Problem on Unresolved Resonance Data in ENDF/B-VI, etc.

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At the 2003 symposium on nuclear data it is pointed out that the self-shielding correction for the unresolved resonances of many nuclei in JENDL-3.3 is too large around the upper energy of the unresolved resonance region. It is investigated whether ENDF/B-VI, BROND-2.2 and CENDL-2.1 have the same problem for unresolved resonance data as JENDL-3.3. More than half of nuclei with unresolved resonance data in ENDF/B-VI, BROND-2.2 and CENDL-2.1 have the same problem as JENDL-3.3.

1. Introduction

At the 2003 symposium on nuclear data the followings are pointed out [1];

1) Elastic scattering cross section data of many nuclei with self-shielding correction in JENDL-3.3 [2] have a large strange ramp at the upper energy of the unresolved resonance region as shown in Fig. 1.

2) Larger average reduced neutron widths are required to obtain average elastic scattering cross sections in the unresolved resonance region but they cause larger self-shielding correction in many nuclei of JENDL-3.3 with unresolved resonance data.

3) The average reduced neutron widths or the upper energy of the unresolved resonance region in JENDL-3.3 should be checked.

Other evaluated nuclear data libraries may have the same problems. ENDF/B-VI [3], BROND-2.2 [4] and CENDL-2.1 [5] are investigated in this paper.

2. Method

The check procedure is the same as that described in Ref. 1;

1) Matxs files of ENDF/B-VI, BROND-2.2 and CENDL-2.1 with unresolved resonance data were produced with the NJOY [6] code in the same conditions as MATXSLIB-J33 [7].

2) Multigroup libraries of elastic scattering cross section with self-shielding correction for each nuclei [100 % abundance] from the matxs files of ENDF/B-VI, BROND-2.2 and CENDL-2.1 were made with the TRANSX [8] code.

3) Multigroup elastic cross section data with self-shielding correction were checked.

4) If the elastic cross section with self-shielding correction of a nucleus has a large strange ramp at the upper energy of the unresolved resonance region, it is judged that the unresolved resonance data of the nucleus have some problems.

3. Nuclei with unresolved resonance data in ENDF/B-VI

All the data of nuclei (~ 80) with unresolved resonance data in ENDF/B-VI were examined. As a result, it is found out that the self-shielding correction for elastic scattering cross sections in unresolved resonance region is too large around the upper energy of the unresolved resonance region for about half of the nuclei (~ 40) as shown in Figs. 2 and 3. Table 1 summarizes all the nuclei with unresolved reso-

nance data in ENDF/B-VI. In this table unresolved resonance data of nuclei with bold character may have inadequate average reduced neutron widths or the upper energy of the unresolved resonance region.

4. Nuclei with unresolved resonance data in BROND-2.2

All the data of nuclei (~ 70) with unresolved resonance data in BROND-2.2 were examined. It is found out that the self-shielding correction for elastic scattering cross sections in unresolved resonance region is too large around the upper energy of the unresolved resonance region for about half of the nuclei (~ 40) as shown in Figs. 4 and 5. Table 2 summarizes all the nuclei with unresolved resonance data in BROND-2.2. In this table unresolved resonance data of nuclei with bold character have inadequate average reduced neutron widths or the upper energy of the unresolved resonance region.

5. Nuclei with unresolved resonance data in CENDL-2.1

All the data of nuclei with unresolved resonance data in CENDL-2.1 were examined. It seems that the self-shielding correction for elastic scattering cross sections in unresolved resonance region is too large around the upper energy of the unresolved resonance region for about half of the nuclei as shown in Figs. 6 and 7. Table 3 summarizes all the nuclei with unresolved resonance data in CENDL-2.1. In this table unresolved resonance data of nuclei with bold character have inadequate average reduced neutron widths or the upper energy of the unresolved resonance region.

