International Atomic Energy Agency

INDC(CPR)-038
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REVISION OF THE INELASTIC SCATTERING CROSS SECTION EVALUATION OF ^{238}U FOR CENDL-2.1

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Beijing

1995

IAEA NUCLEAR DATA SECTION, WAGRAMERSTRASSE 5, A-1400 VIENNA

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November 1995

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Abstract

Revised evaluated data for the inelastic neutron scattering cross-section and the secondary neutron spectrum are presented for U-238 in graphical form, compared with the earlier data that exist in the evaluated nuclear data libraries ENDF/B-6 and JENDL-3. The new data will be included in the Chinese evaluated nuclear data library CENDL-2.1.

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Revision of the Inelastic Scattering Cross Section Evaluation of ^{238}U for CENDL–2.1

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The evaluated neutron nuclear data set for ^{238}U is quite important for fission reactor technology. Maybe we can say that the available evaluations for ^{238}U in various libraries are in good agreement with each other and good enough for uses except the secondary neutron spectra and / or the inelastic scattering cross sections for which the discrepancies exist among the various evaluations. And to some extent, the discrepancies also exist between the evaluations and the experimental results of benchmark testing.

In our original evaluation for ^{238}U for CENDL–2[1, 2], the direct processes in inelastic scattering are only considered via coupled–channel optical model calculations for 0^+, 2^+ and 4^+ states[3]. From Refs. [1, 2] we can see that our evaluation is also in agreement with the other evaluations for various libraries except the total inelastic scattering cross sections for which large discrepancies exist especially below 6 MeV. Actually our total inelastic scattering cross section evaluations (see Fig. 1) are in good agreement with the recent experimental data provided by M. Baba[4] and previous data of R. Batchelor[5]. However, benchmark calculation for the evaluated data set of ^{238}U for CENDL–2 showed that the total inelastic scattering cross sections are too low and / or the secondary neutron spectra are too hard. Obviously, this problem may be resolved with enhancing the total inelastic scattering cross sections and reducing the elastic scattering cross sections or increasing the inelastic scattering cross sections to the lowest lying levels (2^+, 4^+ and 6^+). In this way, however, the secondary neutron spectra can not be changed essentially since the energies of the inelastic scattering groups from 2^+ 4^+ 6^+ states are nearly the same as the elastic groups. Actually, it is difficult to identify them in the experimental measurements. Fortunately, for application purposes, all of these groups can be approximately considered as elastic neutrons. In this sense, what we should do is to coincide the sums of the cross sections scattered to 0^+, 2^+, 4^+ and 6^+ states with the experimental values correspondingly. In this revision, such sums have been adjusted to the measured data by A. B. Smith et al.[6], as shown in Fig. 2.

Then, in order to improve the total inelastic scattering cross sections and / or the secondary neutron spectra essentially, we must enhance the inelastic scattering to the higher lying states, for example, 1^-, 3^-, 5^- and even more higher levels based on measured data. In this revision, direct components to 14 levels (6^+ and above) are calculated by using DWUCK4 in addition to the FMT (written by Zhang Jingshang based on semi–classical theory of multi–step nuclear reaction processes) calculations, and the β values was adjusted so that the calculations coincide with the measured data for discrete levels[7~10] and double–differential neutron emission cross sections at 14 MeV [11~13].

Some evaluated results are shown in the Figs. 1 ~ 9. For comparisons, the corresponding evaluated data of ENDF / B–6 and JENDL–3 and experimental data are also shown in these figures.

By using the present version for inelastic scattering of ^{238}U, the results of data testing for homogeneous fast benchmark assemblies are in better agreement with experimental values[14] than the others.

Acknowledgement

The authors would like to thank Dr. Zhou Delin for the beneficial discussions during this work and Drs. Zhang Jingshang and Shen Qingbiao for their helps in the model theory calculations.

