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EVALUATIONS OF FISSION PRODUCT CAPTURE CROSS SECTIONS FOR ENDF/B-V

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EVALUATIONS OF FISSION PRODUCT CAPTURE CROSS SECTIONS FOR ENDF/B-V

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Capture cross section evaluations have been made for the 36 most important fission product absorbers in a fast reactor system. These evaluations were obtained using a generalized least-squares approach with calculations being performed with the computer code FERRET. These results will provide the major revisions to the ENDF/B-IV Fission Product Cross Section File which will be released as part of ENDF/B-V. Input for the cross section adjustment calculations included both integral and differential experimental data results. The differential cross sections and their uncertainties were obtained from the CSIRS library. Integral measurement results came from CFRMF and STEK Assemblies 500, 1000, 2000, 3000, 4000. Comparisons of these evaluations with recent capture measurements will be presented.

[Capture cross sections; Fast Reactors]

Introduction

There has been extensive activity world-wide, recently, in evaluating fission product capture cross sections, important for fast reactor application. Nuclear data laboratories in Australia, France, Italy, the Netherlands, Japan, the United Kingdom, the U.S.S.R., and the United States have been especially productive in the past few years. Absorption and other effects by fission product nuclei will become increasingly important as fast reactors come on line and begin to operate. Consequently, accurate and complete capture data evaluations will be required. To this end, the ENDF/B-IV fission product cross section file has been updated to produce the ENDF/B-V file, using important new evaluation techniques and recent experimental results from both integral and differential measurements.

In this paper, we present the results of these re-evaluations where use was made of a generalized least squares adjustment procedure[1] to obtain a nominal cross section curve and uncertainty information in the form of a covariance matrix which linked energy points. This procedure involves calculations which use the finite element representation of the FERRET[2] data adjustment code.

Results

Typical results of these evaluations are shown in Figures 1-14, where the "adjusted" curves will be used for ENDF/B-V. Also shown is the data used as input to the FERRET code. This includes both differential and integral data and their uncertainties. Also inputted to the calculation was an "a priori" description which combined multi-group average cross sections obtained from resonance parameters for the resolved resonance region with "smooth" average cross section from ENDF/B-IV for the higher energy region. The resonance parameters used were from ENDF/B-IV or BNL-325[3] as indicated. The histogram or multi-group cross section description in the resonance region is required for the FERRET least squares calculation because following the exact resonance structure takes too many points for the standard computer calculations, especially for the covariance matrix part.

The integral data came from reaction rate measurements in STEK Assemblies 500, 1000, 3000, 4000[4] and CFRMF[5]. ENDF/B-IV evaluations also used earlier CFRMF measurements which helped normalize nuclear models calculations made with the Hauser-Feshbach computer code NCAP[6].

Figure 1 shows results for the important absorber Sm149. As can be seen from the curves, significant changes occur in going from ENDF/B-IV to ENDF/B-V. The ENDF/B-IV result was made with nuclear model calculations where no previous experimental data existed in 1973. Also shown in Figure 1 are "adjusted" cross sections using the FERRET code, comparing various results when only integral data is used or differential data is used. For the Sm149 case, the results are consistent with each other. For some of the other cases shown in Figures 5 - 14, this does not necessarily occur.

Error estimates are outputted from the FERRET code and Figure 2 shows fractional uncertainty versus energy for the Sm149 case, where the final uncertainty changes from about 60% to 10% (1σ) in going from ENDF/B-IV to ENDF/B-V. Figure 4 shows the case of the adjusted curve using STEK measurement compared to recent integral results at EBR-II adjusted by Anderl, et al,[7] for Sm147. The full energy region (1eV-10MeV) evaluation is shown in Figure 5 for Mo97. Comparisons to recent differential measurements by Macklin etal,[8] is shown in Figures 6-10 for Ru101, Ru102, Ru104, Pd104, and Pd108. Finally, results for four of the top ten fission product absorbers (Tc99, Rh103, Ag109, and Cs133) are given in Figures 11-14.

