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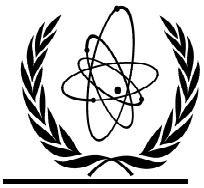

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Review of JENDL/HE-2007 Neutron-Induced Fission Cross Sections of Uranium-235 and 238 above 200 MeV

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Policy Planning and Administration Department
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October 2023

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Abstract

The neutron-induced fission cross section of uranium-235 evaluated for JENDL/HE-2007 above 200 MeV is wrongly compiled in the library file. This report provides the correct numbers. The neutron-induced fission cross section of uranium-238 compiled in this file above 500 MeV was also reviewed, and new cross sections are recommended.

Review of JENDL/HE-2007 neutron-induced fission cross sections of uranium-235 and 238 above 200 MeV

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1. ^{235}U(n,f) cross section

The high energy part of the ^{235}U(n,f) cross section for the JENDL/HE-2007 library [1] above 200 MeV was evaluated by using the FISCAL code [2]. This code calculates fission cross sections by using the following systematics on the fission probability P_f (fission cross section divided by the total reaction cross section):

$$P_f(x, E_{\mathrm{exc}}) = p_1\left[1 - e^{-(E_{\mathrm{exc}} - p_2)\,p_3}\right],$$

where $x = Z^2/A$ with Z and A are the atomic and mass numbers of the compound nucleus (Z = 92 and A = 236 for ^{235}U(n,f) cross section) and E_{exc} is the excitation energy of the compound nucleus. The three parameters for the ^{236}U compound system are p_1=0.81, p_2=5 and p_3=0.1. After calculation of the fission probability, this code calculates the total reaction cross section σ_r to obtain the fission cross section σ_f by $\sigma_f = P_f \sigma_r$. See Ref. [1] for more details about the FISCAL code. Unfortunately, the values calculated by this code were not correctly compiled in the ENDF format, and wrong values are disseminated in the JENDL/HE-2007 file. Table 1 provides the correct ^{235}U(n,f) cross sections of the JENDL/HE-2007 library above 200 MeV. **These values must be quoted as the JENDL/HE-2007 cross sections above 200 MeV**.

Table 1: ^{235}U(n,f) cross sections evaluated for the JENDL/HE-2007 library.

E_n (MeV)	σ (b)	E_n (MeV)	σ (b)
200	1.41924	380	1.52048
210	1.42346	400	1.53145
220	1.42666	450	1.55591
230	1.43074	500	1.57621
240	1.43550	550	1.59274
250	1.44080	600	1.60603
260	1.44649	700	1.62503
280	1.45867	800	1.63689
300	1.47138	900	1.64419
320	1.48417	1000	1.64867
340	1.49674	1500	1.65502
350	1.50288	2000	1.65554
360	1.50889	3000	1.65558

The cross sections in Table 1 are compared with those compiled in the JENDL/HE-2007 file, IAEA High-Energy Reference 2015 [3] and experimental datasets [4-7] in Fig. 1.

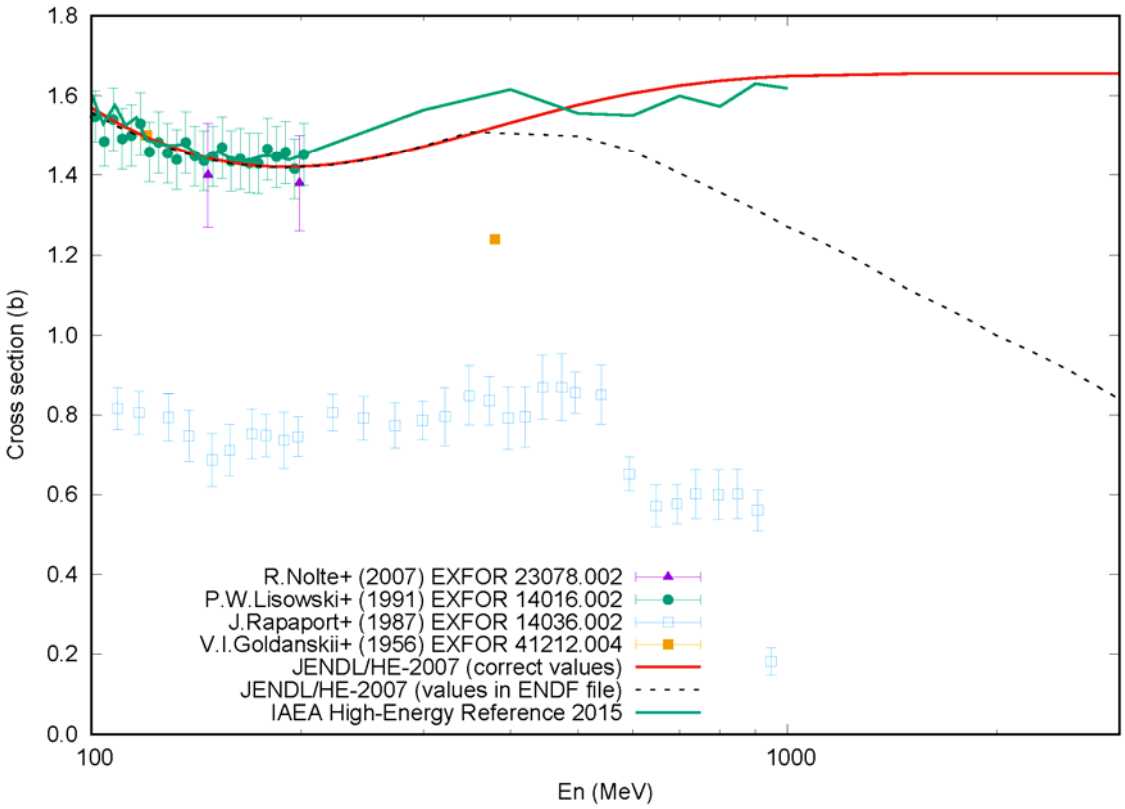

Figure 1. ^{235}U(n,f) cross sections evaluated for the JENDL/HE-2007 library (red) and compiled in the JENDL/HE-2007 file (dashed) compared with IAEA High-Energy Reference 2015 (green) [3] and experimental datasets [4-7].