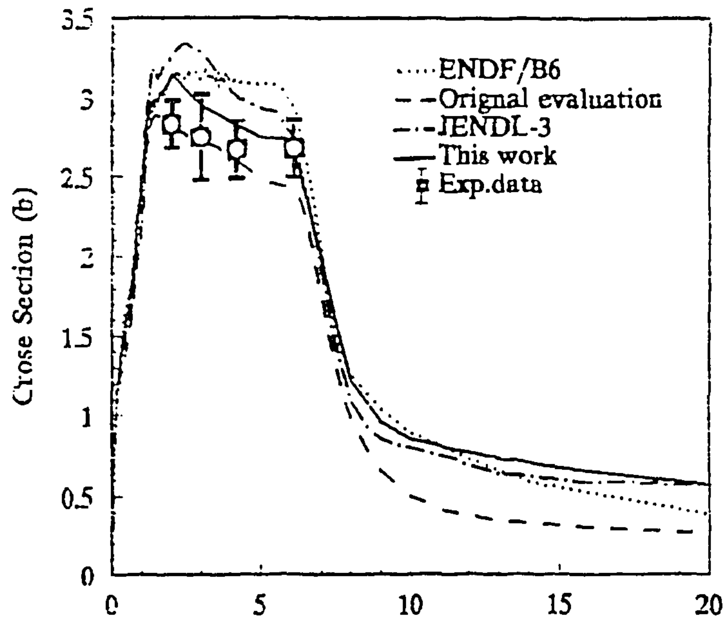

Fig. 1 Total inelastic scattering cross section

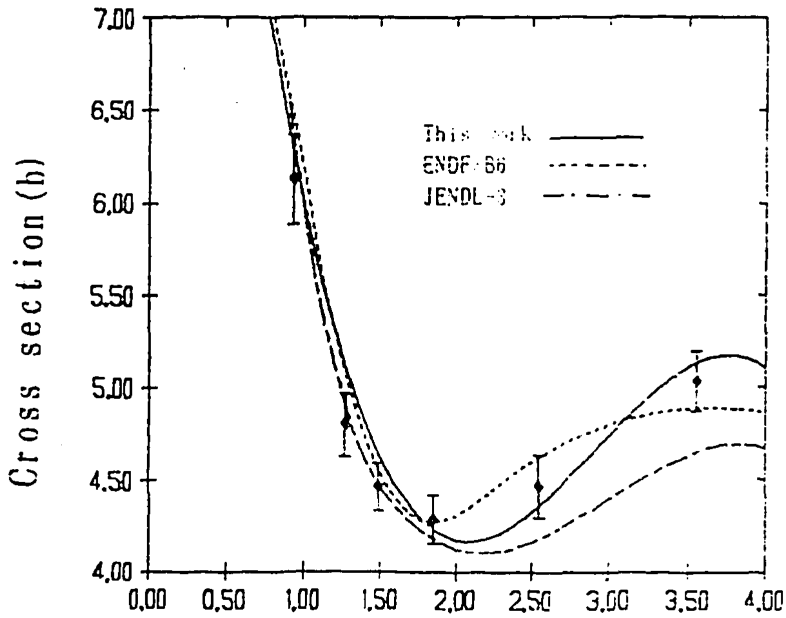

Fig. 2 Sum of the scattering cross sections to 0^+, 2^+, 4^+ and 6^+ states

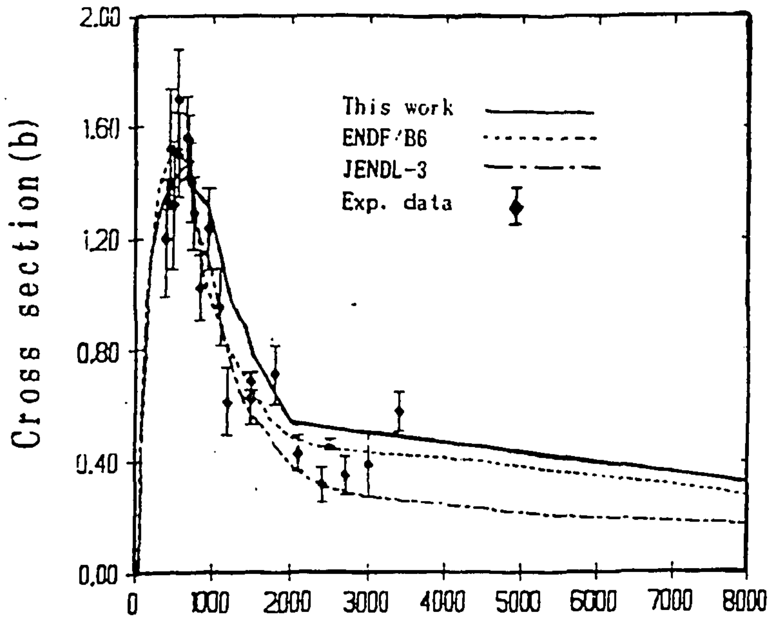

Fig. 3 Inelastic scattering cross section to 2^+ (44.89 keV) state

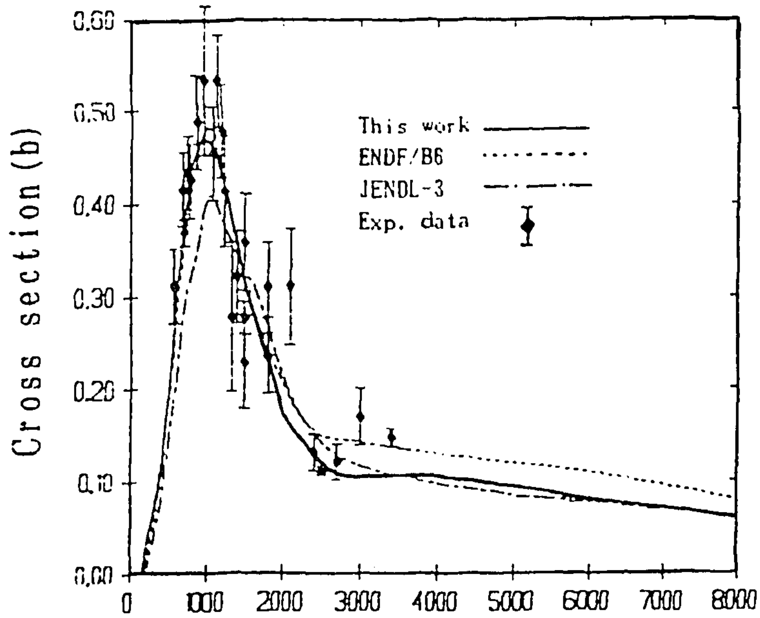