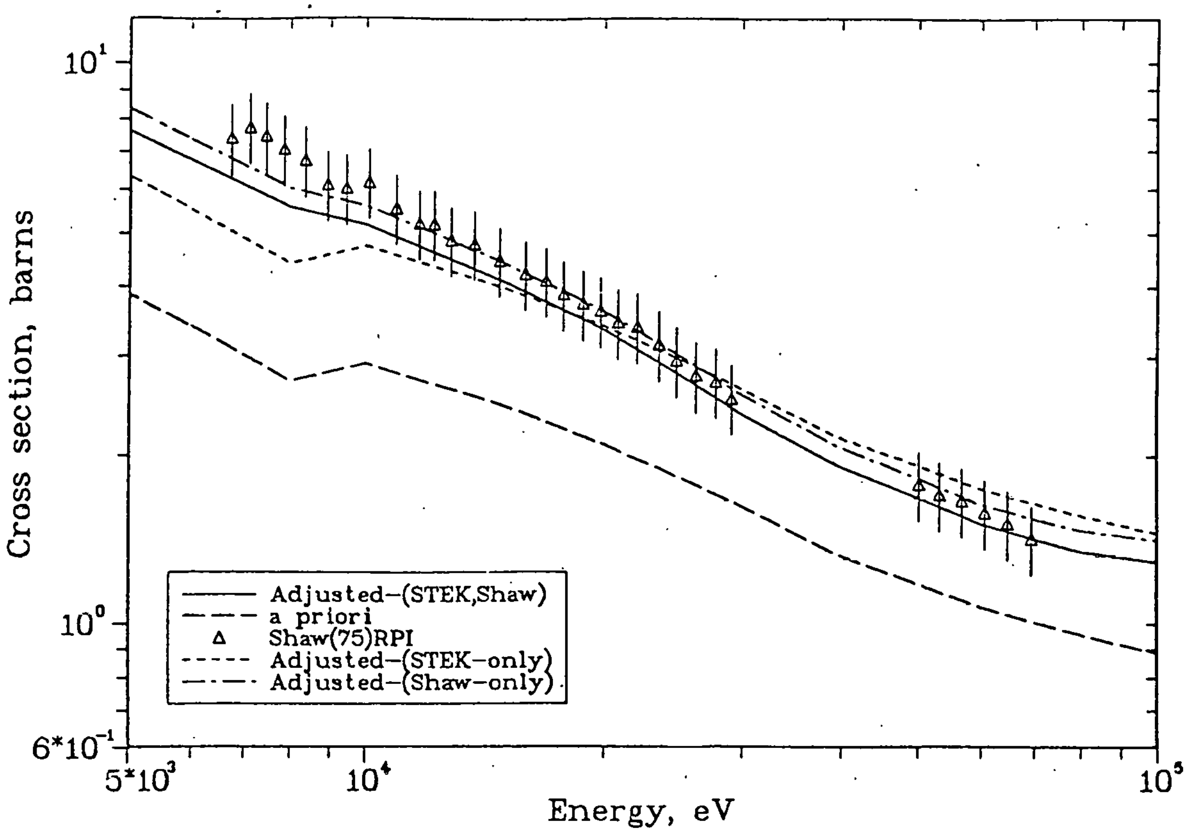

Fig. 1. Sm149 capture cross section evaluations and differential data.

