Present Status of JENDL-3.3

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The latest version of JENDL General Purpose Library, JENDL-3.3, is being compiled. The evaluations for JENDL-3.3 have been performed mainly by the Medium-Heavy Nuclide Data Evaluation WG, the Heavy Nuclide Data Evaluation WG and the Delayed Neutron WG in the Japanese Nuclear Data Committee. The main objective of the evaluations is to solve the problems that were pointed out in JENDL-3.2.

1. Introduction

The library JENDL-3.2 [1] was released in 1994, and it has been used in various fields. This library was examined [2] by considering the feedback from users. As a result, we found several problems in JENDL-3.2: overestimation of k_{eff} for thermal reactors, inadequate neutron spectra for heavy nuclides, neglect of direct and semi-direct processes in capture cross sections, and inconsistency between natural and isotopic data. Two Working Groups, Medium-Heavy Nuclide Data Evaluation WG and Heavy Nuclide Data Evaluation WG, were organized to solve these problems in the Japanese Nuclear Data Committee. The two WGs carefully looked into the JENDL-3.2 data by comparing with differential and integral measurements. After that, the evaluated data have been improved.

This paper describes how the evaluation was performed in the heavy and medium-heavy mass regions.

2. Evaluation

2.1 Heavy Nuclides

2.1.1 Resonance Parameters of ^{235}U

The biggest problem of JENDL-3.2 is that the k_{eff} values are overestimated by 0.3~1% for thermal reactors as compared with those of JENDL-3.1. We adopted the resonance parameters obtained by Leal et al. [3] for JENDL-3.3. These parameters were recommended to use by the NEANSC Working Party on Evaluation Cooperation Subgroup 18. Figures 1 and 2 show the fission and capture cross sections of ^{235}U, respectively. Smaller fission cross sections below 0.3 eV lead to decreasing the k_{eff} values. One can see a large difference in the capture cross section between JENDL-3.3 and JENDL-3.2 in the energy region from several hundreds of eV to 2 keV.

2.1.2 Fission Cross Sections of U and Pu Isotopes

Fission cross sections of $^{233, 235, 238}$U and $^{239, 240, 241}$Pu were simultaneously evaluated [4] by taking account of ratio measurements as well as absolute measurements in the energy region from 30 keV to 20 MeV, as was done in the JENDL-3.2 evaluation. About 170 sets of measurements (4560 data points) were used in the evaluation. The evaluated ^{233}U(n,f) and ^{235}U(n,f) cross sections are shown in Figs. 3 and 4, respectively. It is found from Fig 3 that the presently evaluated ^{233}U(n,f) cross sections are lower than those of JENDL-3.2 above 300 keV. As for ^{235}U, the present values are different from the JENDL-3.2 cross sections above 14 MeV, which comes from the fact that the experimental data measured by Lisowski et al. [5] were employed in the present evaluation above 12 MeV. The change in the fission cross section of ^{235}U influenced other cross sections through their ratios.

2.1.3 Neutron Emission Spectra

Fission neutron spectra from ^{235}U and ^{239}Pu were re-evaluated by the multi-modal analyses. The ratio of JENDL-3.3 to JENDL-3.2 is illustrated in Fig. 5 at thermal energy. As for ^{235}U, the JENDL-3.3 spectrum is harder than that of JENDL-3.2.

Unphysical continuum neutron spectra from the (n,n') reaction are contained for some nuclides in JENDL-3.2. These spectra were replaced with the calculations using the EGNASH code [6]. In JENDL-3.3, we use the ENDF interpolation law INT=22 for neutron spectra, leading to appropriate interpolation of the spectra between the adjacent incident energies given in the library.

Concerning delayed neutron spectra, we adopted those values calculated by Brady and England [7] which were recommended to use by the Delayed Neutron WG.

2.2 Medium-Heavy Nuclides

2.2.1 Outline of Evaluations

Resonance parameters of V, Cr, Fe, Co and W isotopes were updated. The Reich-Moore formula was used for these nuclei except W.

The data for natural elements were contained in JENDL-3.2. However, there is inconsistency between the natural and isotopic data. In JENDL-3.3, we did not make elemental data for structural-material nuclei. In the case where experimental data on total cross sections were available for a natural element, isotopic data were evaluated so that the sum of the isotopic data reproduced the measurements of the natural element.

The EGNASH code was rigorously used to evaluate the cross sections for the threshold reactions such as (n,2n) and (n,p). The neutron emission spectra were taken from the DDX data in JENDL/F-99 [8] for many nuclides.

