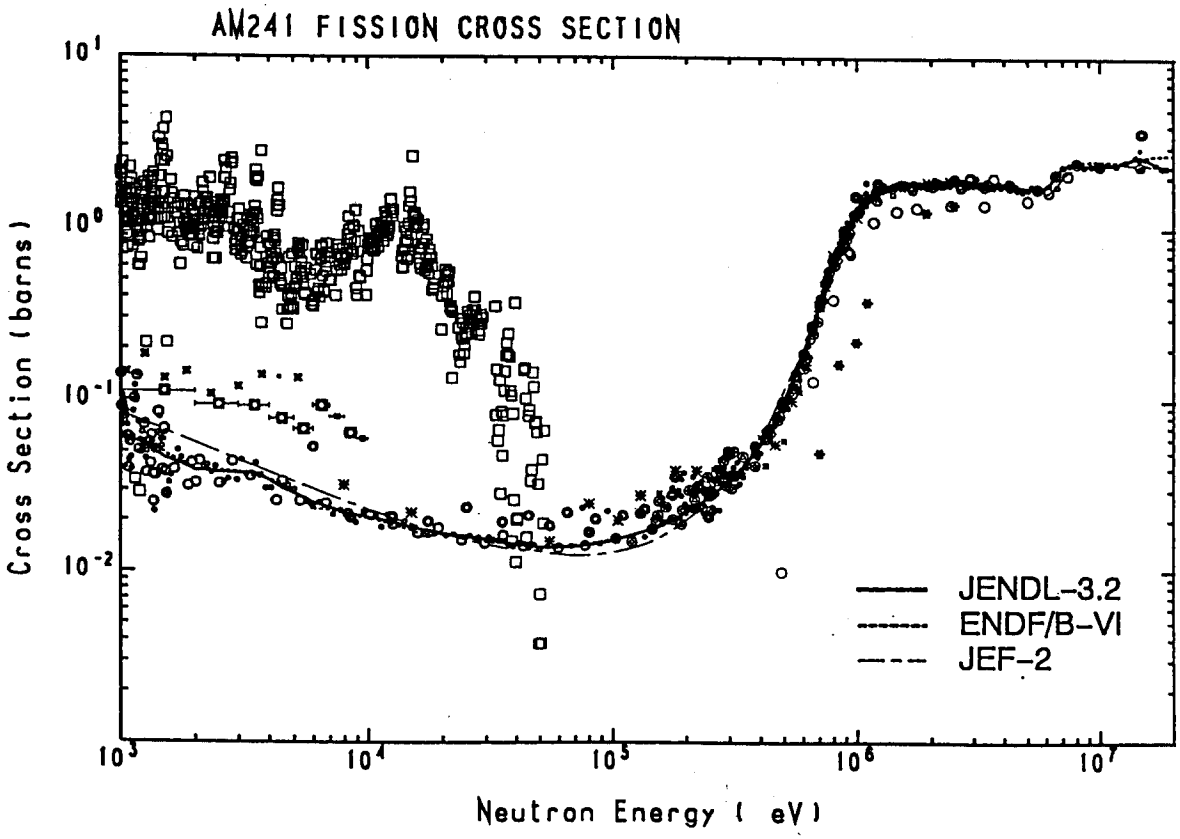


Fig. 3(1) ^{241}Am fission cross section



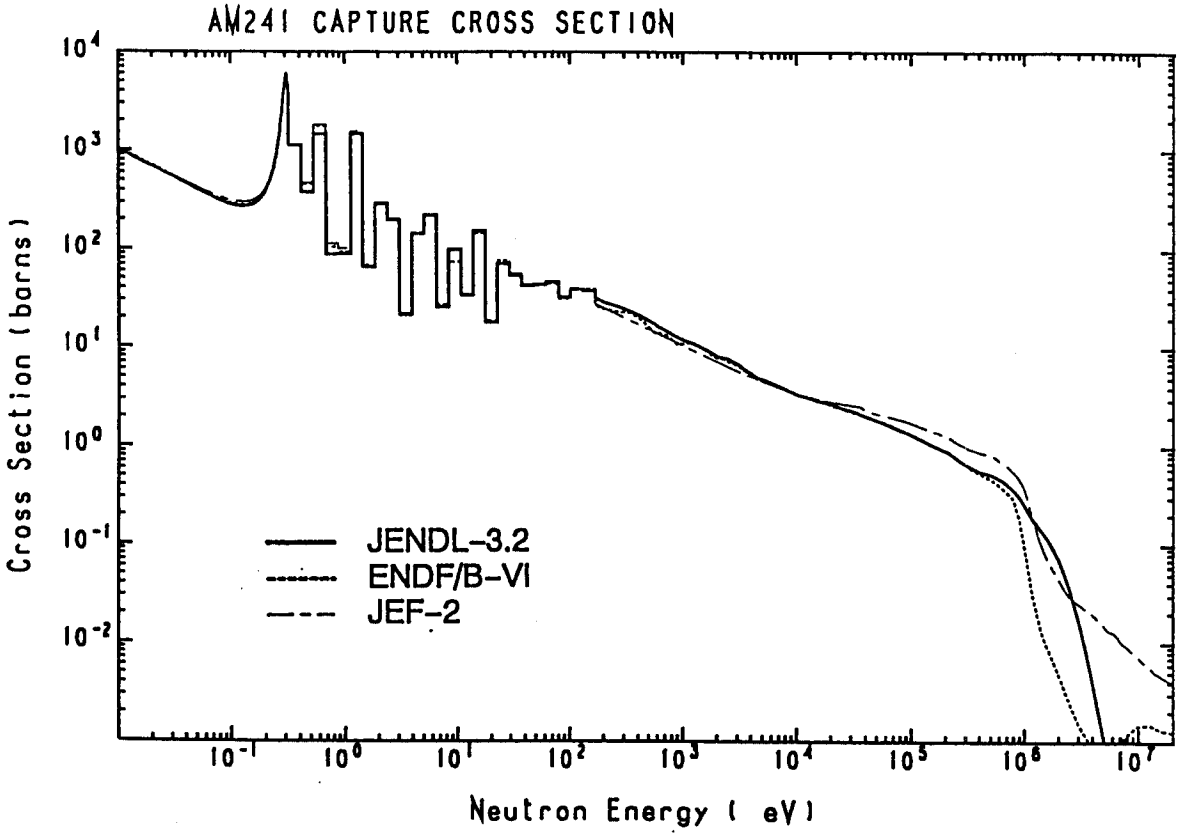
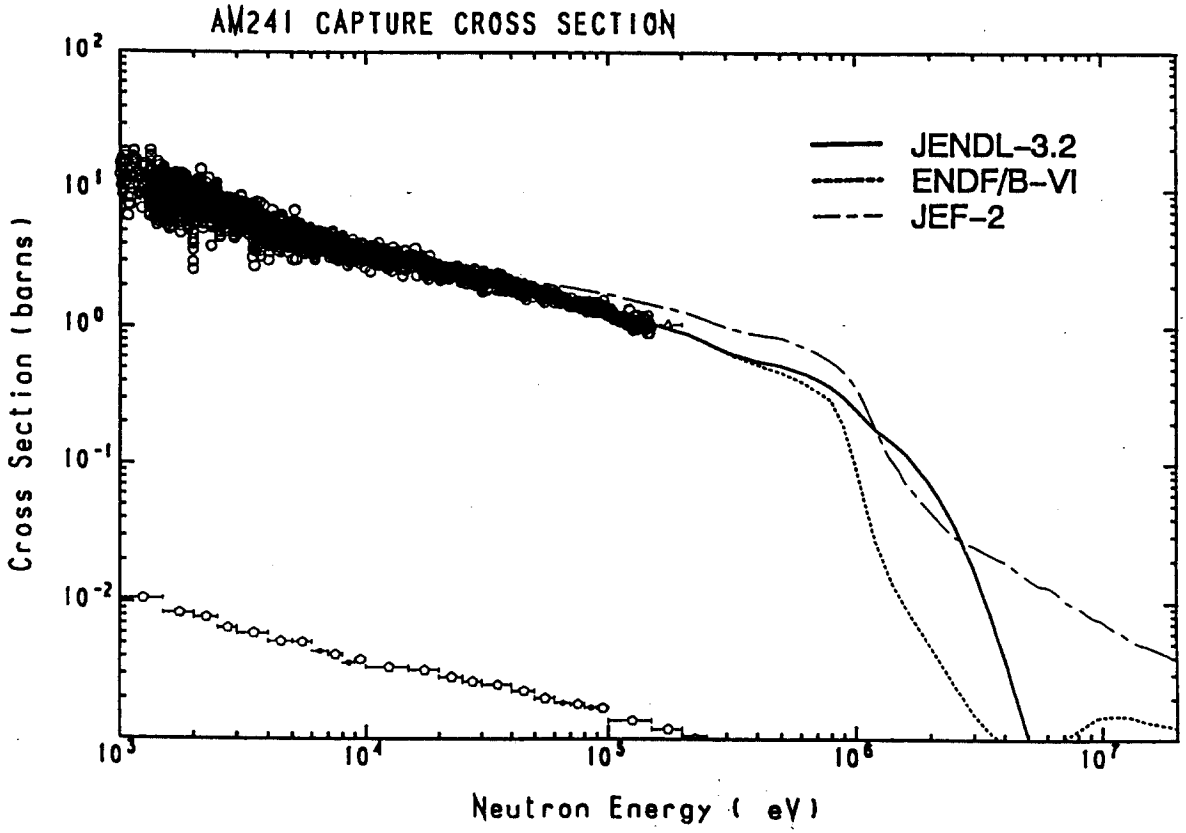


