SG10 Activities on Inelastic Scattering Cross Sections for Fission Product Nuclei

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(1) Comparison with IRMM data: Completed

At the last WPEC meeting at ANL last year, I sent the notes on comparison of evaluated inelastic scattering cross sections for Pd isotopes with the new data measured at IRMM. It showed that JENDL-3.2, in which direct inelastic scattering contributions were taken into account by means of the DWBA calculation, were in good agreement with the measured data. This result may be the same for the other FP nuclei. So, I concluded that the DWBA is applicable to evaluation of excitation function of inelastic scattering to one phonon state, while the evaluation for deformed nuclei such as Nd and Sm should be relied on the coupled channel theory. At the meeting, the home task to confirm the conclusion by comparing the evaluated data with the new data measured at IRMM for Mo, since nuclei. with the mass around 100 has a possibility showing some kind of anomalous behavior of cross sections which are much interest from view point of astrophysics.

H. Weigmann at IRMM sent to me the new experimental data for molybdenum isotopes (Mo-96, 98 and 100): A paper describing the details of their work will be presented at the Conference on Nuclear Data for Science and Technology in Trieste, 1997 (authors: I.-G. Birn, E. Wattecamps and H. Weigmann). S. Chiba at JAERI have plotted them with JENDL-3.2 as shown in Figures 1 through 3 which show good agreement except for Mo-100.

As for Mo-100, Y. Nakajima at JAERI and I have checked the consistency

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*N.B. The IRMM data for Mo-100 are composed of the sum of the cross section for the first level at 536 keV plus 0.88 * the cross section for the second level at 695 keV (only this sum could be determined because the intensity of the 160 keV transition between these two levels could not be measured), and cross section for the third level at 1064 keV excitation energy for incident neutron energies E < 2.0 MeV.*

Optical model parameters used for evaluation of inelastic scatterring cross sections were those of Walter and Guss (1985 Santa Fe Conf., p.1079) for JENDL-3.2, and those determined by Iijima and Kawai for JENDL-3.1 (J. Nucl. Sci. Technol., 20,77 (1983)).

the experimental data between the IRMM data and the others, by comparing them with the reference data (here modified data of JENDL-3.1). I think the IRMM data are generally consistent with the data of ANL and University of Kentucky. Then, we made a parameter study for the DWBA calculation to improve evaluation of the cross section for the first level at 536 keV. In the calculation, the optical model parameter are those which were employed for evaluation of JENDL-3.1. The deformation parameter is 0.231 based on Raman's evaluation (Atomic and Nuclear Data Table, 36, 1 (1987)). The calculated results are shown in Figs. 4 and 5.

Figure 4 compares the calculations with the IRMM data. The sum of the cross section for the first level plus the second level is overestimated as like JENDL-3.2. The thick dotted line which gives good agreement with the experimental values is the result with half contribution of direct inelastic scattering which means the deformation parameter is reduced by a factor of square root of two. Thus, I think we can obtain good results by choosing the optimum nuclear model parameter set with the DWBA method. The result for the third level is good.

Figure 5 shows the comparison of the excitation function for the individual levels up to 1136 keV. A relation of the calculated values to the measured data is on the contrary between the first and the second levels. Since it is much likely that the contamination of raw experimental data into each level happenes, sum of them is better for comparison. However, the result with Raman's parameter must be overestimated. The reduced parameter gives better result as for the IRMM data. Between Figs. 4 and 5, I think the experimental data measured at IRMM are consistent with the others.

Finally, I have reached conclusion that the DWBA is applicable for most nuclei in the fission product mass region, while the coupled channel theory is needed for some nuclei in the deformed nucleus region.

(2) Final Report: In Progress

I will write the final report of the SG10 by adding the result mentioned above to the contents which were presented at the International Conference on Nuclear Data (at Gatlinburg in 1994) and at the Specialists' Meeting on Fission Product Nuclear Data (at JAERI in 1993).