6. Summary

It is investigated whether ENDF/B-VI, BROND-2.2 and CENDL-2.1 have the same problem for unresolved resonance data as many nuclei in JENDL-3.3 ; elastic scattering cross section data of many nuclei with self-shielding correction have a large strange ramp at the upper energy of the unresolved resonance region since the average reduced neutron widths or the upper energy of the unresolved resonance region are inadequate. The problem for unresolved resonance data appears not only in many nuclei of JENDL-3.3, but also in many nuclei of ENDF/B-VI, BROND-2.2 and CENDL-2.1. All the unresolved resonance data in ENDF/B-VI, BROND-2.2 and CENDL-2.1 should be rechecked and revised by considering self-shielding correction in the next version.

References

[1] Konno C. : JAERI-Conf 2004-005, p. 236 (2004).
[2] Shibata K., et al. : J. Nucl. Sci. Tech. $\underline{39}$, 1125 (2002).
[3] Cross Section Evaluation Working Group : BNL-NCS-17541 (ENDF-201) (1991).
[4] Manokhin V.N., et al. : IAEA-NDS-90 Rev. 8 (1994).
[5] Liang Qichang, et al. : IAEA-NDS-60 Rev. 3 (1996).
[6] MacFarlane R.E. and Muir D.W. : LA-12740-M (1994).
[7] Kosako K., et al. : JAERI-Data/Code 2003-011 (2003).
[8] MacFarlane R.E. : LA-12312-MS (1993).

Table 1 Nuclei with unresolved resonance data in ENDF/B-VI.

Zr-91, Mo-nat, Tc-99, **Ru-101, -102, Rh-103,** Ag-109, **Cd-106, -108, -110, -112, -114, -116, Xe-131, Nd-145, Pm-147,** Sm-147, **-149, -150,** -151, **-152, Eu-151,** -152, **-153,** -154, **Gd-152, -154,** -155, -157, **Dy-164, Er-167,** Hf-nat, **-174,** -176, -177, **-178,** -179, **-180, Ta-181, -182,** W-nat, **-182, -183, -184, -186,Re-185, -187, Ir-191, -193,** Th-232, Pa-231, 233, **U-232,** -233, -234, -235, -236, -237, -238, Np-238 **Pu-236, ,-238,** -239, **-240,** -241, **-242, -243, -244,** Am-241, -242, -242m, -243 **Cm-242,** -243, -244, -245,-246, -247, -248, Bk-249, Cf-249, **-250, -251, -252,** -253, **Es-253**

Bold : Unresolved resonance data have some problems.

Table 2 Nuclei with unresolved resonance data in BROND-2.2.

Cr-50, -53, Fe-54, -56, -57, -58, NI-58, -60, -61, -62, -64, **Zr-nat, -90, -91, -92, -93, -94, -95, -96, Nb-93, Tc-99, Ru-101, -102, -104, Rh-103, Pd-105, -106, -107, -108, Ag-109,** Sn-nat, I-129, Xe-131, **Nd-143, -145,** Pm-147, Sm-nat, -147, **-148,** -149, **-150,** -151, **-152, -154,** Eu-153, **Gd-155, -157, Er-162, -164, -166, -167,** -168, -170, Ta-181, **W-182,** -183, **-184, -186, Re-nat,** Th-232, U-233, -235, -238, Pu-238, -239, **-240, -242,** Am-241, -242m, -243, Cm-242, **-244**

Bold : Unresolved resonance data have some problems.

Table 3 Nuclei with unresolved resonance data in CENDL-2.1.

Zr-nat, **Mo-nat, Ag-nat, -107, -109**, In-nat, **Lu-nat, Hf-nat,** Ta-181, U-235, -238, Np-237, Pu-239, -240, **Am-241, Bk-249,** Cf-249