2.2.2 Iron Data

The resonance parameters of $^{54,\,56}$Fe were taken from ENDF/B-VI and JEF-2.2, respectively. As a result, the upper limit of the resolved resonance region turned out to be 700 keV for ^{54}Fe and 850 keV for ^{56}Fe, while those of JENDL-3.2 is 250 keV for both nuclei.

The total cross sections of $^{54,\,56}$Fe were revised above the resonance region. As for ^{54}Fe, the evaluation is based on the experimental data measured by Carlton et al. [9] and Conelis et al. [10] Three sets of the measurements [11-13] were used to estimate the total cross sections of elemental iron. The total cross section of ^{56}Fe was obtained by subtracting the contribution of other isotopes from the elemental data. It is found from Fig. 6 that the presently evaluated cross sections are higher than those of JENDL-3.2 in the energy region from 1 keV to 1 MeV on the average.

3. Concluding Remarks

The evaluation for JENDL-3.3 was described with an emphasis on heavy-nuclide data. The number of nuclides, whose data are revised, would be about 90. It is expected that 18 new evaluations are compiled into JENDL-3.3 such as Hg, Er and a few minor actinides. We are going to release the library in the spring of 2001.

Acknowledgment

The members of the Japanese Nuclear Data Committee have made great efforts to carry out the JENDL-3.3 evaluations, which were briefly described in this paper. The authors would like to appreciate their cooperation.

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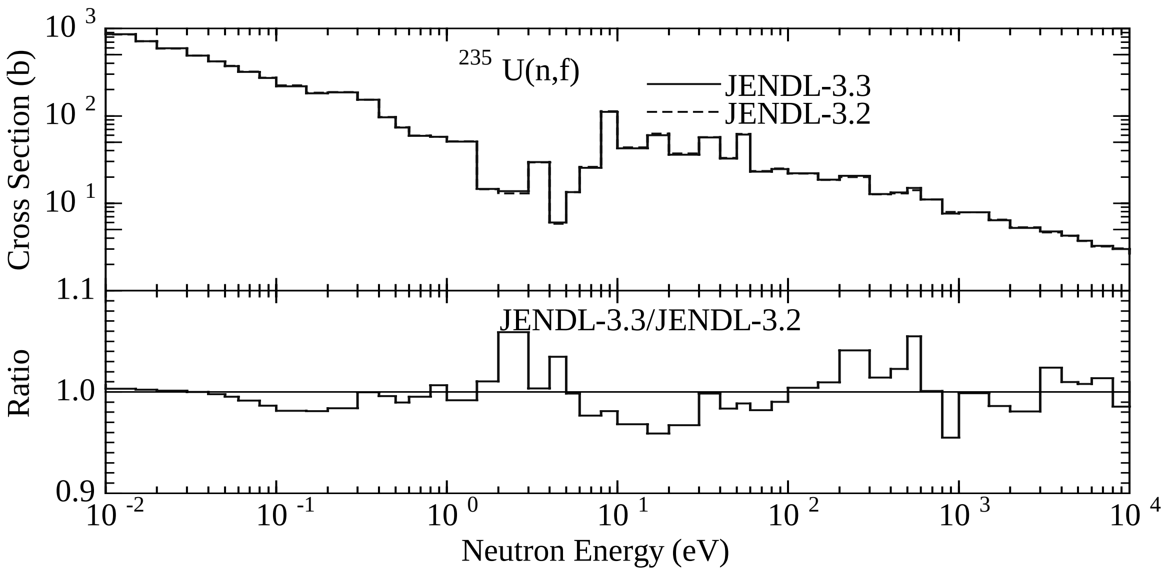

Fig. 1 Fission cross sections of ^{235}U.