The intercomparison of the integral tests for the STEK experiment should be enveloped in the scope of Subgroup 17 on fission product capture cross section, as I insisted in the last WPEC meeting at ANL, since I could not wait for the result of JEF-2.

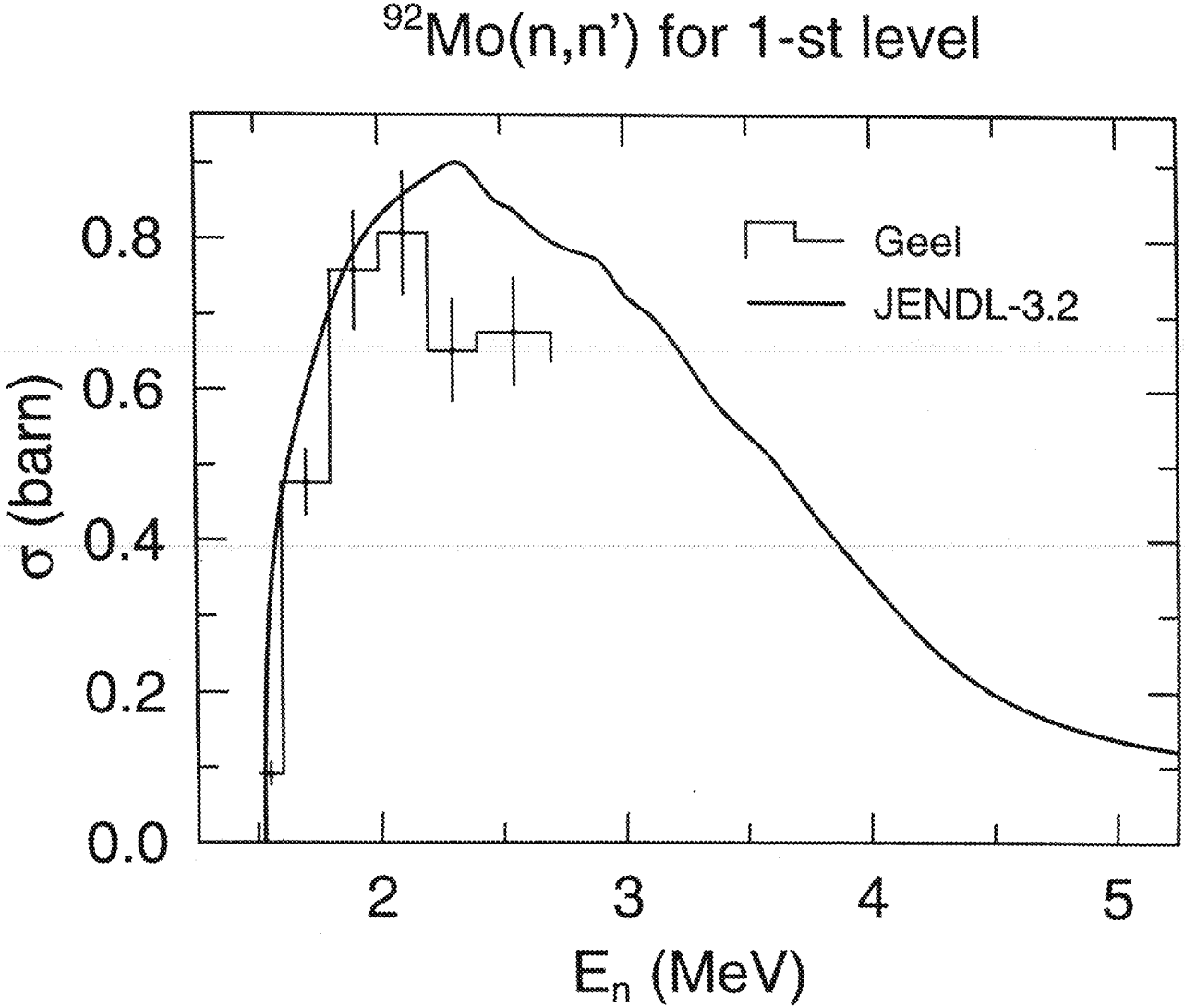

Fig. 1 Comparison of JENDL-3.2 with the data measured at IRMM for inelastic scattering cross section of Mo-92.