Fig. 4 Inelastic scattering cross section to 4^+ (148.4 keV) state

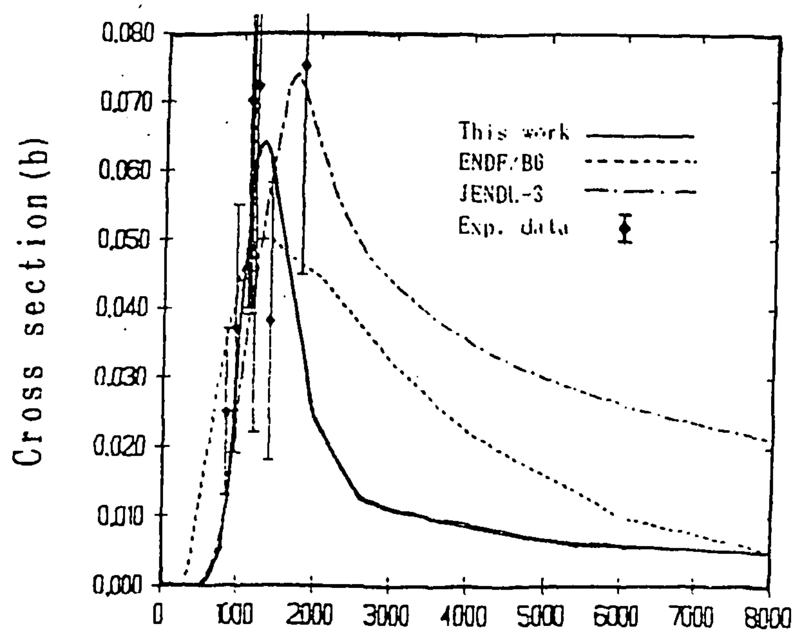

Fig. 5 Inelastic scattering cross section to 6^+ (307.2 keV) state

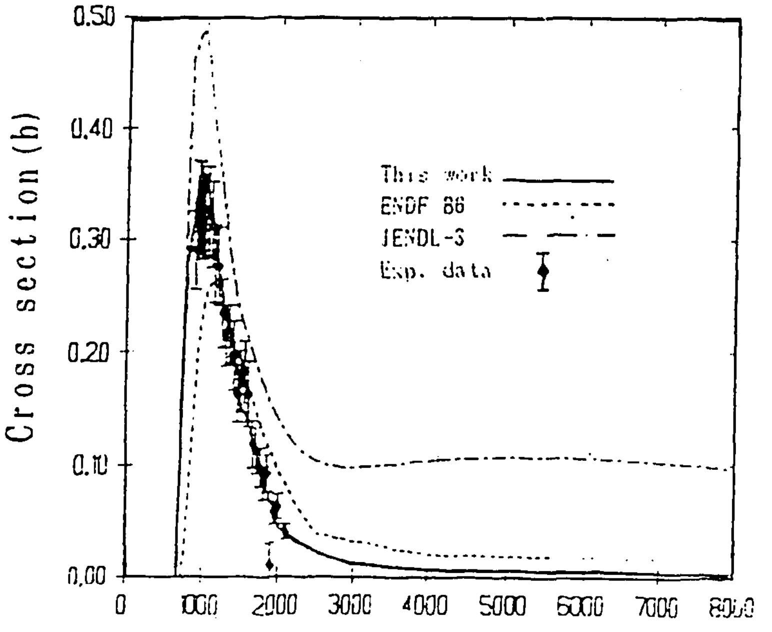

Fig. 6 Inelastic scattering cross section to 1⁻ (680.1 keV) state

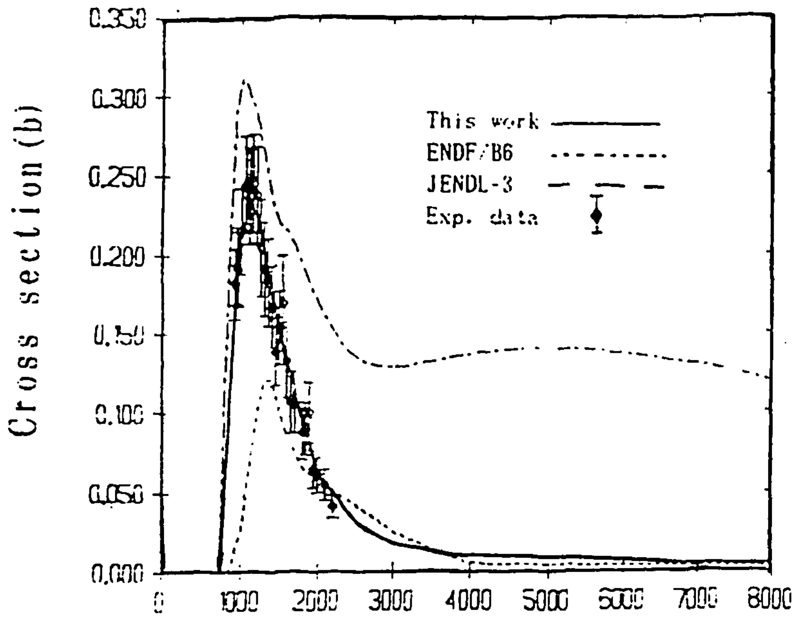