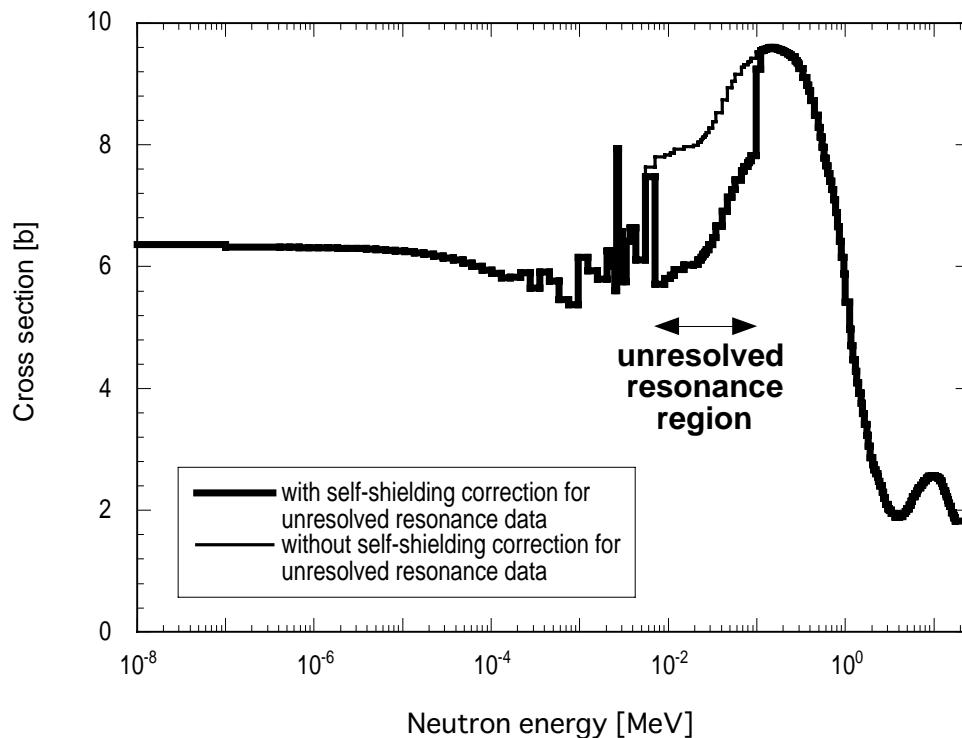**Bold** : Unresolved resonance data have some problems.