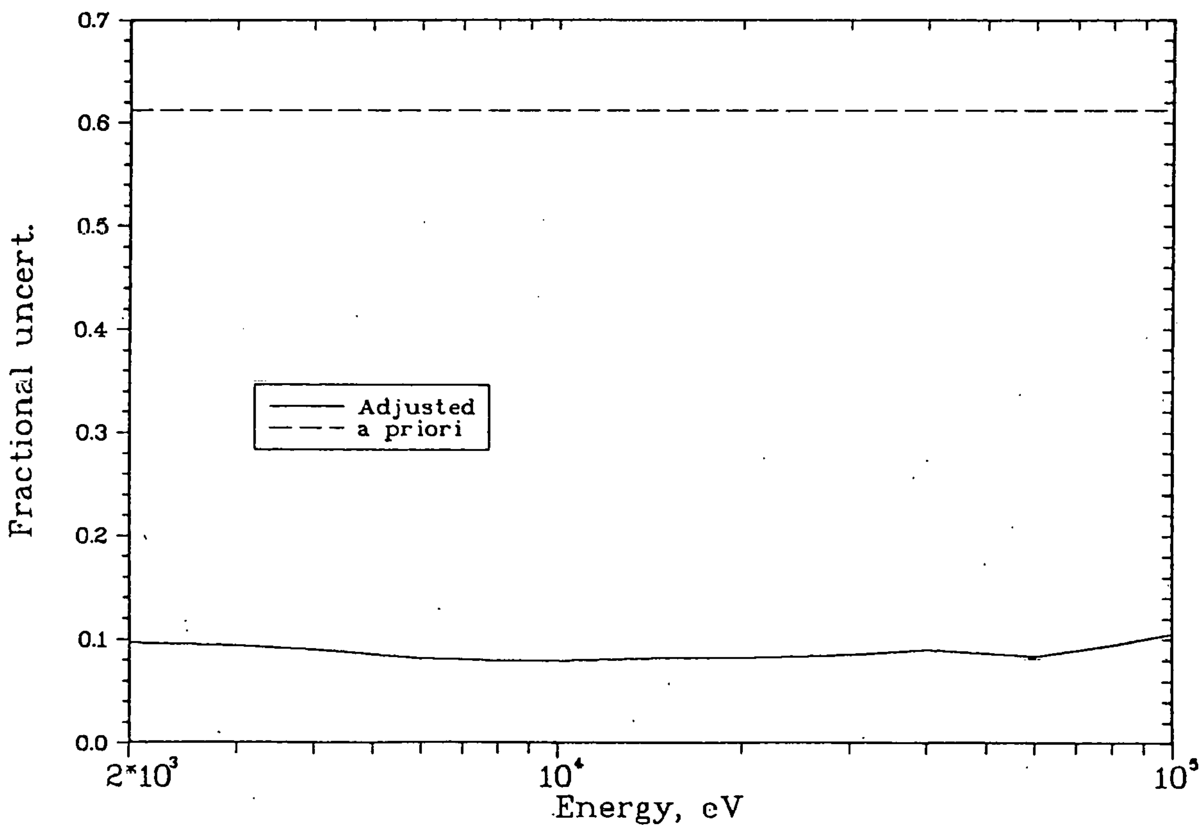

Fig. 2. Sm149 fractional uncertainty evaluations.