Fig. 7 Inelastic scattering cross section to 3⁻ (731.9 keV) state

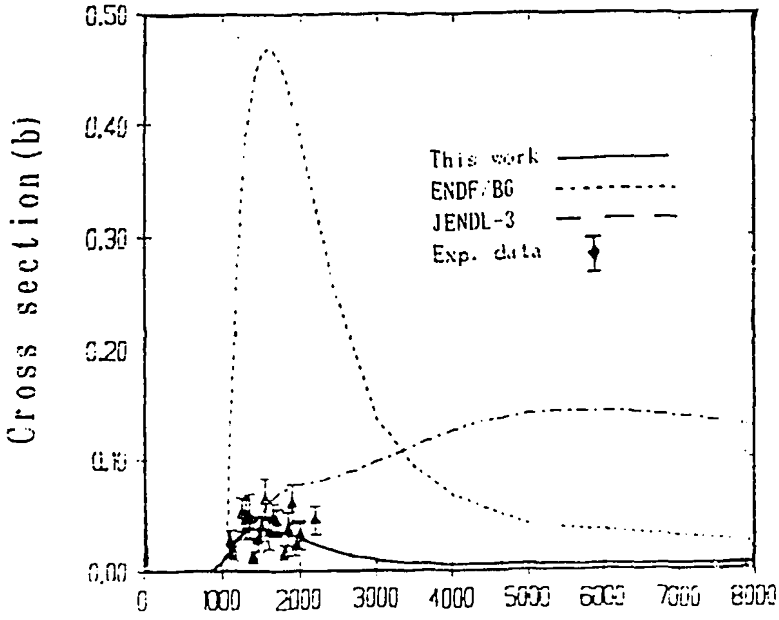

Fig. 8 Inelastic scattering cross section to 5^- (827.1 keV) state

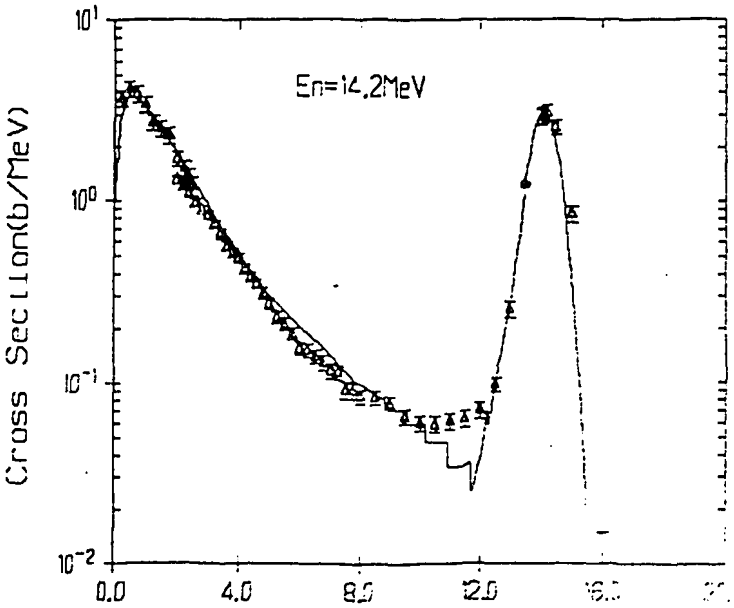

Fig. 9 Calculated secondary neutron spectrum at E_n = 14.2 MeV

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