Fig. 4(1) ^{241}Am capture cross section



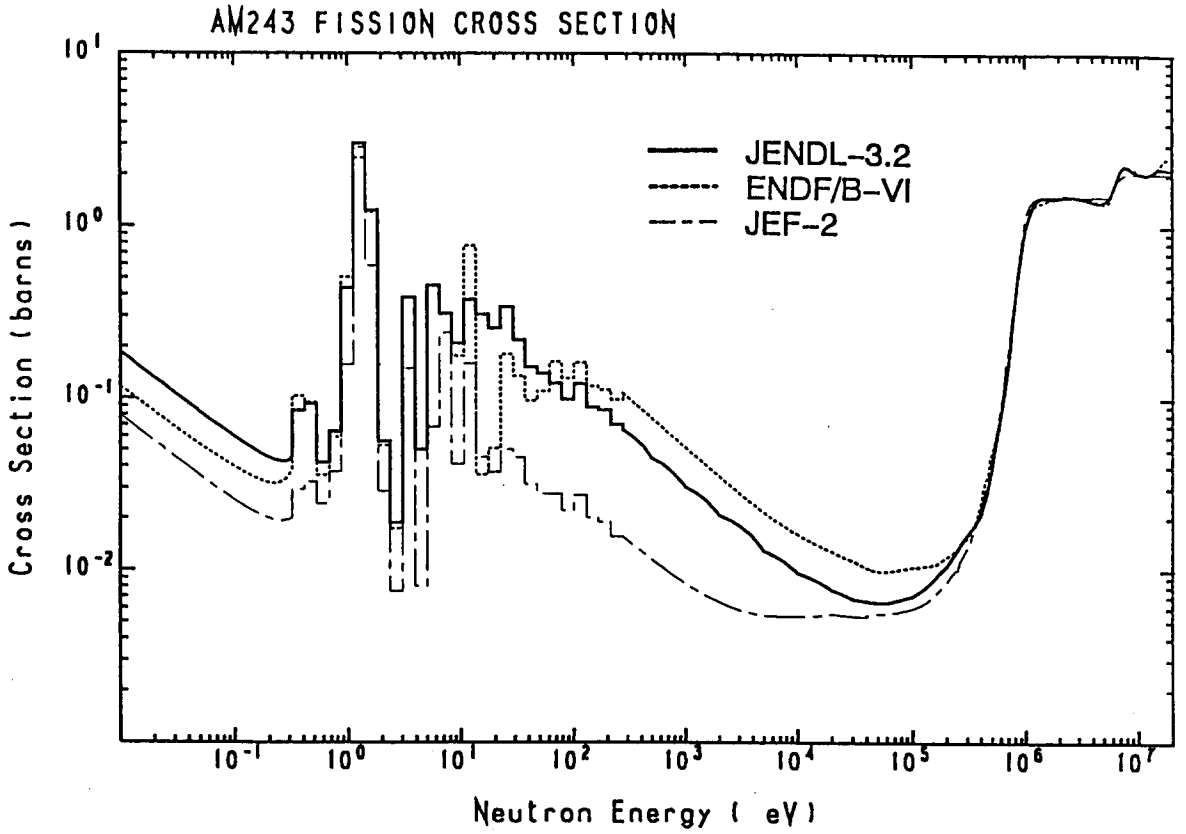
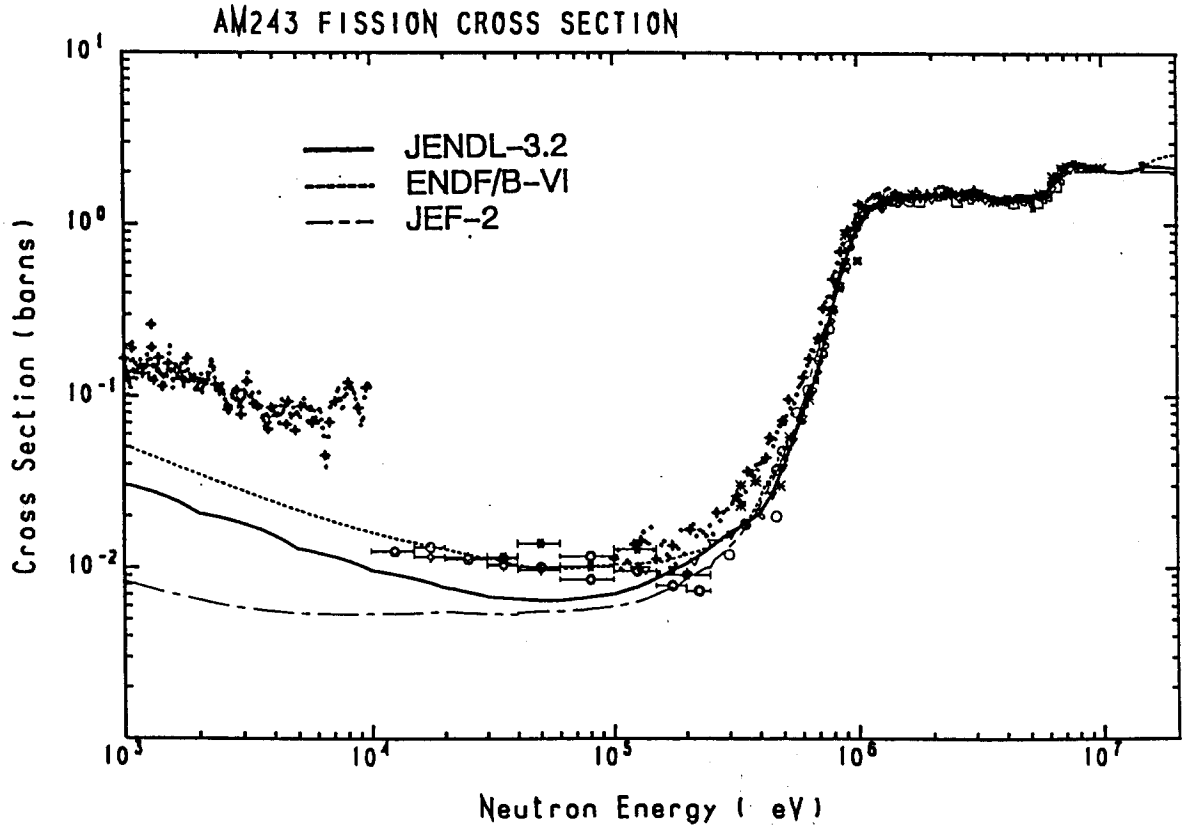


Fig. 5(1) ^{243}Am fission cross section



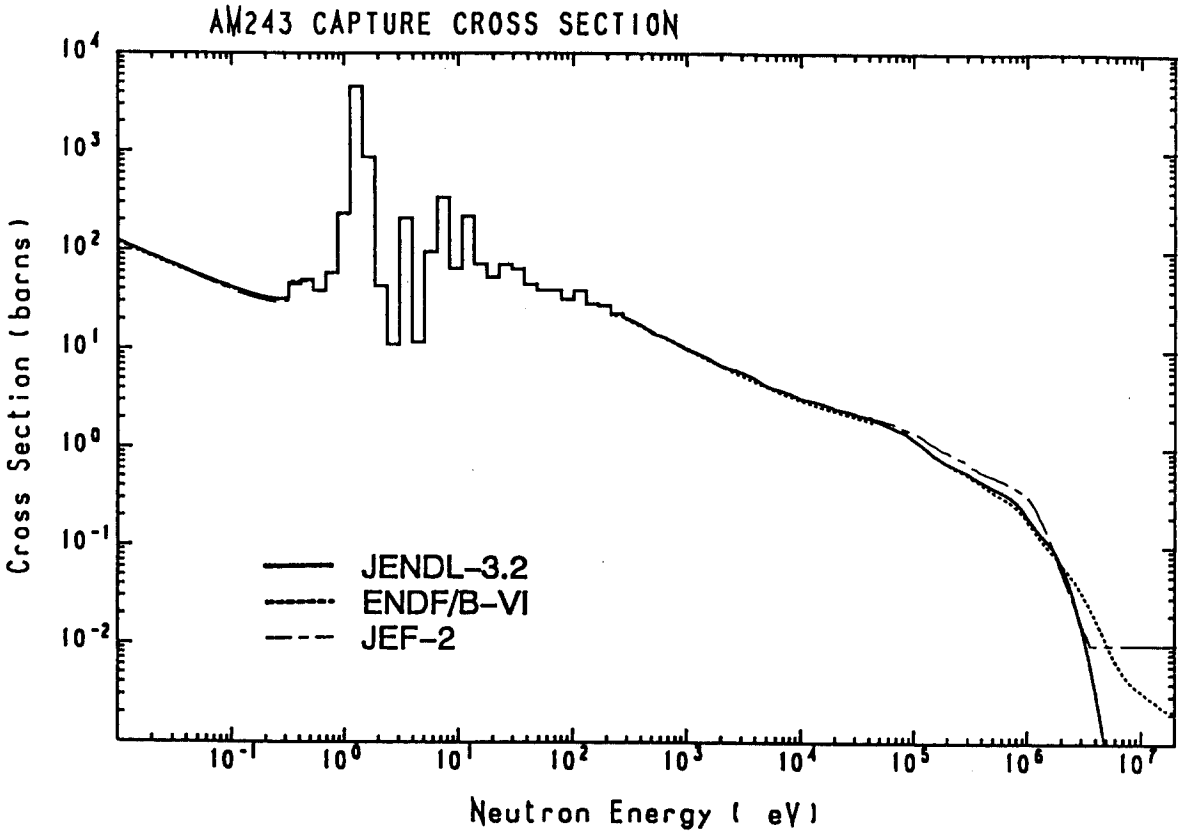
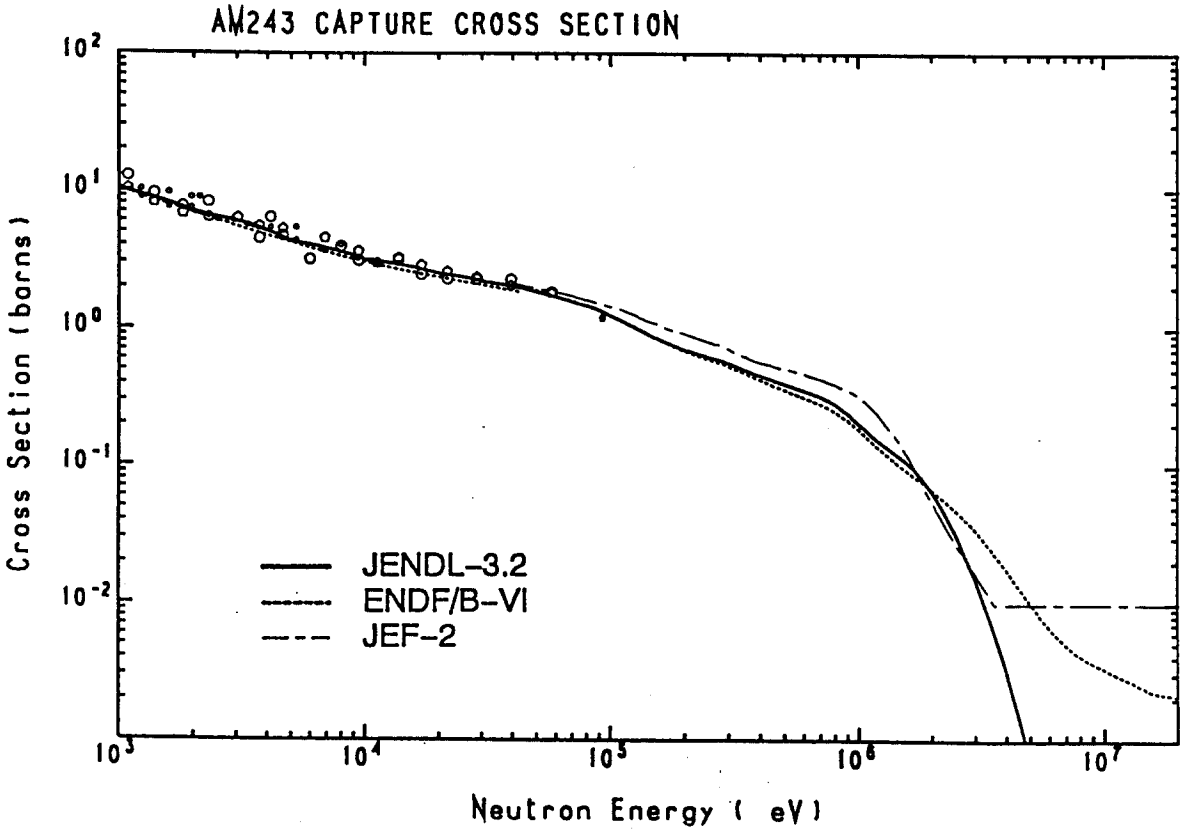