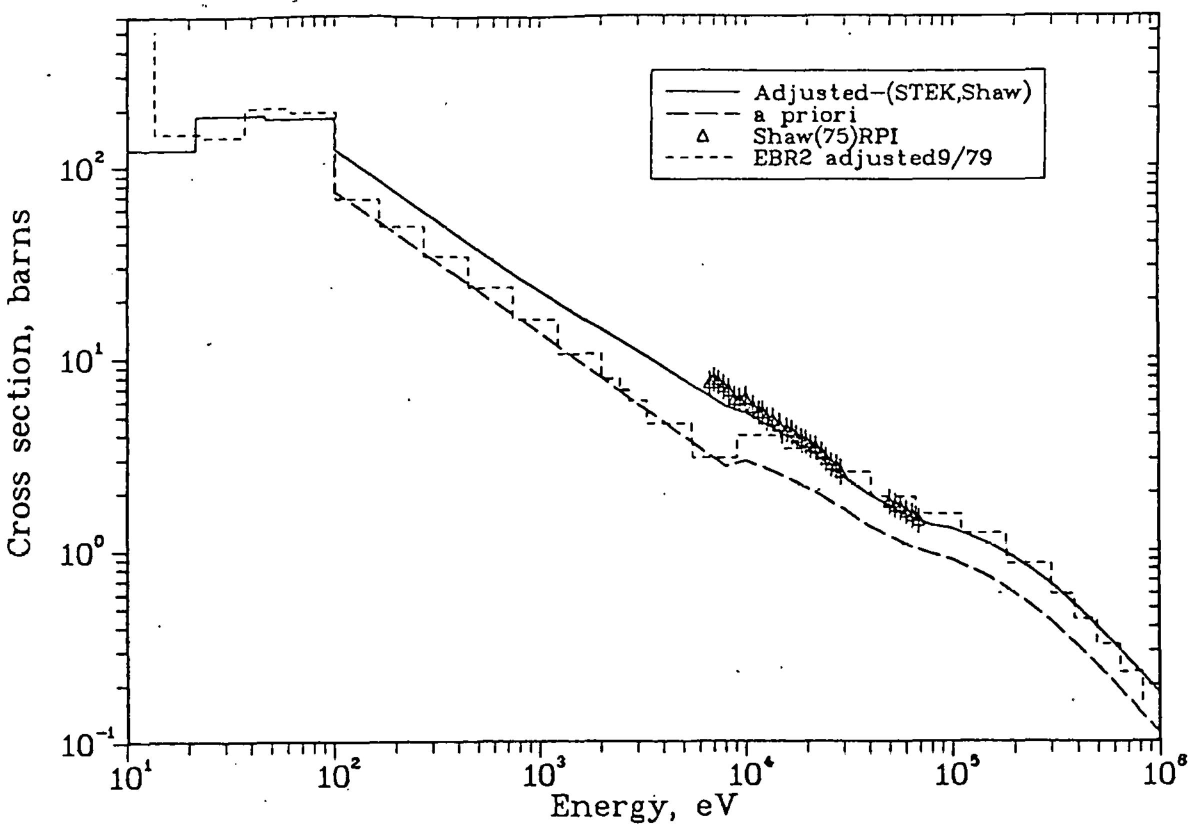

Fig. 3. Sm149 capture cross section evaluation comparison to EBR-II results.