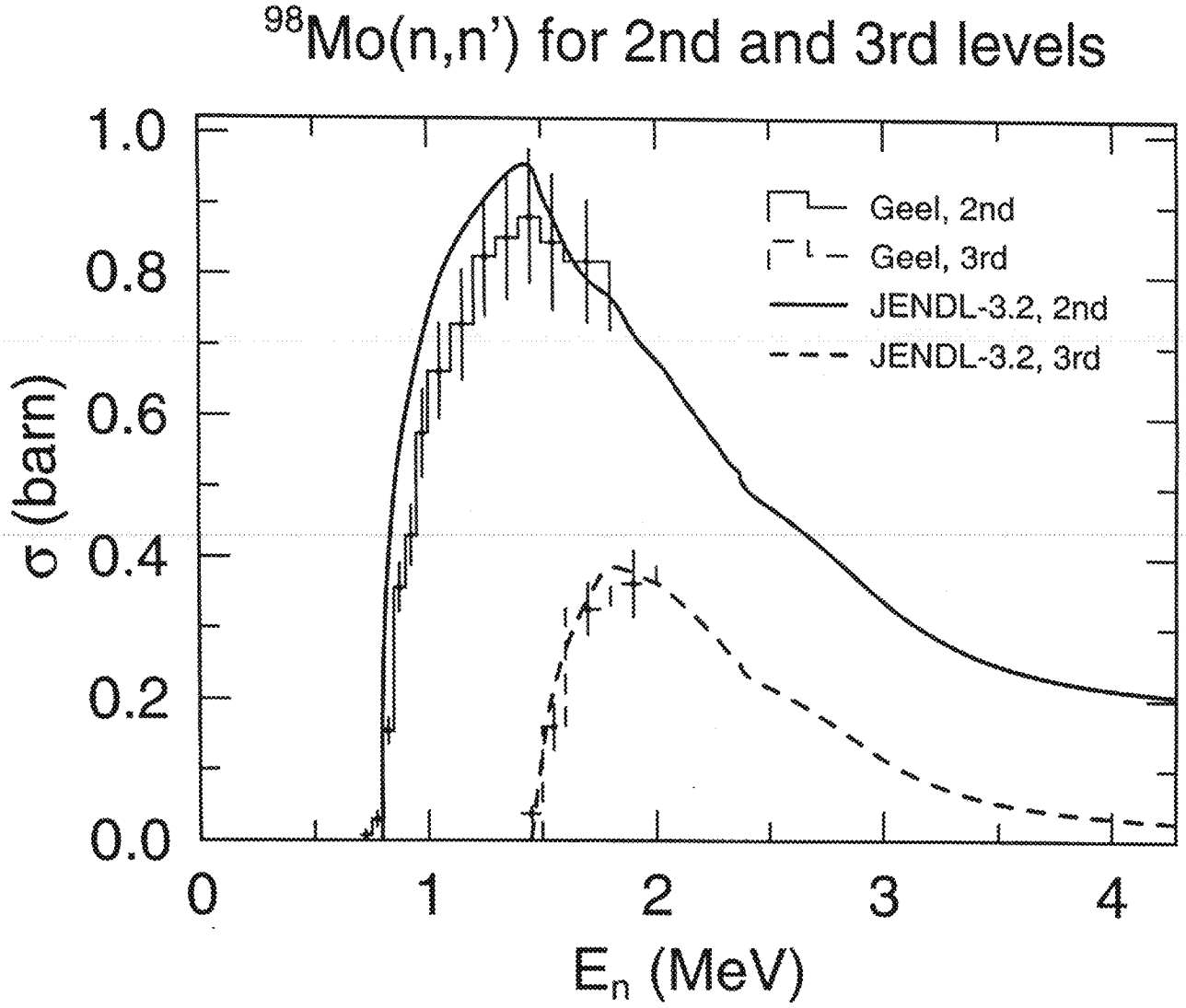

Fig. 2 Comparison of JENDL-3.2 with the data measured at IRMM for inelastic scattering cross section of Mo-98.