Fig. 1 Self-shielding corrected elastic scattering cross section of ^{93}Nb in JENDL-3.3.
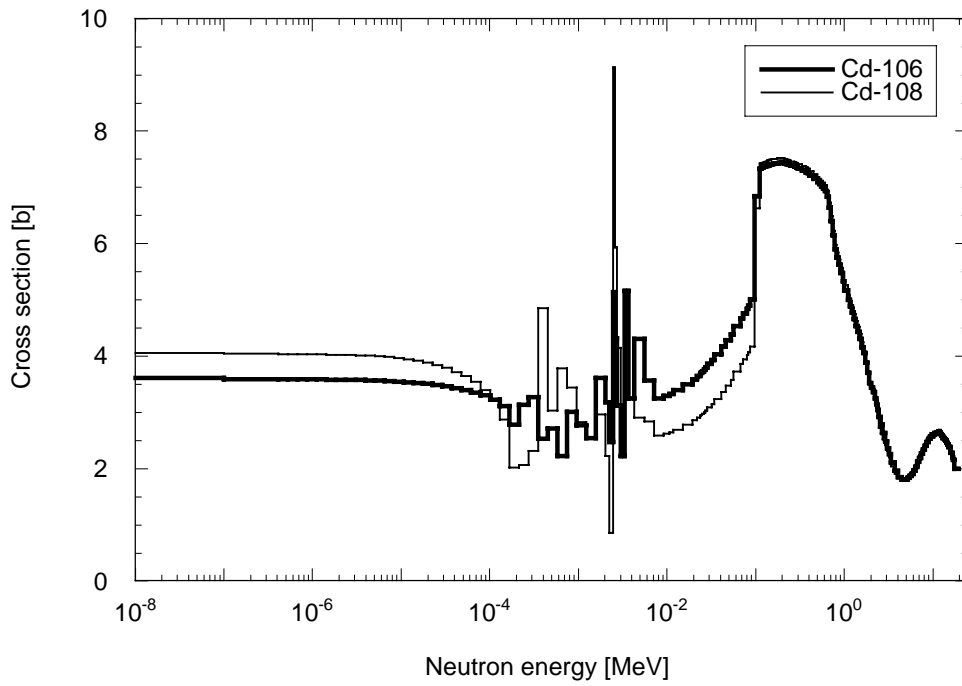
Fig. 2 Self-shielding corrected elastic scattering cross section of ^{106}Cd and ^{108}Cd in ENDF/B-VI.
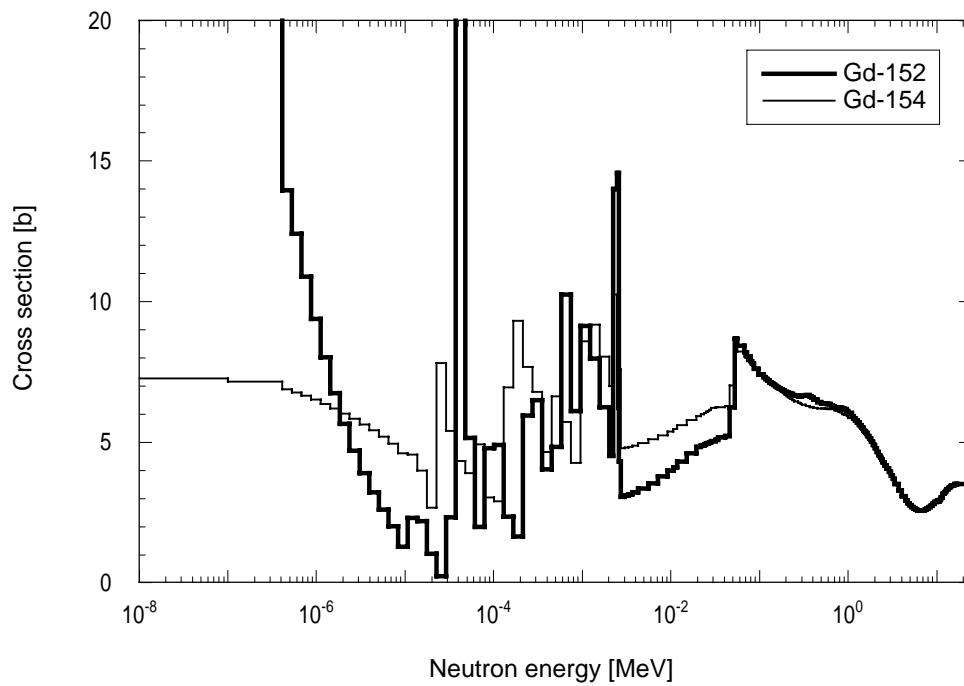

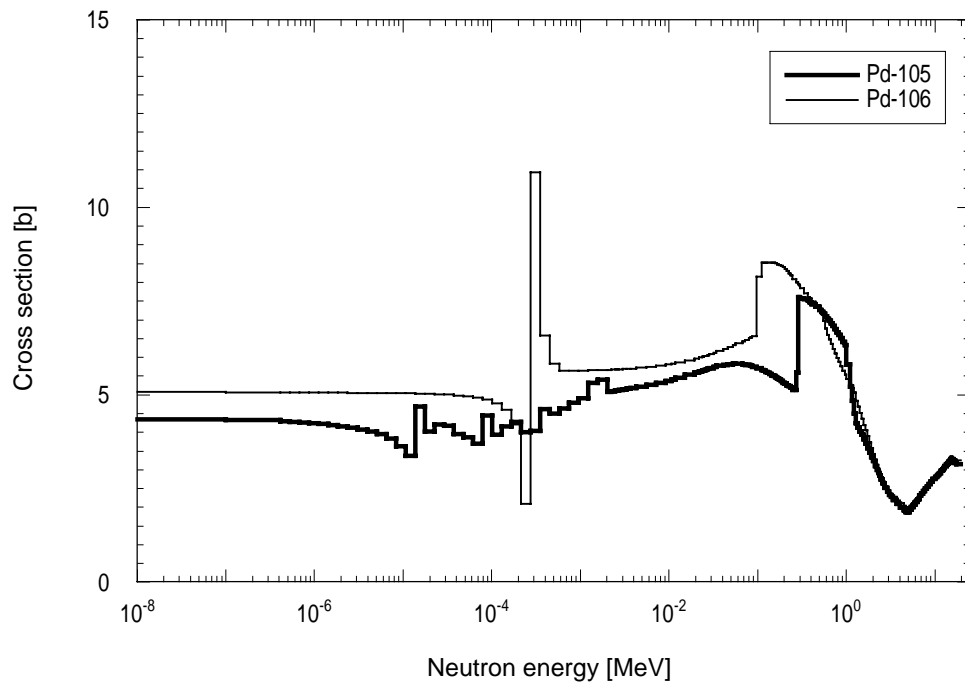Fig. 3 Self-shielding corrected elastic scattering cross section of ^{152}Gd and ^{154}Gd in ENDF/B-VI.