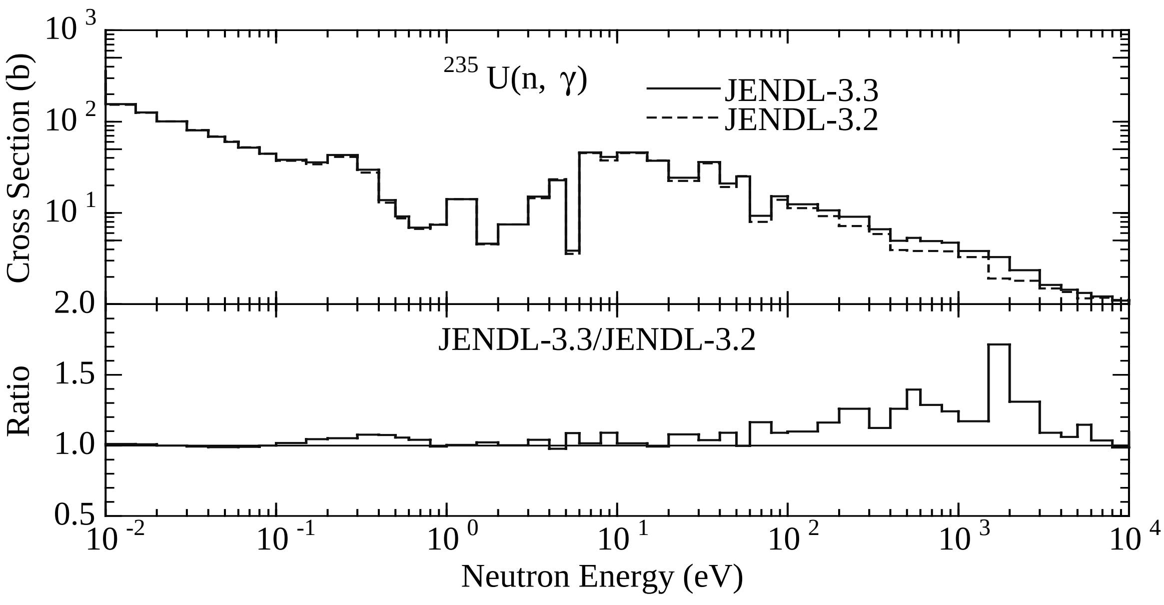

Fig. 2 Capture cross section of ^{235}U.

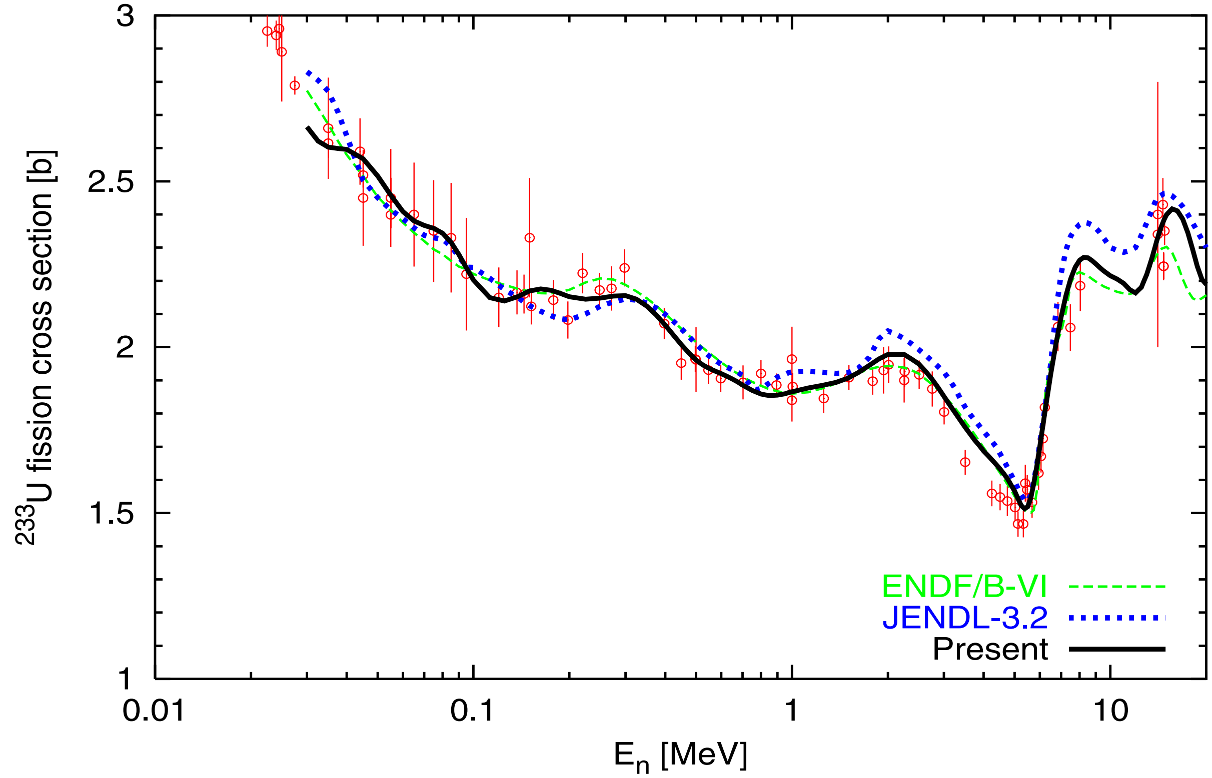

Fig. 3 Fission cross section of ^{233}U.