Fig. 6(1) ^{243}Am capture cross section



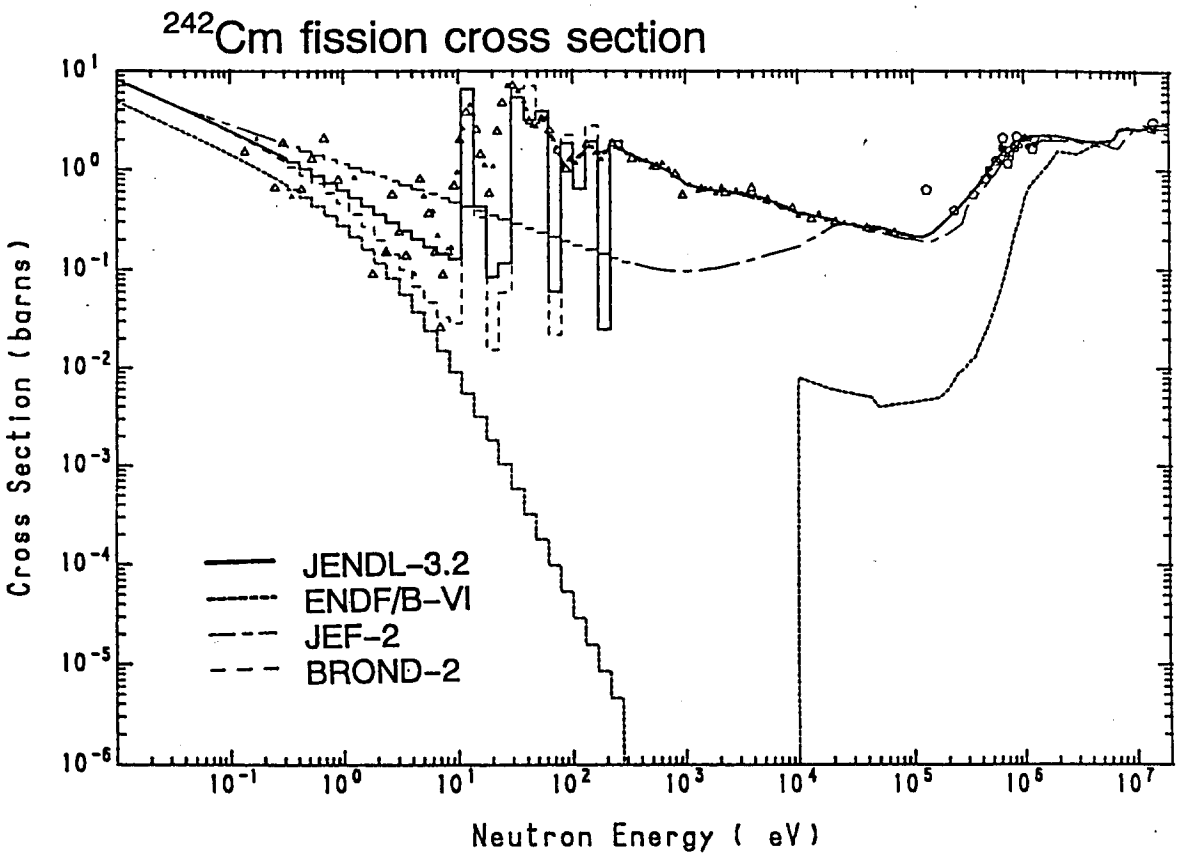


Fig. 7(1) ^{242}Cm fission cross section

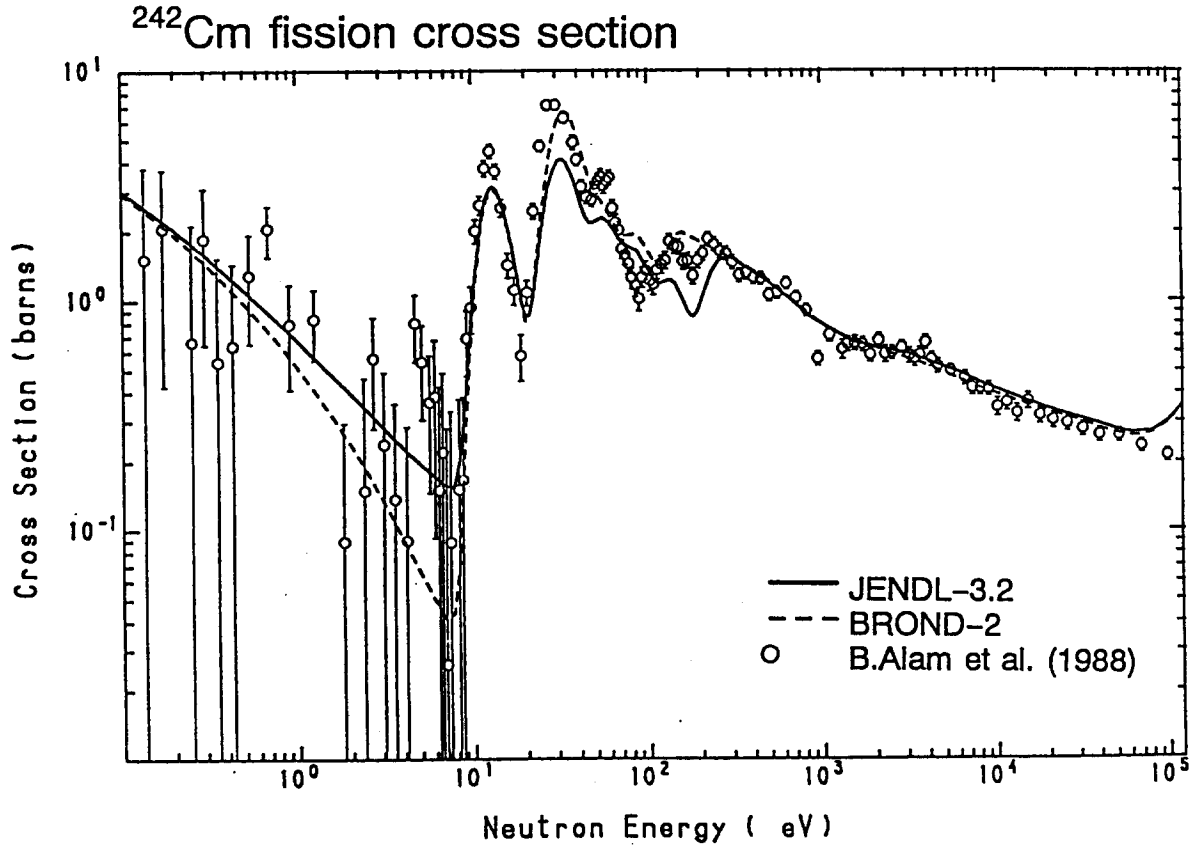


Fig. 7(2) ^{242}Cm fission cross section