2. ^{238}U(n,f) cross section

It is seen in Fig. 2 that the ^{238}U(n,f) cross sections compiled in the JENDL/HE-2007 library file are also suffered a similar compilation error. Not like the ^{235}U(n,f) case, the values calculated by FISCAL for ^{238}U(n,f) is too high comparing to the values compiled in the JENDL/HE-2007 library file below 200 MeV. and it indicates the JENDL/HE-2007 evaluation did not adopt the default output of the FISCAL code for the ^{238}U(n,f) case. In order to examine performance of the FISCAL systematics, a new calculation of the ^{238}U(n,f) cross sections was done with the (1) fission probability corresponding to a parameter set (p_1=0.72, p_2=4.9 and p_3=0.05) and (2) total reaction cross sections calculated from the total and elastic scattering cross sections in the JENDL/HE-2007 file. The cross sections from FISCAL systematics in Table 2 are recommended above 500 MeV instead of those compiled in the JENDL/HE-2007 file.

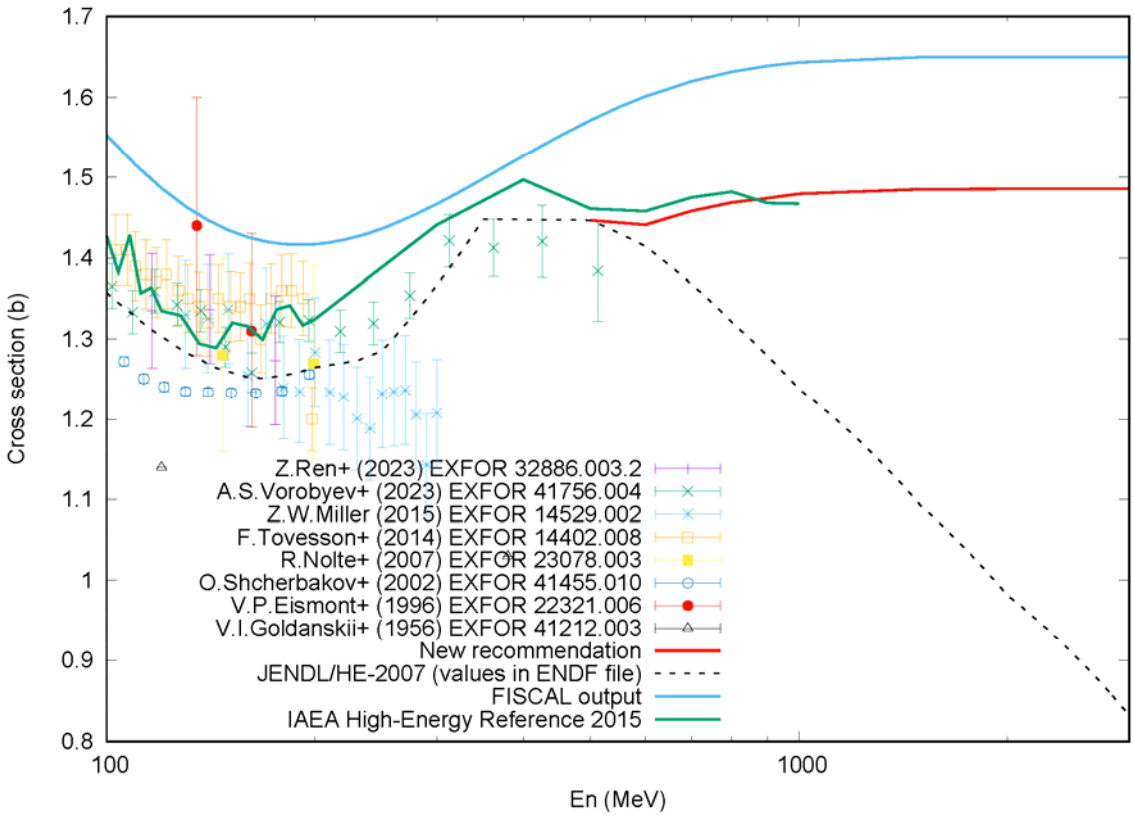

Figure 2. ^{238}U(n,f) cross sections recommended by the FISCAL systematics (red), compiled in the JENDL/HE-2007 file (dashed) and FISCAL output (cyan) compared with IAEA High-Energy Reference 2015 (green) [3] and experimental datasets [4, 9-15].

Table 2: ^{238}U(n,f) cross sections recommended by the FISCAL systematics with p_1=0.72, p_2=4.9 and p_3=0.05. The cross section at 500 MeV is taken from the JENDL/HE-2007 file.

E_n (MeV)	σ (b)
500	1.44670
600	1.44101
700	1.45807
800	1.46873
900	1.47402
1000	1.47931
1500	1.48500
2000	1.48543
3000	1.48550

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