Fig. 4 Self-shielding corrected elastic scattering cross section of [105]Pd and [106]Pd in BROND-2.2.
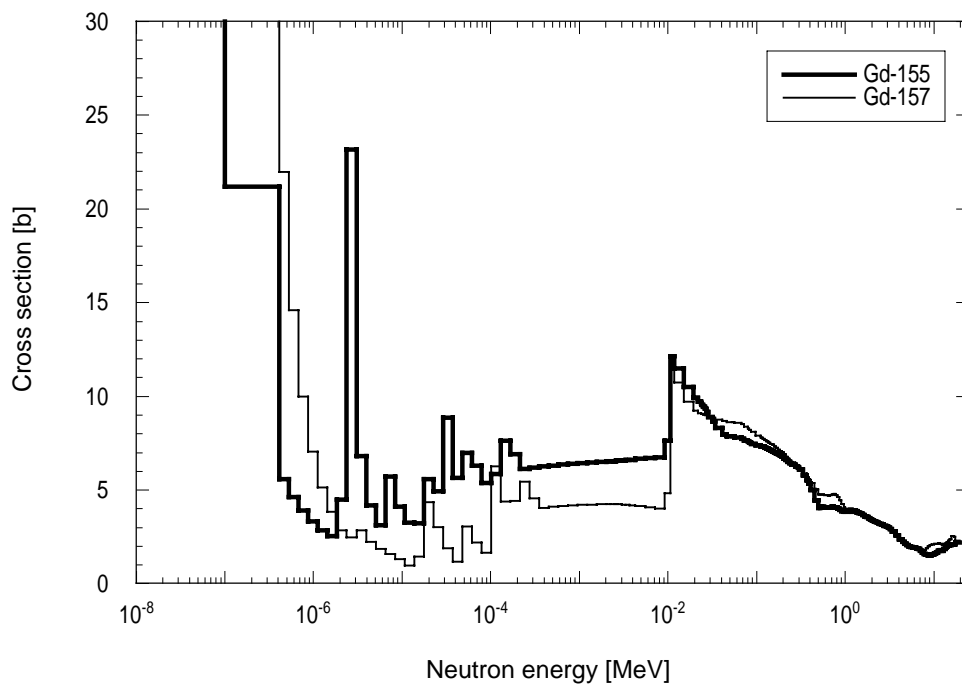