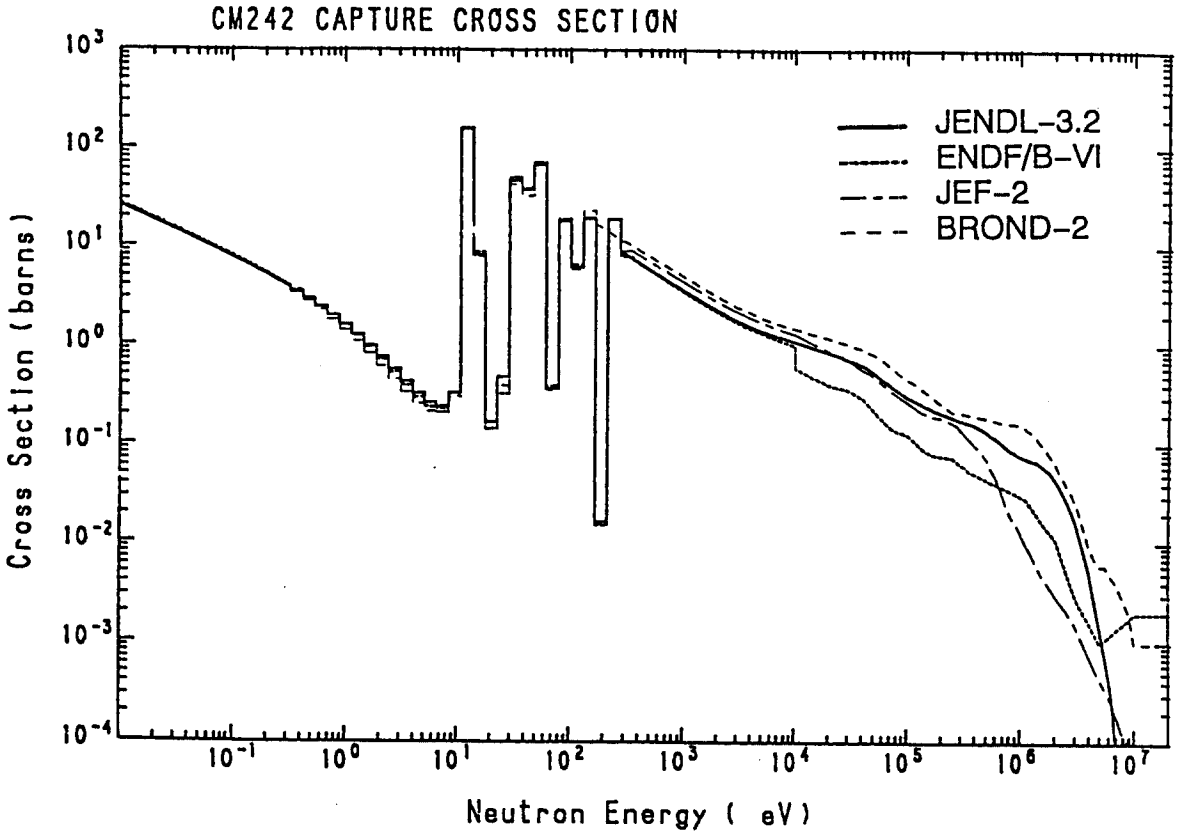


Fig. 8 ^{242}Cm capture cross section

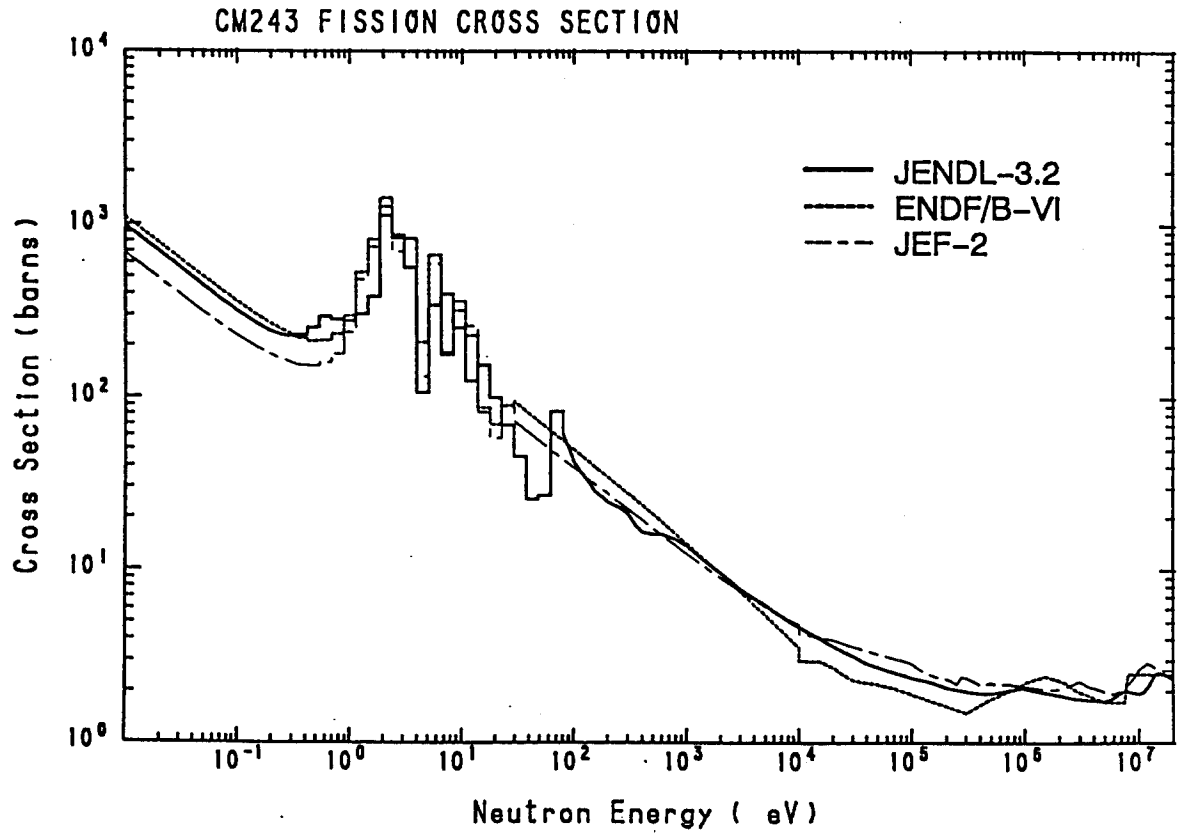


Fig. 9(1) ^{243}Cm fission cross section

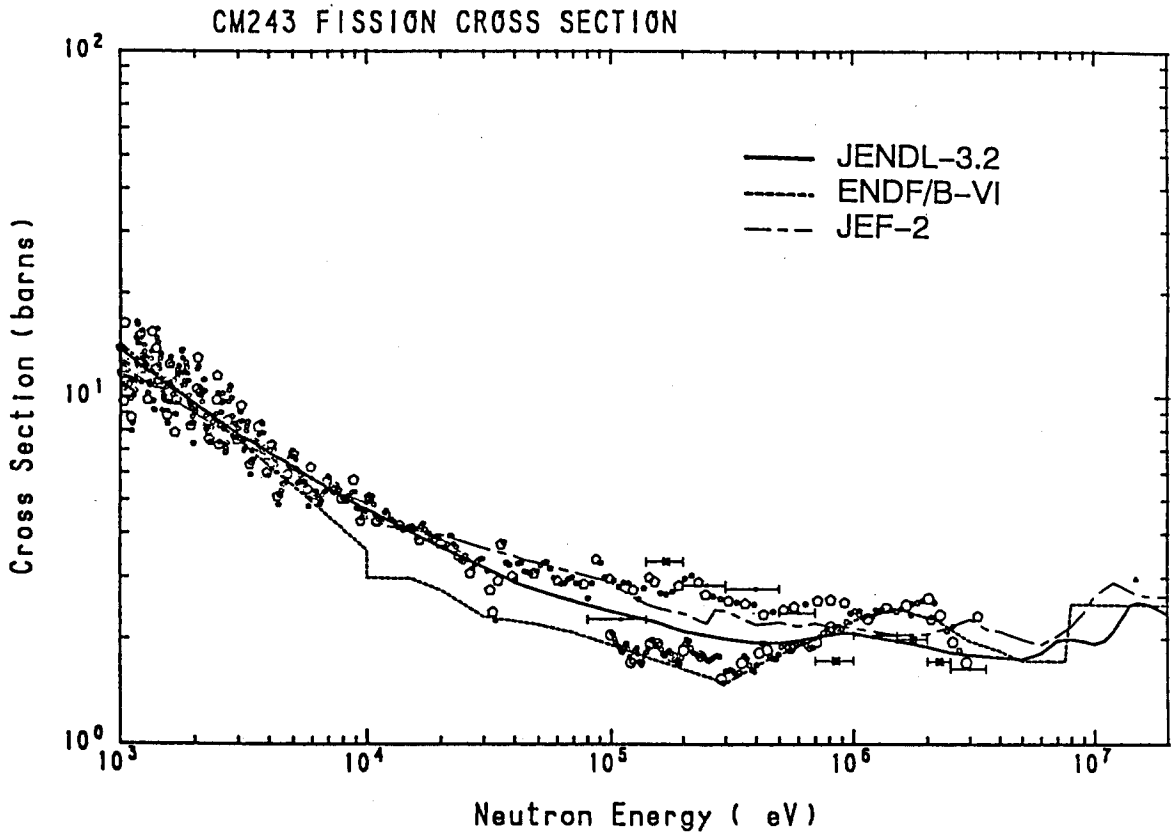
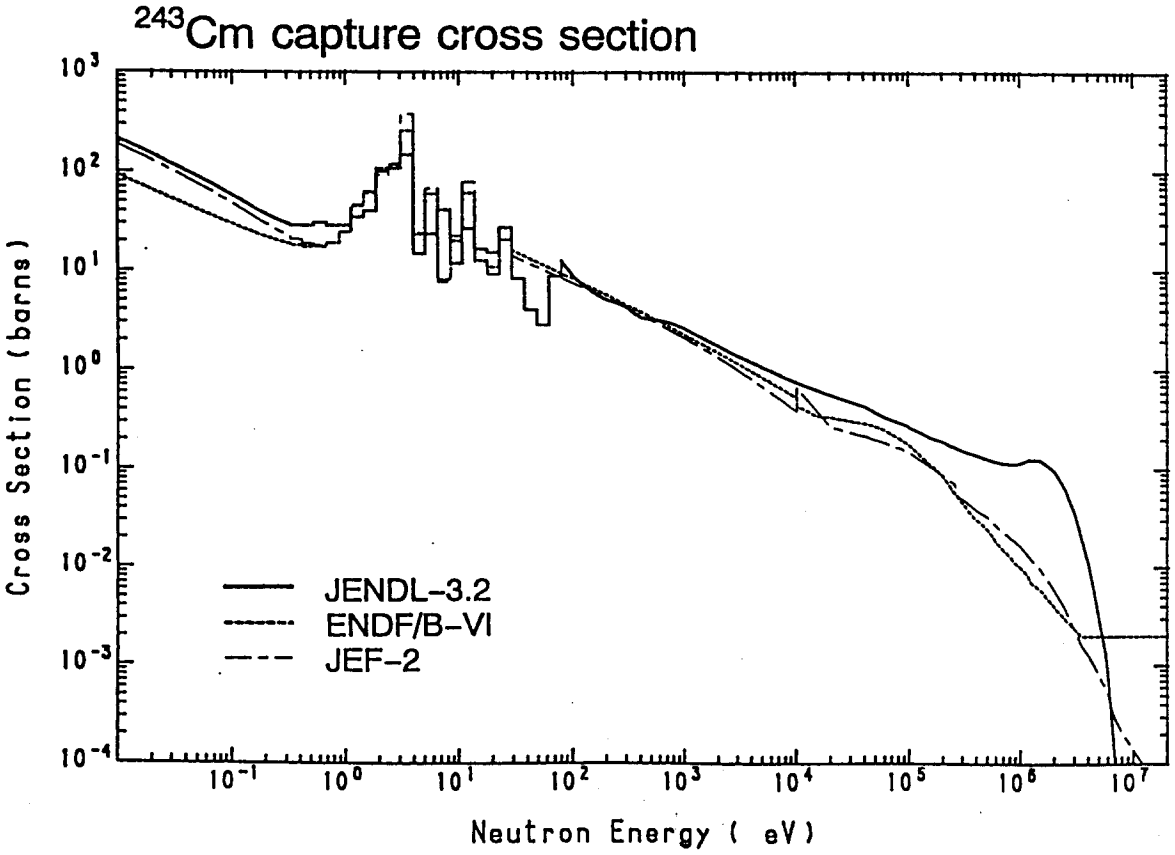