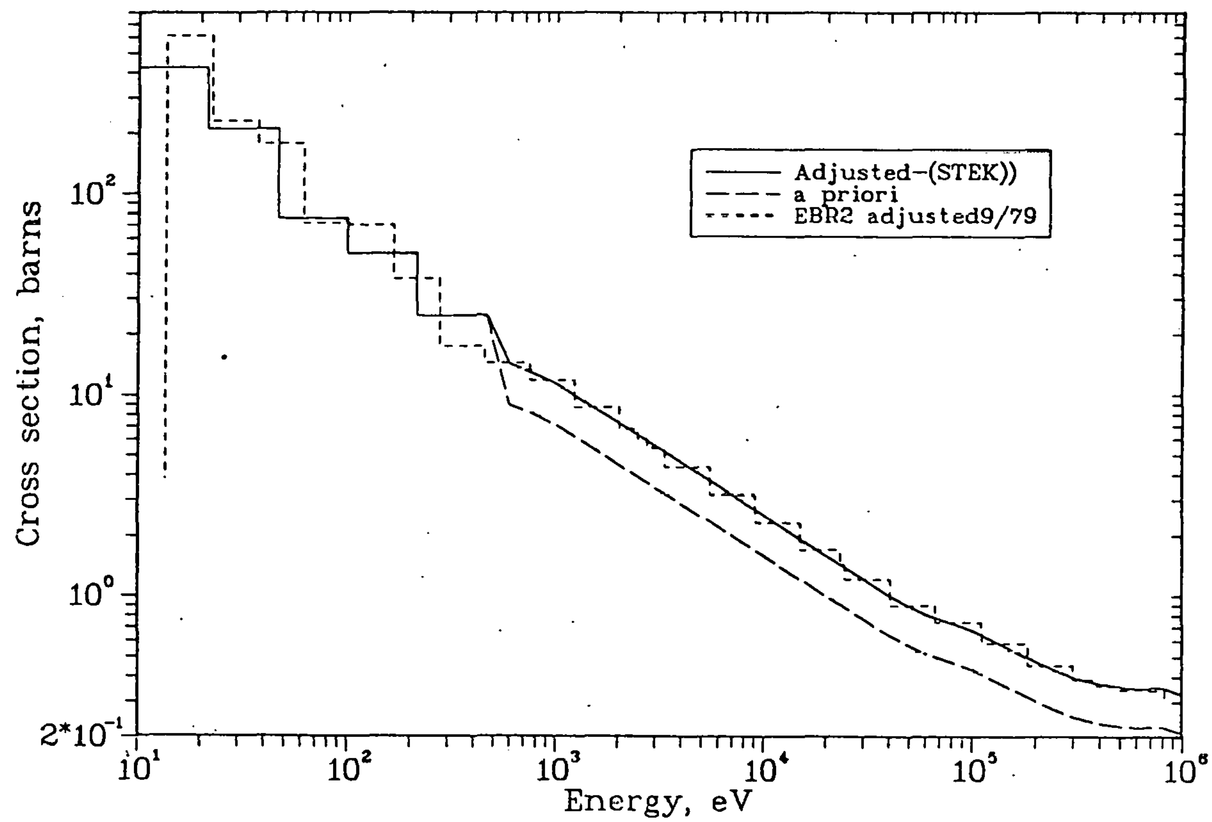

Fig. 4. Sm147 capture cross section evaluation comparison to EBR-II results.

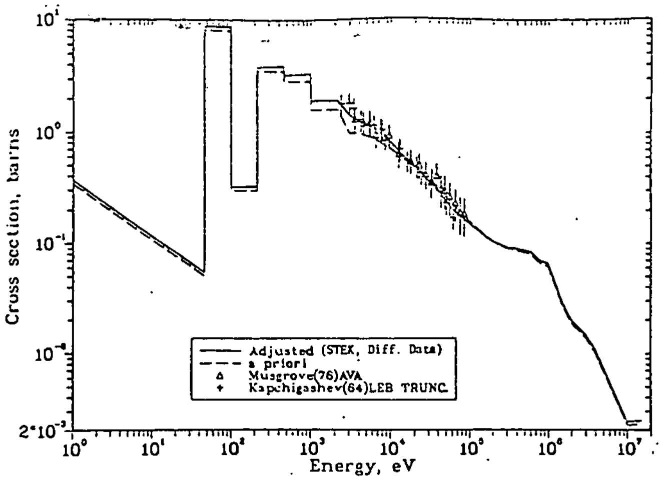

Fig. 5. Mo97 capture cross section evaluations and differential data.

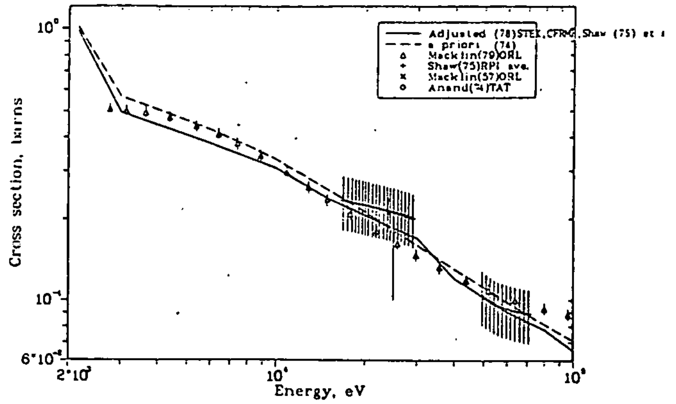

Fig. 8. Ru104 capture cross section evaluations and differential data.

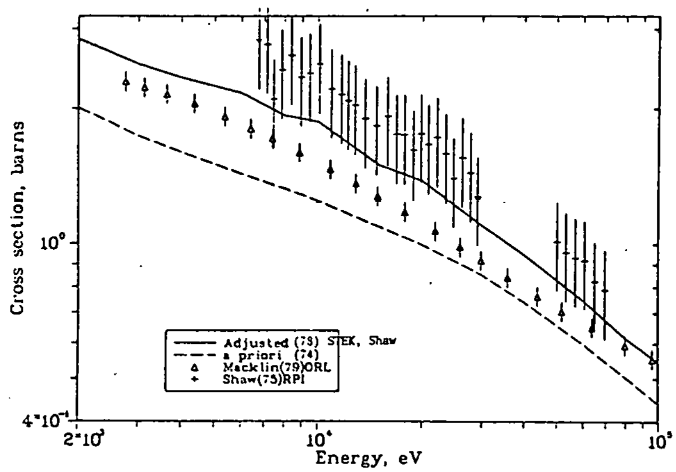

Fig. 6. Ru101 capture cross section evaluations and differential data.