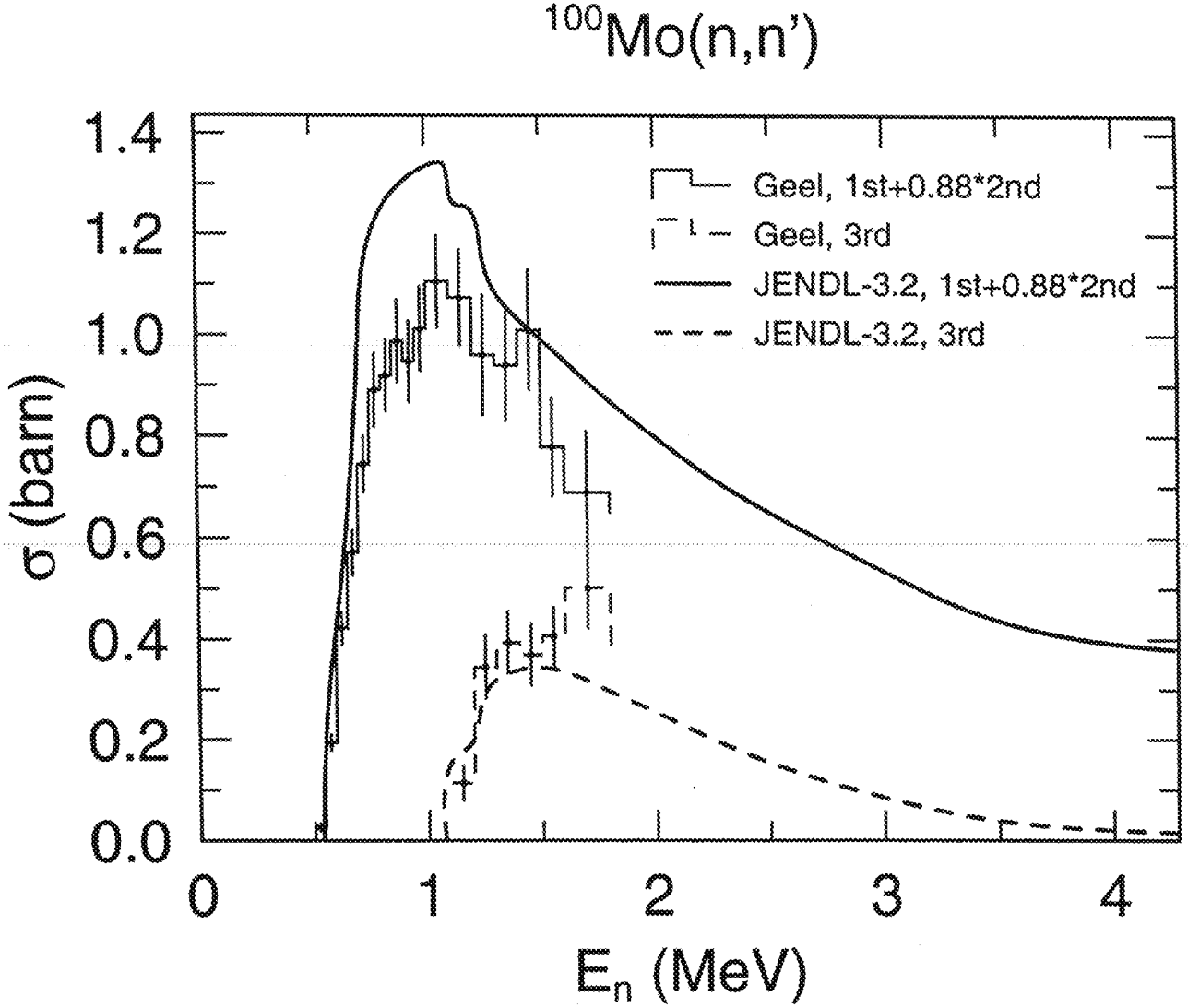

Fig. 3 Comparison of JENDL-3.2 with the data measured at IRMM for inelastic scattering cross section of Mo-100.