Fig. 9(2) ^{243}Cm fission cross section



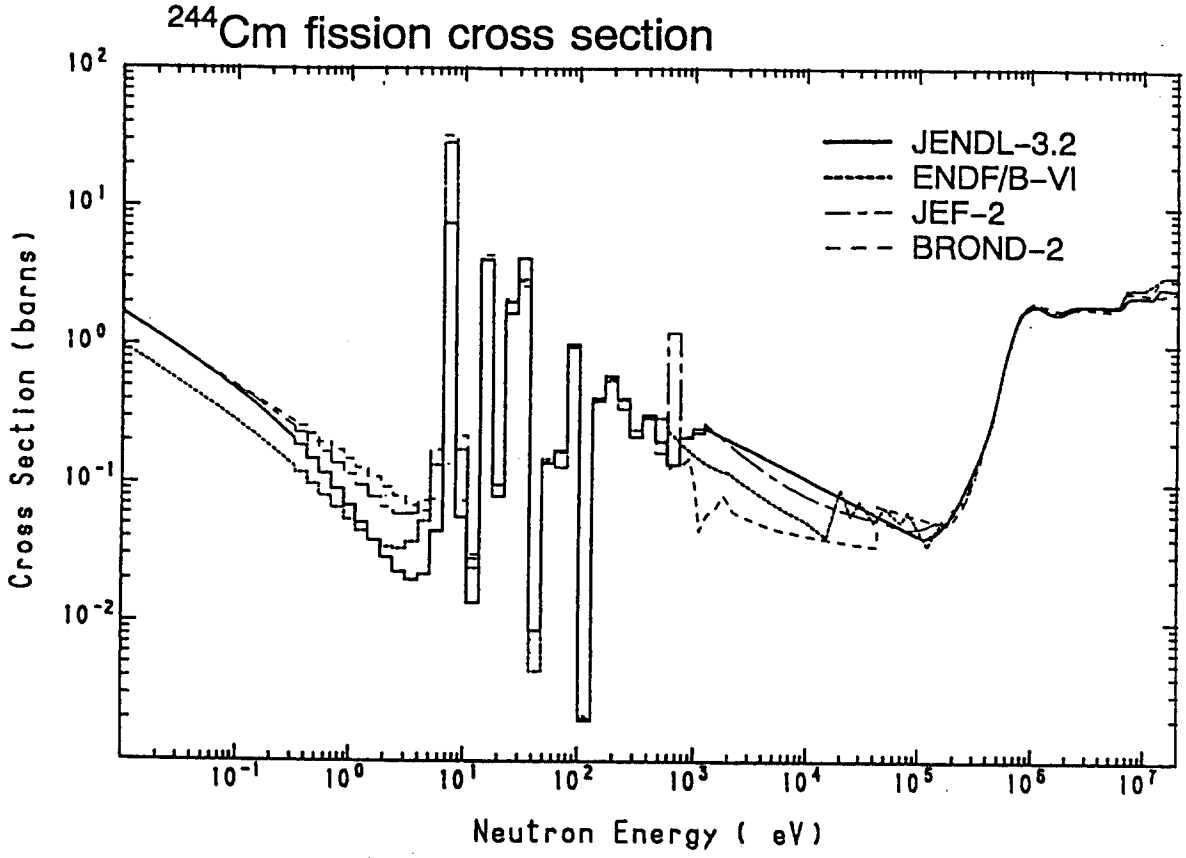


Fig. 11(1) ^{244}Cm fission cross section

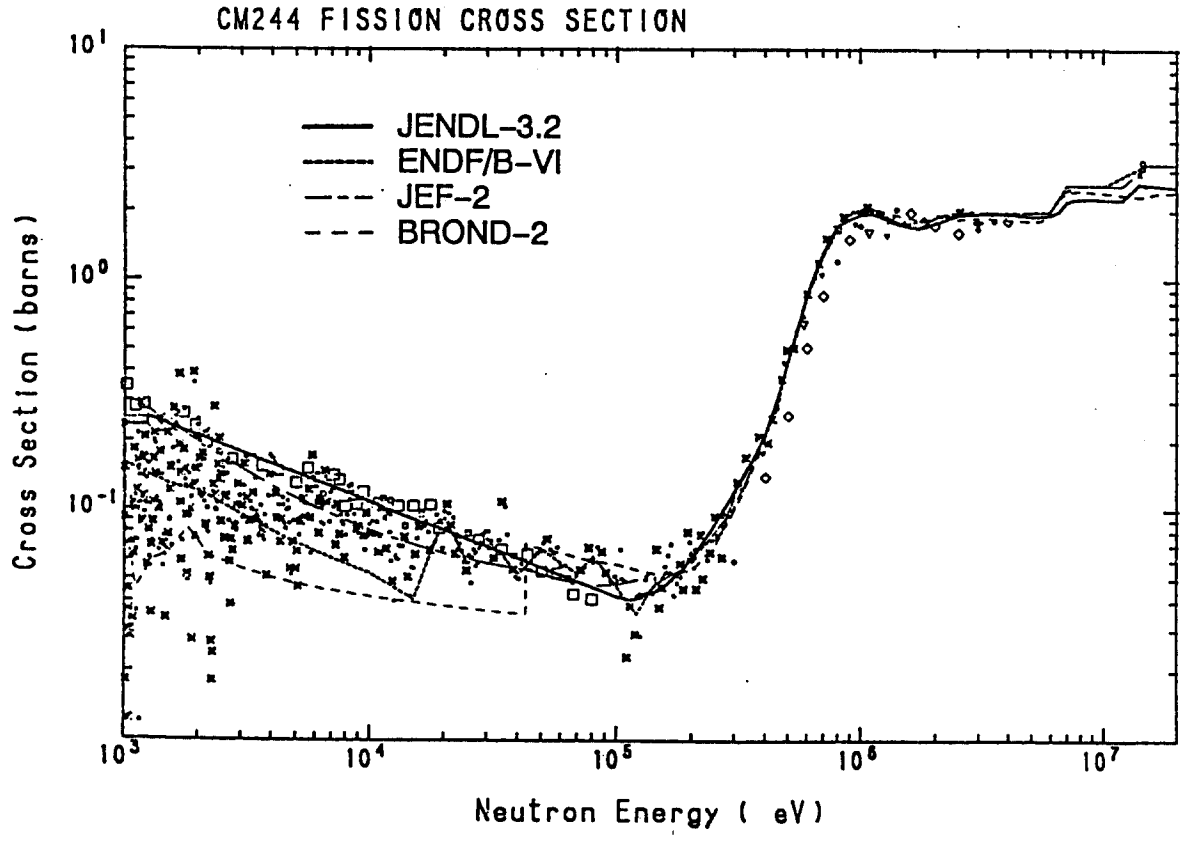


Fig. 11(2) ^{244}Cm fission cross section

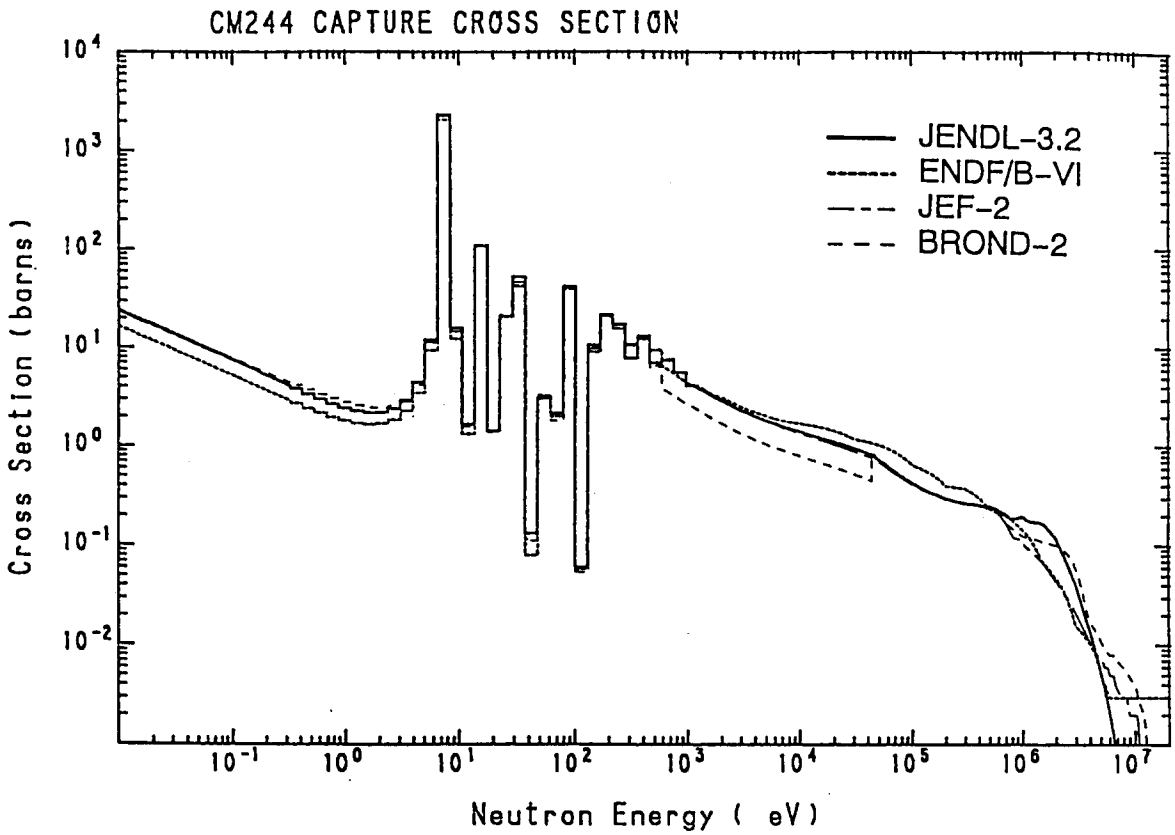


Fig. 12(1) ^{244}Cm capture cross section

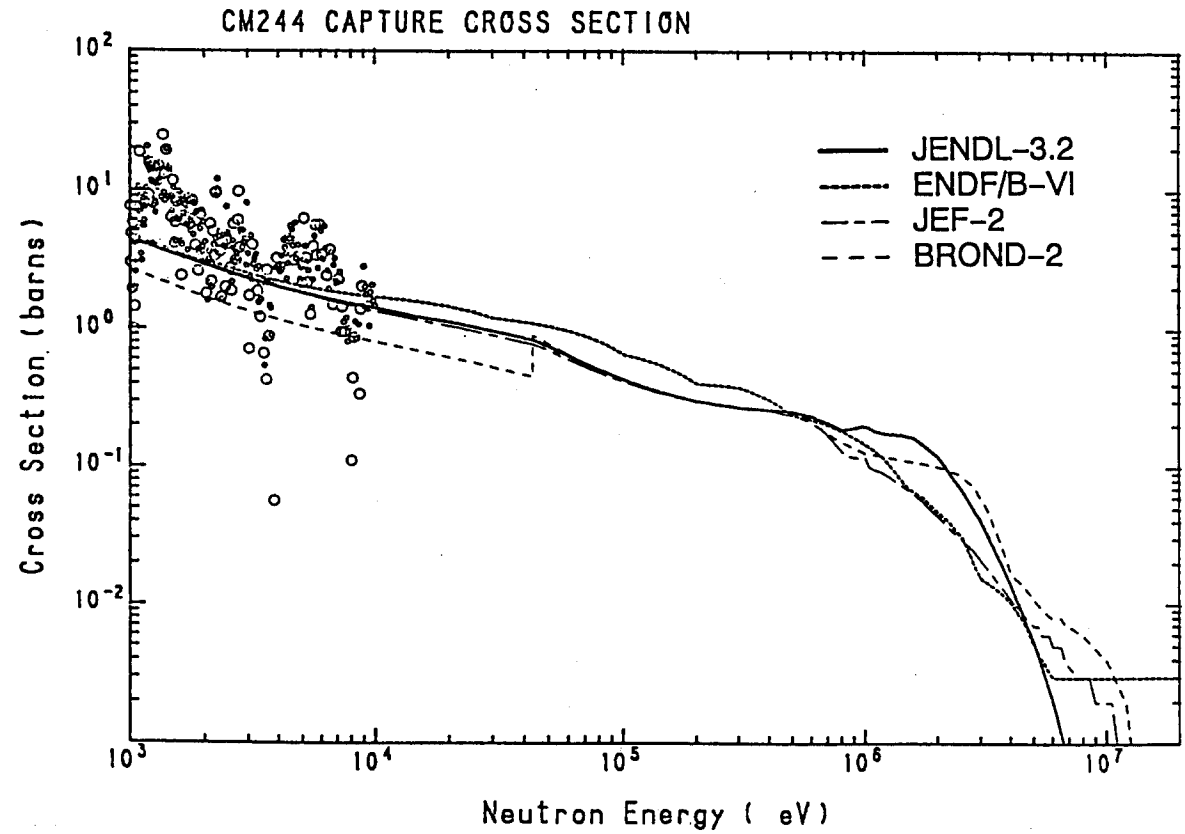