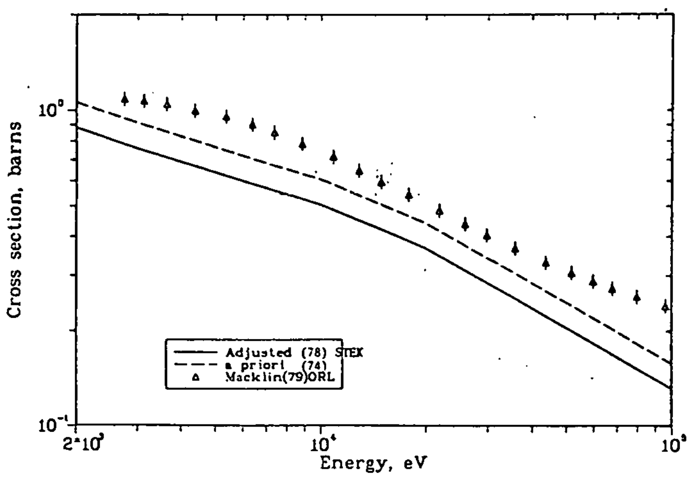

Fig. 9. Pd104 capture cross section evaluations and differential data.

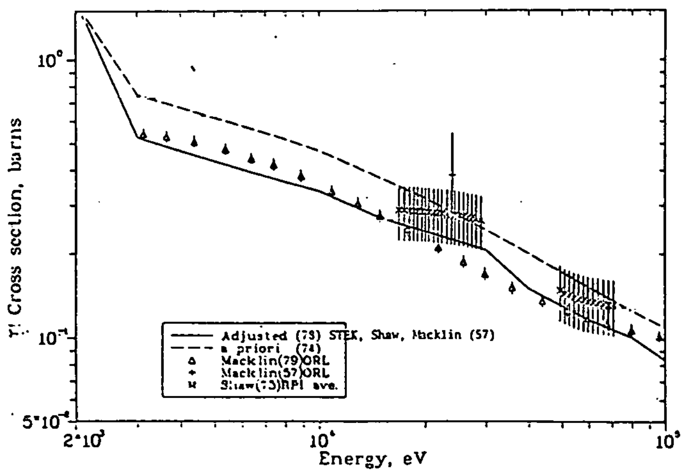

Fig. 7. Ru102 capture cross section evaluations and differential data.

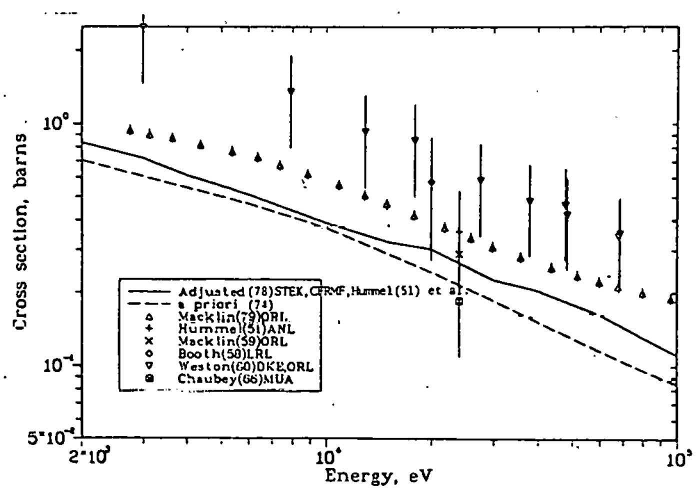

Fig. 10. Pd108 capture cross section evaluations and differential data.

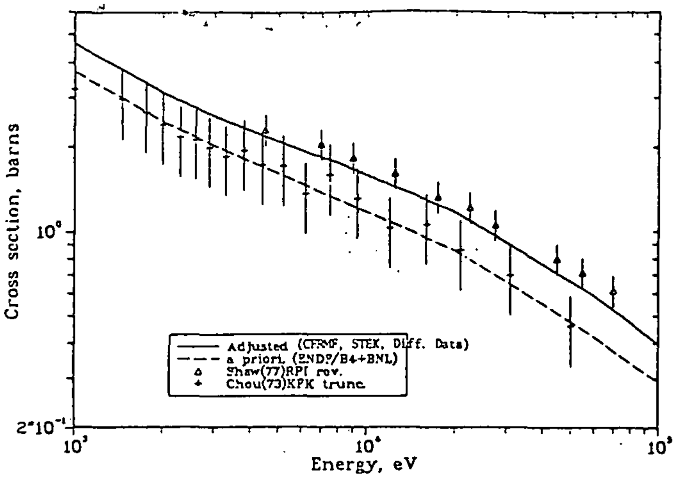

Fig. 11. Tc99 capture cross section evaluations and differential data.