Fig. 5 Self-shielding corrected elastic scattering cross section of [155]Gd and [157]Gd in BROND-2.2.
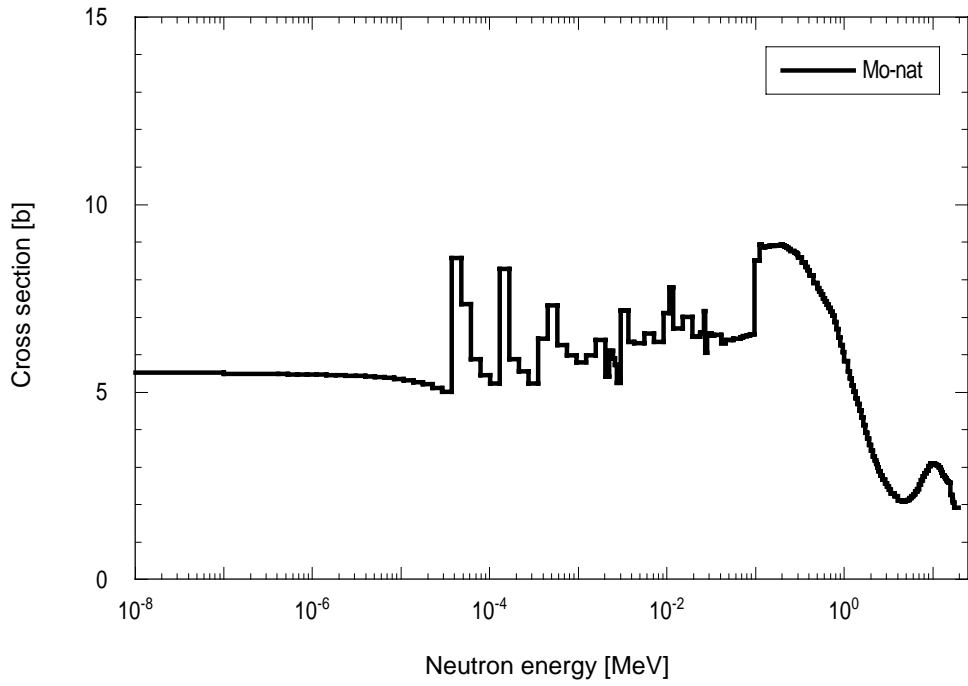
Fig. 6 Self-shielding corrected elastic scattering cross section of Mo-nat in CENDL-2.2.
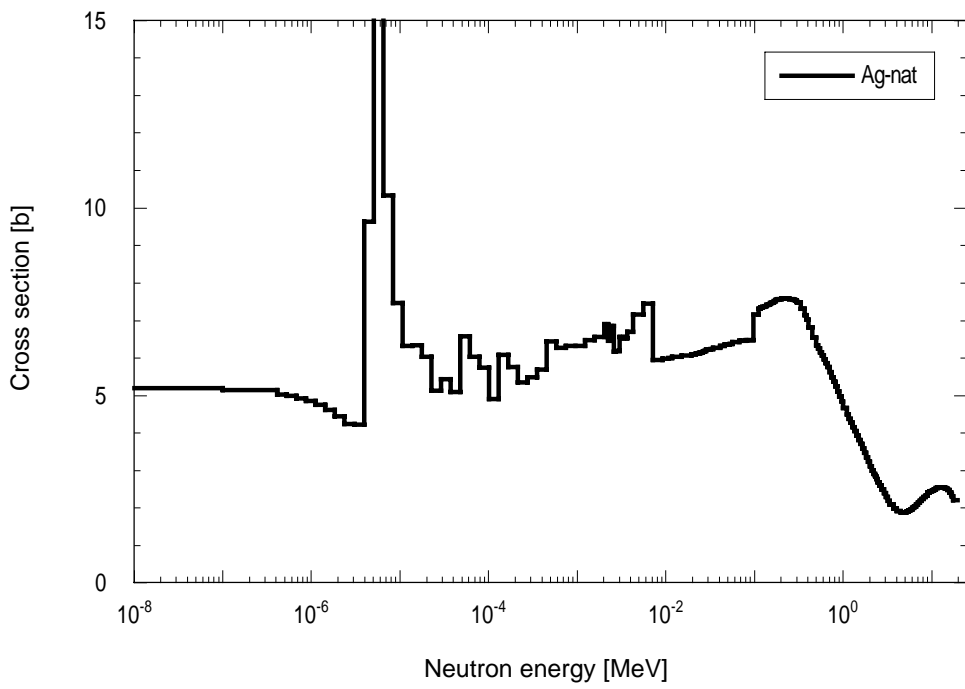

Fig. 7 Self-shielding corrected elastic scattering cross section of Ag-nat in CENDL-2.2.