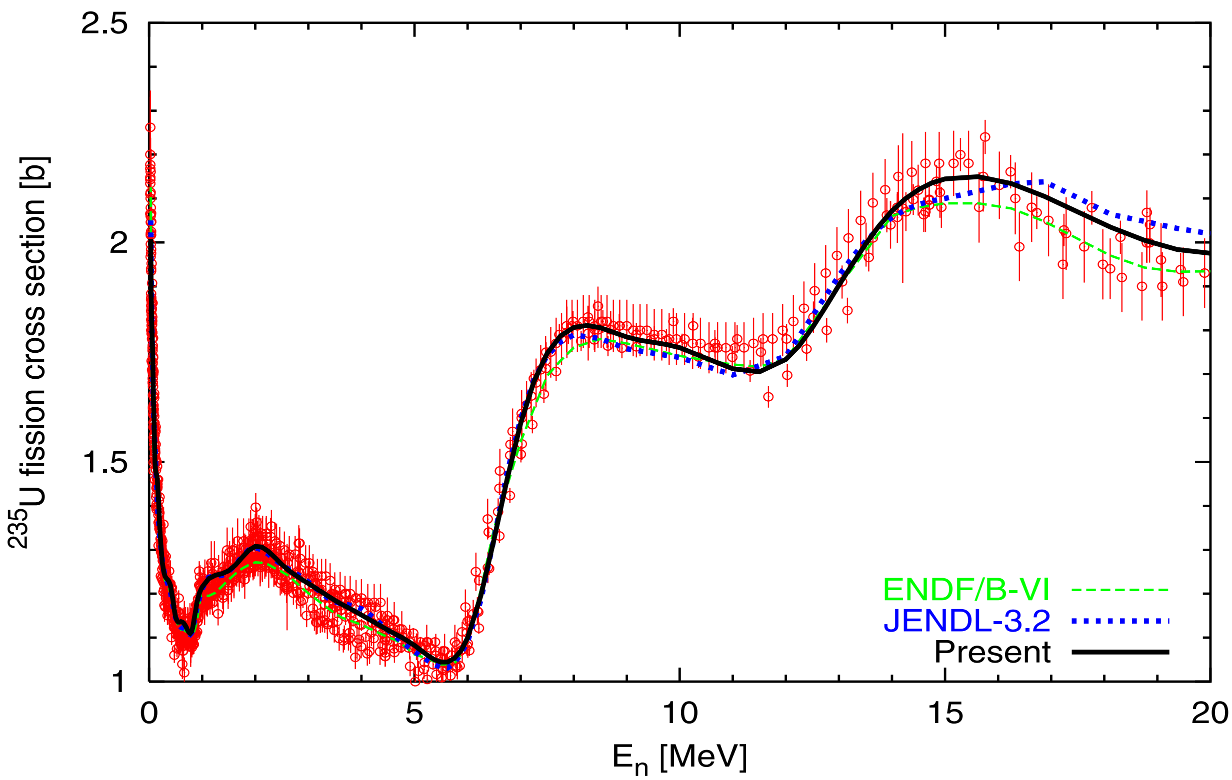

Fig. 4 Fission cross section of ^{235}U.