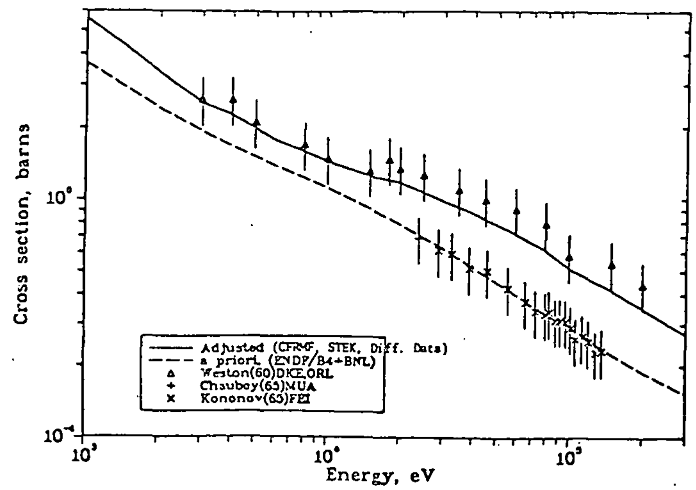

Fig. 13. Ag109 capture cross section evaluations and differential data.

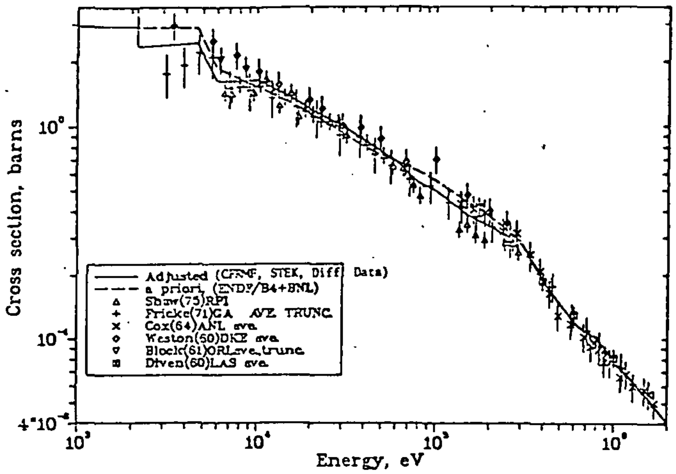

Fig. 12. Rh103 capture cross section evaluations and differential data.

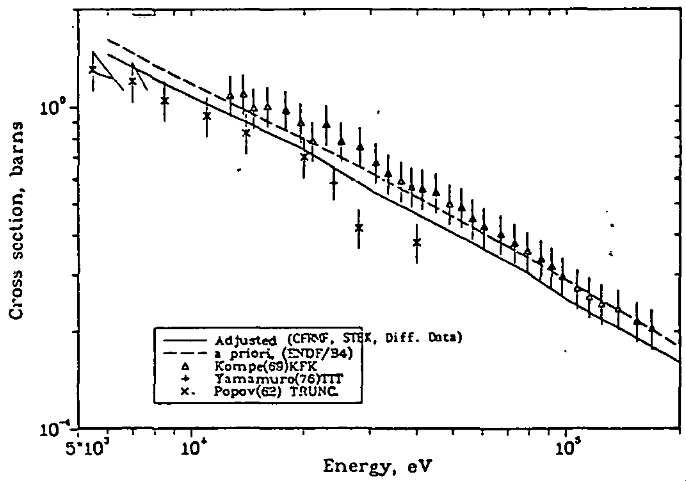

Fig. 14. Cs133 capture cross section evaluations and differential data.

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