Fig. 12(2) ^{244}Cm capture cross section

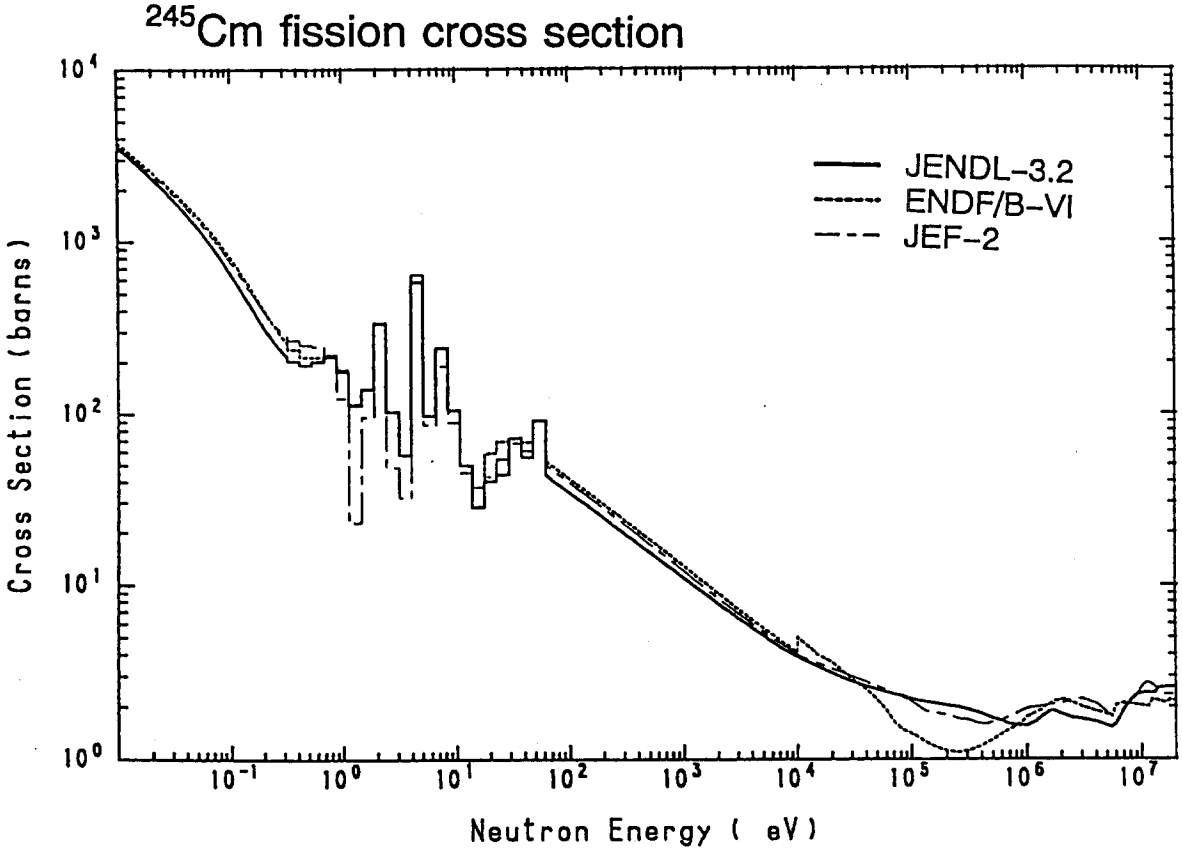


Fig. 13(1) ^{245}Cm fission cross section

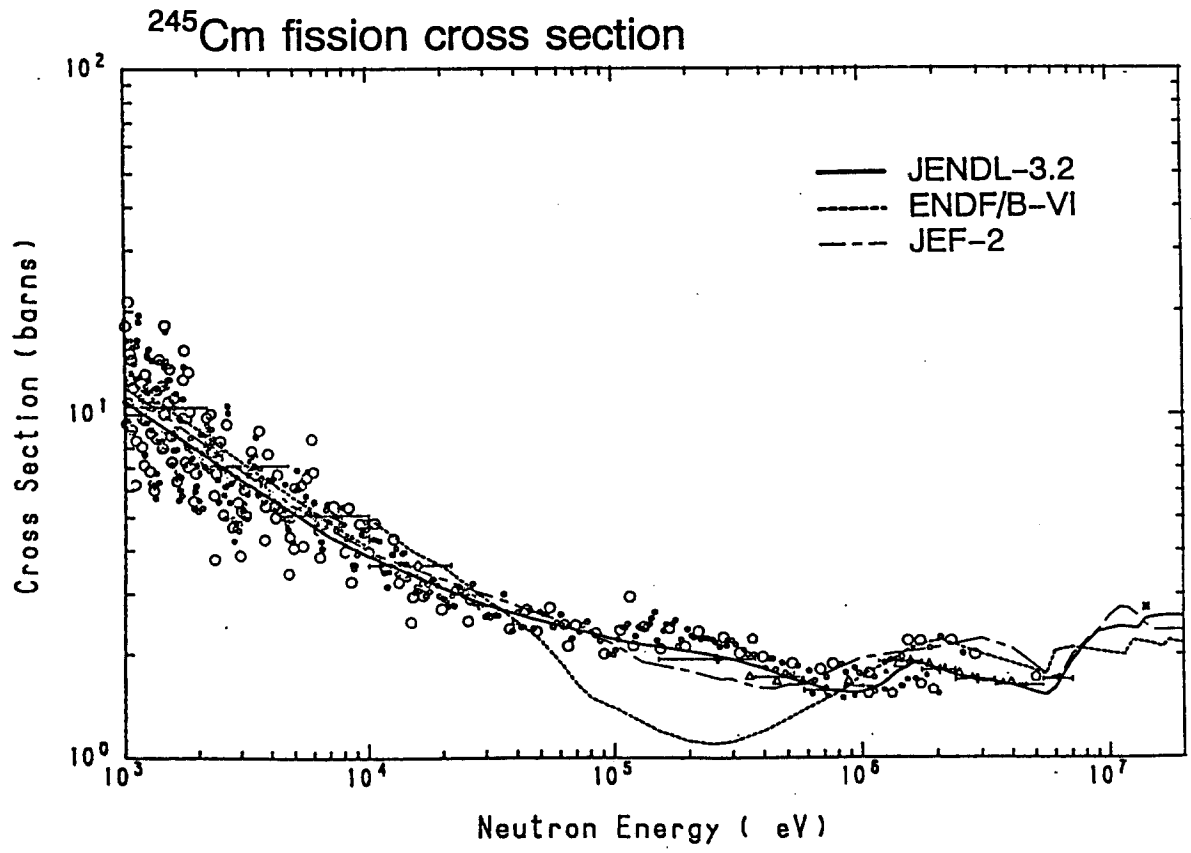


Fig. 13(2) ^{245}Cm fission cross section

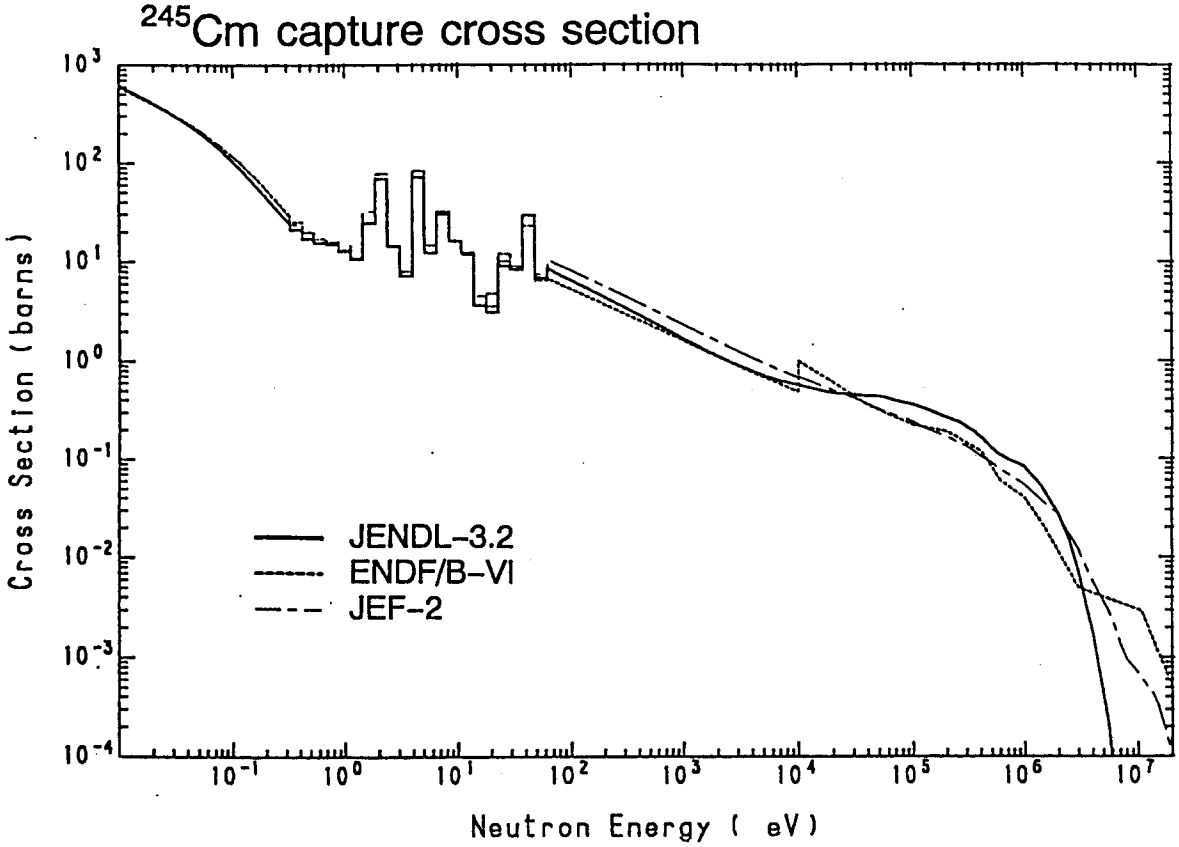


Fig. 14 ^{245}Cm capture cross section

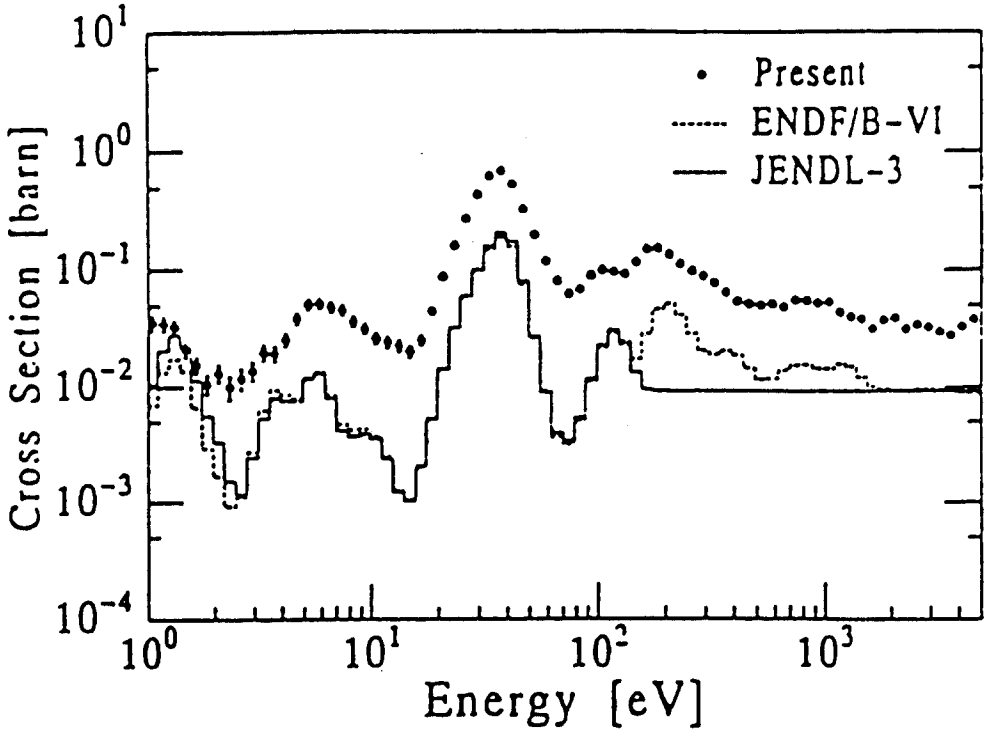