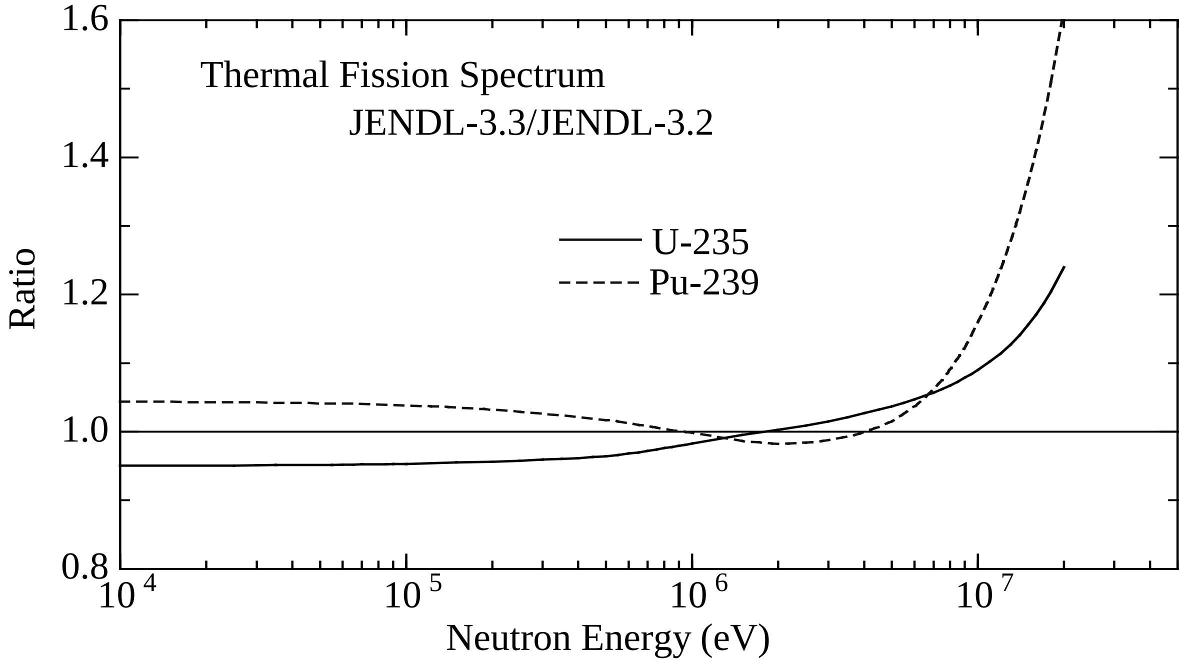

Fig. 5 Thermal fission spectra from ^{235}U and ^{239}Pu.

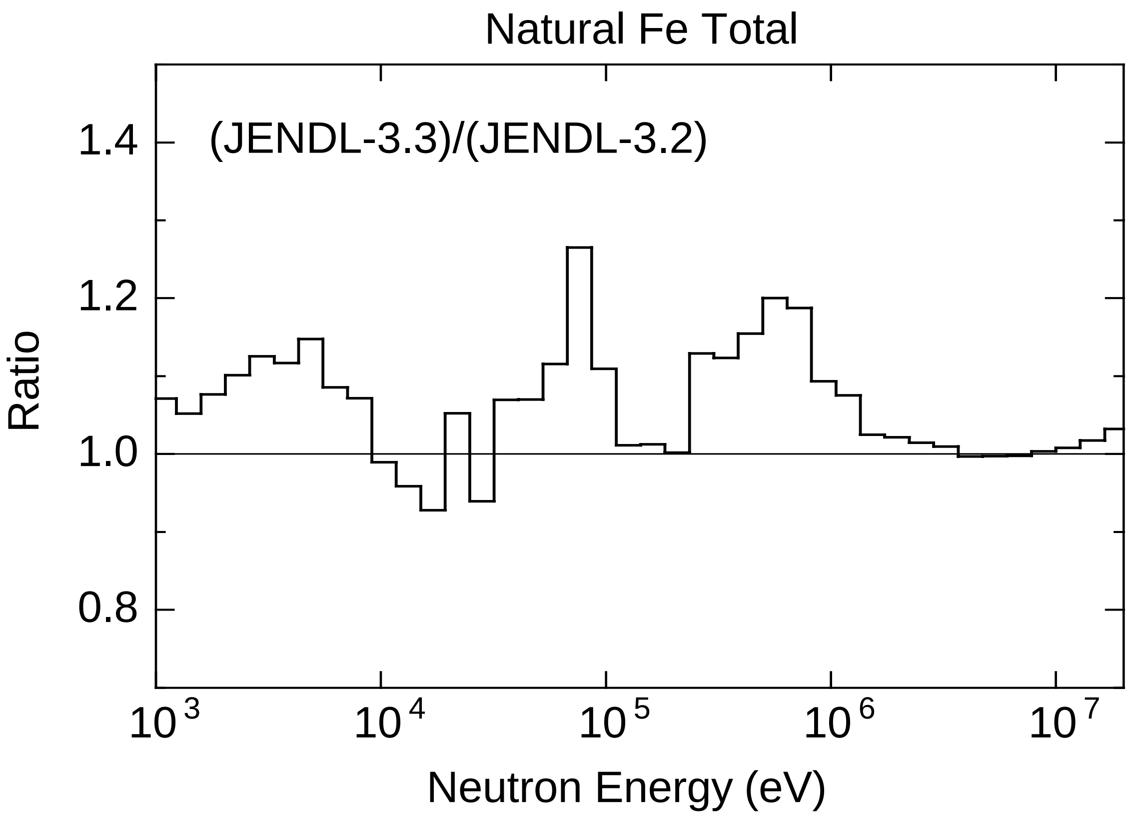

Fig. 6 Total cross section of elemental iron.