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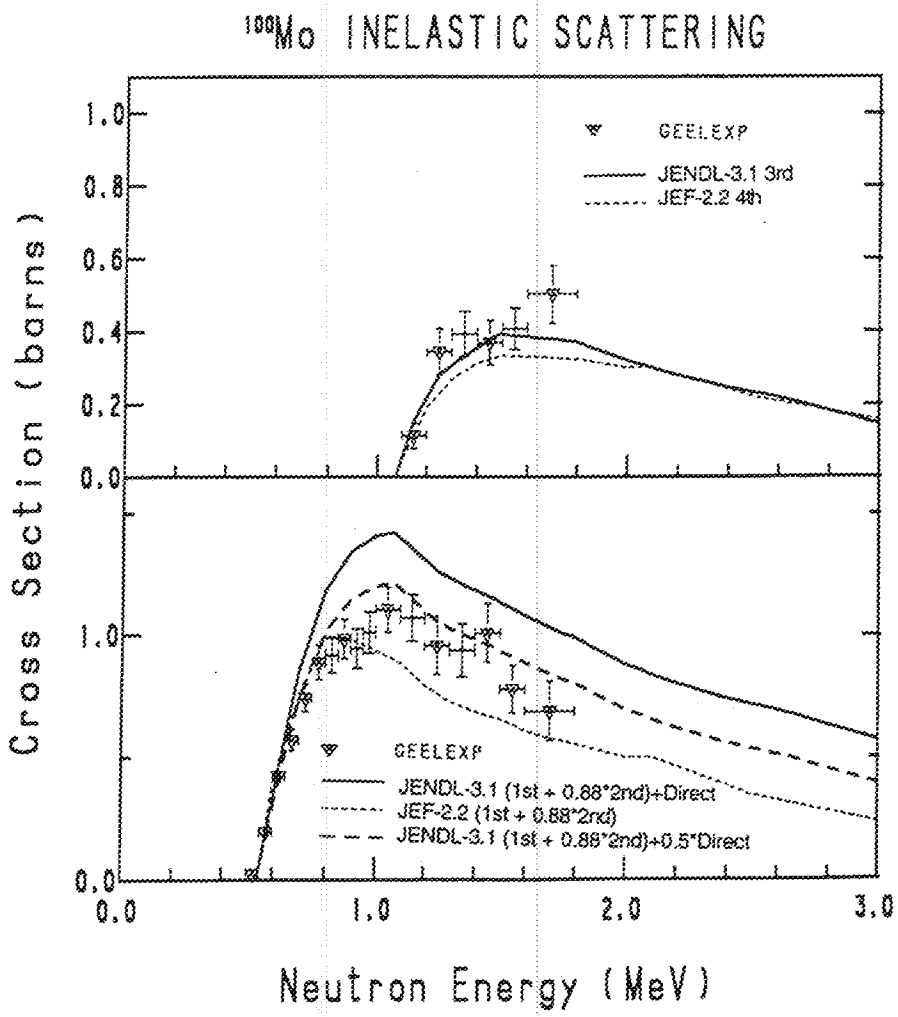

Fig. 4 Comparison of modified JENDL-3.1 data with the experimental one measured at IRMM.for inelastic scattering cross section of Mo-100.