Fig. 15(1) ^{237}Np fission cross section (Taken from Ref. Ya93)

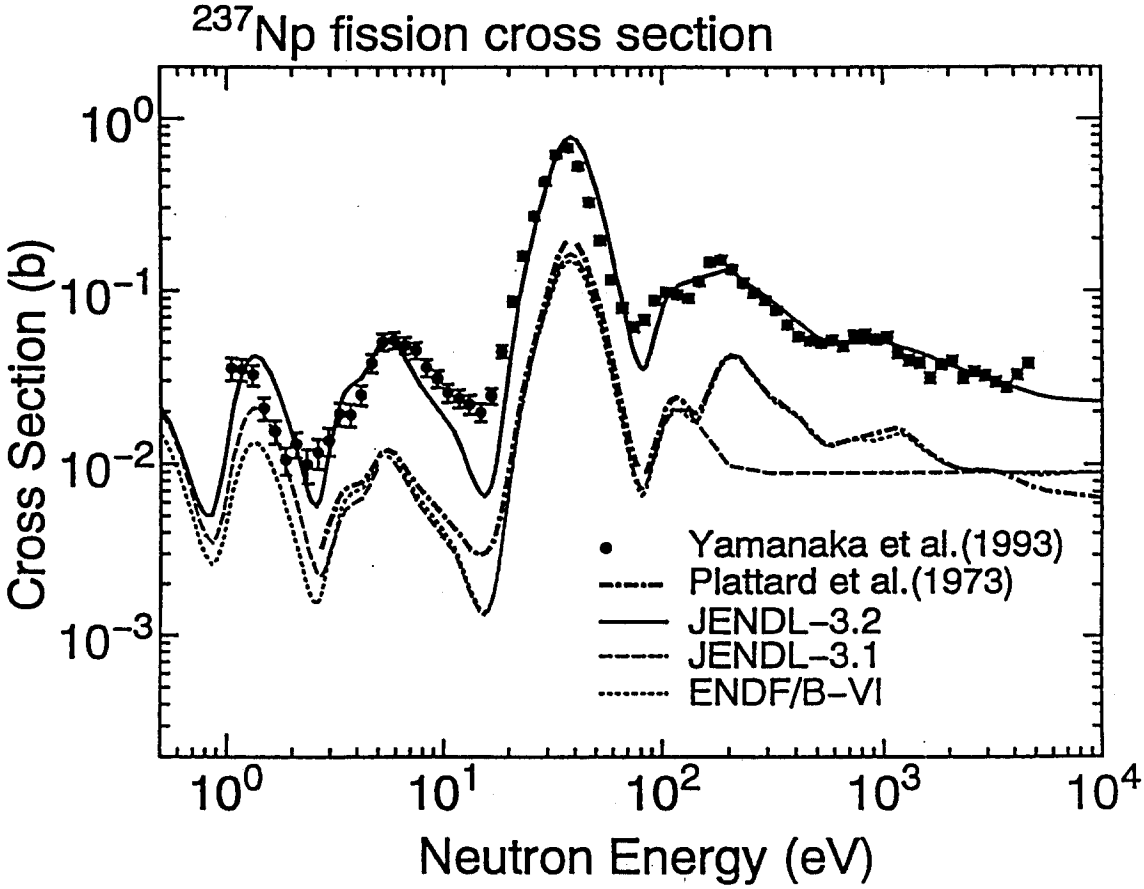


Fig. 15(2) ^{237}Np fission cross section

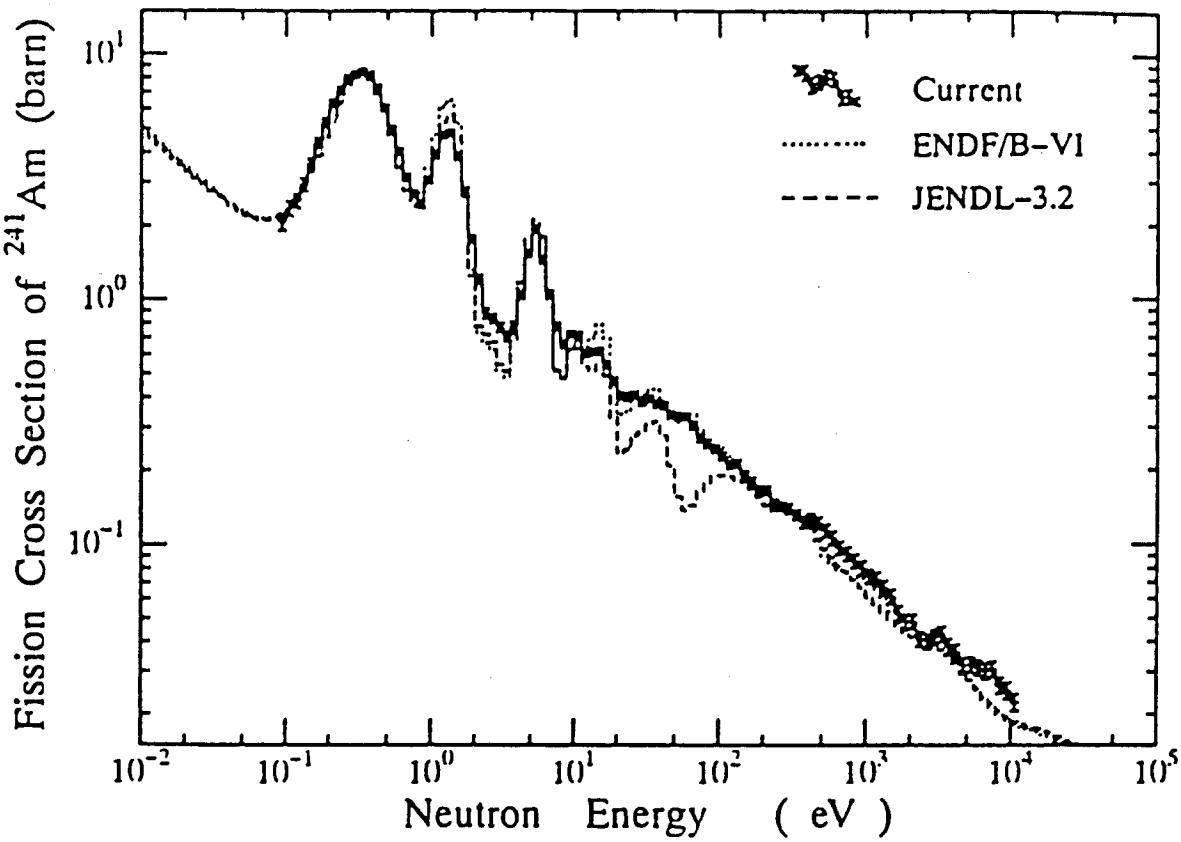


Fig. 16 ^{241}Am fission cross section (Taken from Ref. Ya97)

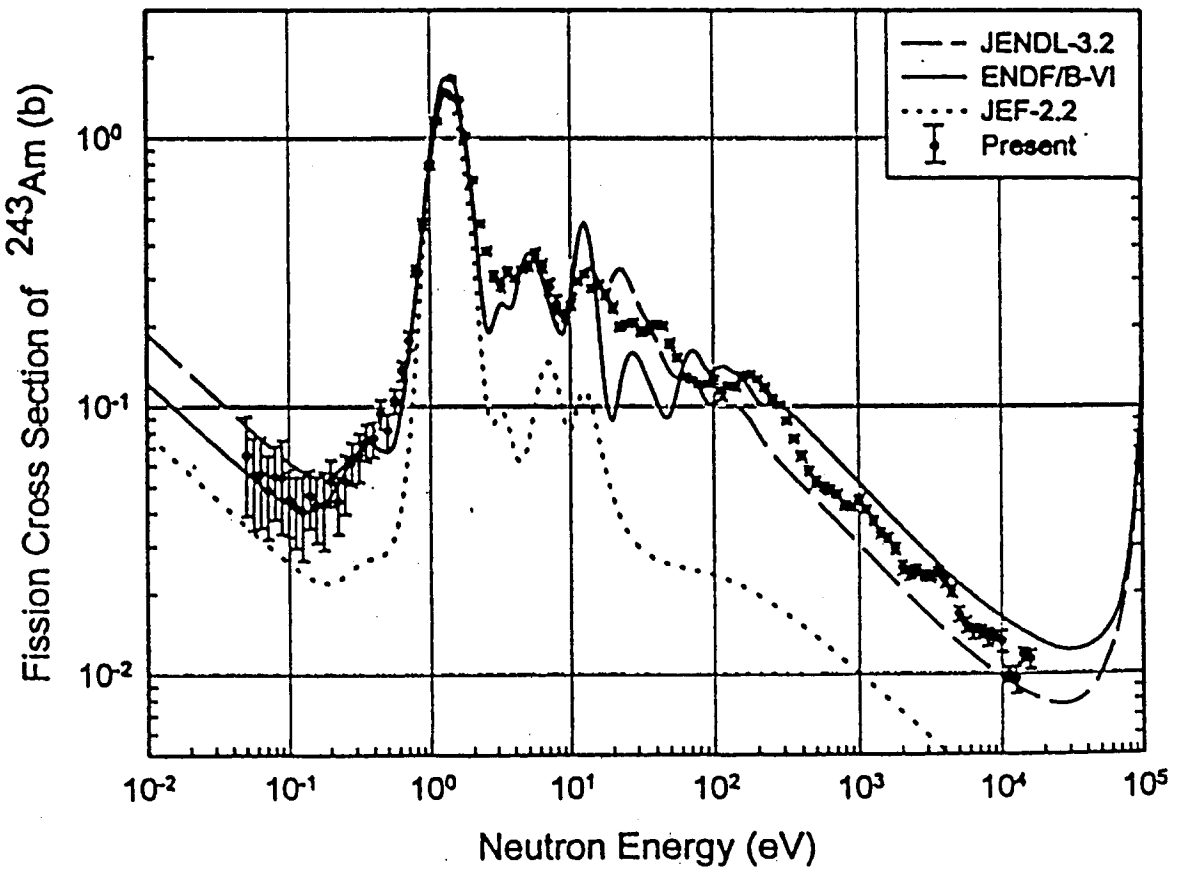


Fig. 17 ^{243}Am fission cross section (Taken from Ref. Ko99)

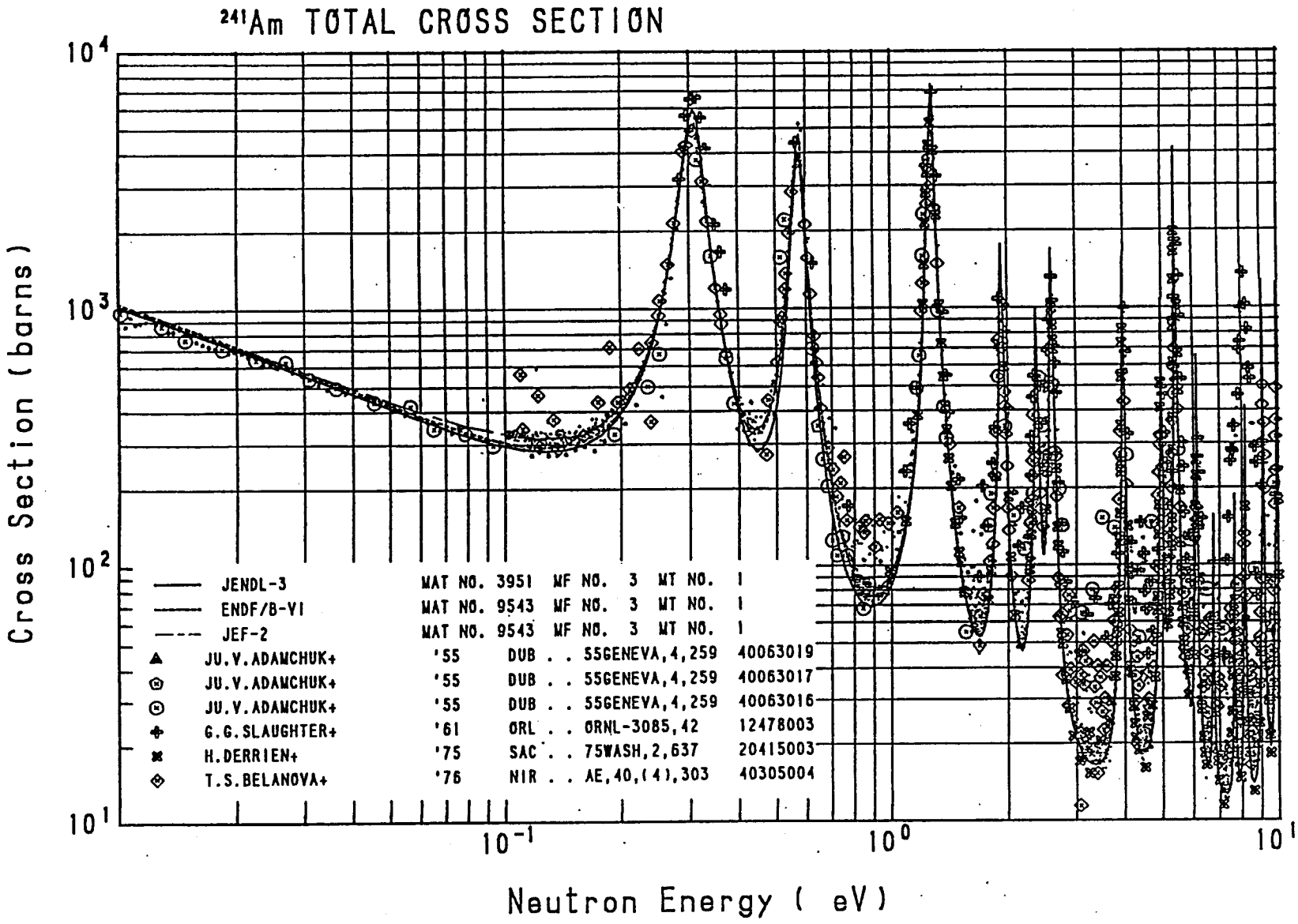


Fig. 18 ^{241}Am total cross section

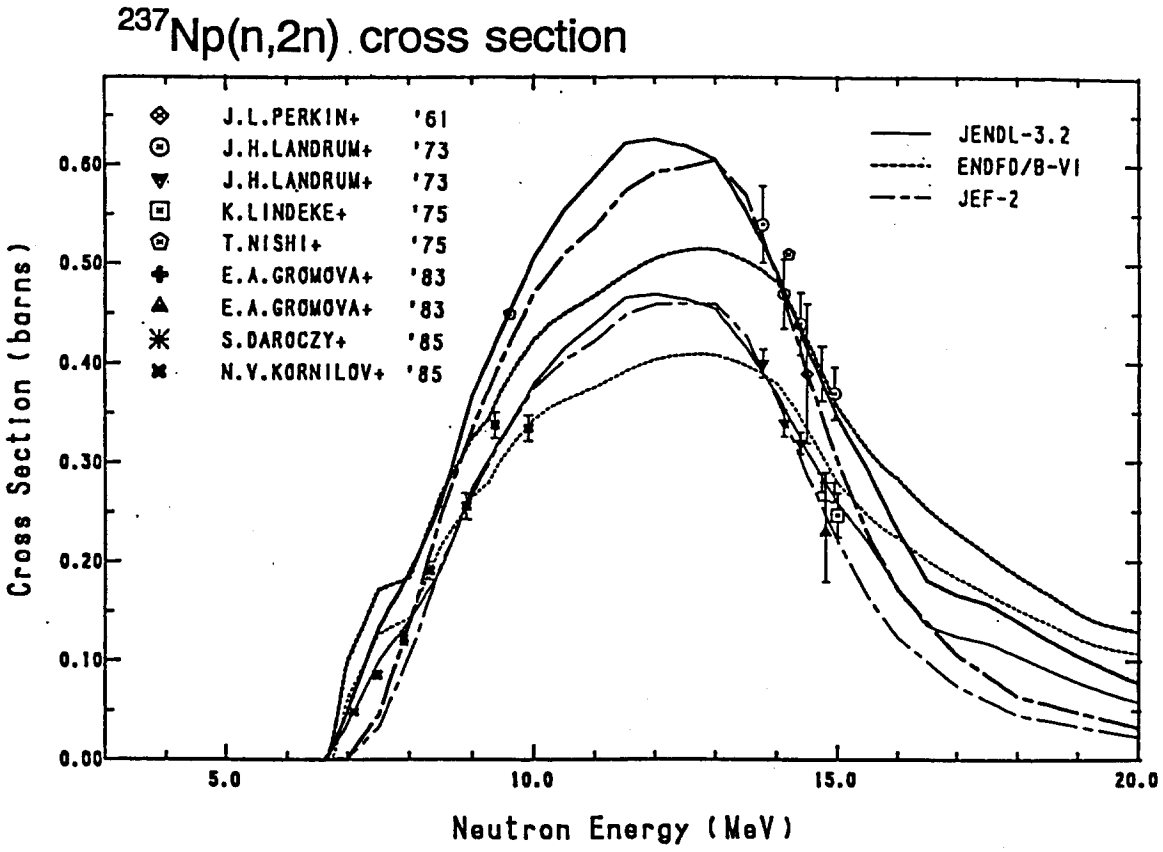


Fig. 19 ^{237}Np(n,2n) cross section

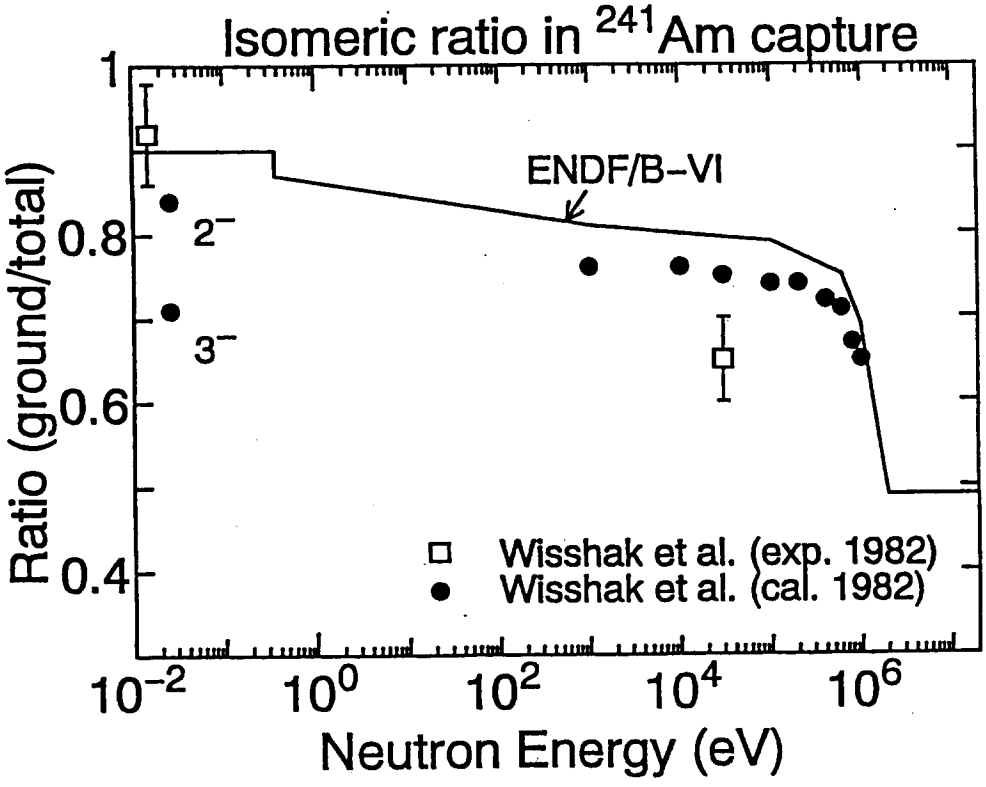


Fig. 20 Isomeric ratio of ^{241}Am neutron capture