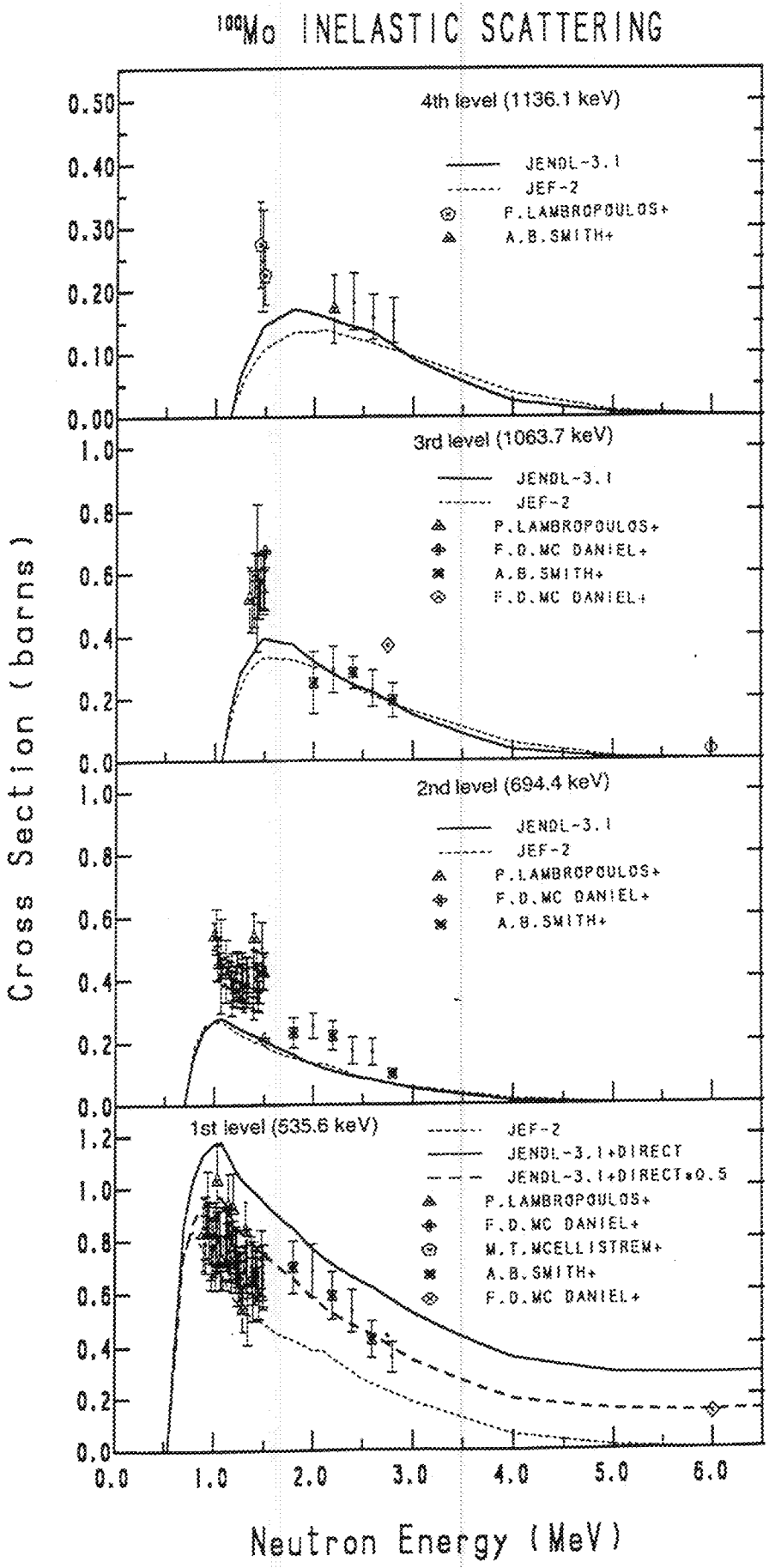

Fig. 5 Comparison of modified JENDL-3.1 data with the experimental one excluding those measured at IRMM.for inelastic scattering cross section of Mo-100.