JEF-2 Tests: ^{238}U Unresolved Resonance Region - Comparison with Thick-Sample Transmission and Self-Indication Data

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1. Introduction

Evaluated data for the unresolved resonance region can be tested by comparing cross section functionals like thick-sample transmission or capture self-indication ratios computed from the evaluated file with resonance-averaged measurements of these quantities. The transmission of a "filter" sample of thickness n (nuclei/b), averaged over a suitably broad energy interval, can be written as follows:

$$\langle e^{-n\sigma}\rangle = e^{-n\langle\sigma\rangle}\left(1+\frac{n^2}{2}\operatorname{var}\sigma - + \ldots\right), \tag{1}$$

where the variance and higher moments of the total cross section σ describe how pronounced the resonance structure is. The relevant parameters are the strength functions and distant-level parameters (or the effective nuclear radii). They determine, for the various partial waves, the ratio of compound (resonance) to direct (potential scattering) cross section. The thicker the sample, the more sensitive are the observed data to the cross section structure.

Capture self-indication ratios are obtained if the transmitted part of the neutron beam is permitted to undergo capture in a thin "indicator" sample placed downstream from the filter and surrounded by gamma-ray detectors. From "filter in" and "filter out" runs one obtains the capture self-indication ratio,

$$\frac{\langle e^{-n\sigma}\sigma_\gamma\rangle}{\langle\sigma_\gamma\rangle} = e^{-n\langle\sigma\rangle}\left(1-n\frac{\langle(\sigma-\langle\sigma\rangle)\sigma_\gamma\rangle}{\langle\sigma_\gamma\rangle}+-\ldots\right), \tag{2}$$

at least for a very thin indicator sample. Usually the sample is not ideally thin, and σ_γ must be replaced by the capture yield that includes self-shielding and multiple scattering. In any case the self-indication ration is sensitive also to the capture cross section, i. e. to the capture strength functions $\langle\Gamma_\gamma\rangle/D$ for the various partial waves, and also to the covariance of capture and total cross section caused by the coincidence of the resonance peaks in both.

2. Comparison of Calculations and Data

Three data sets were available:

REFERENCES

T.Y. Byoun and R.C. Block, Proc. Kiamesha Lake Conf. 1972, p. 1115
M.V. Bokhovko et al., Yad. Konst. 3 (1988) 11
Yu. V. Grigoriev et al., Obninsk report FEI-2072 (1990)

The figures show results of the comparison. The calculations were carried out with the Monte Carlo program SESH (Fröhner 1968) and JEF-2 average resonance parameters.

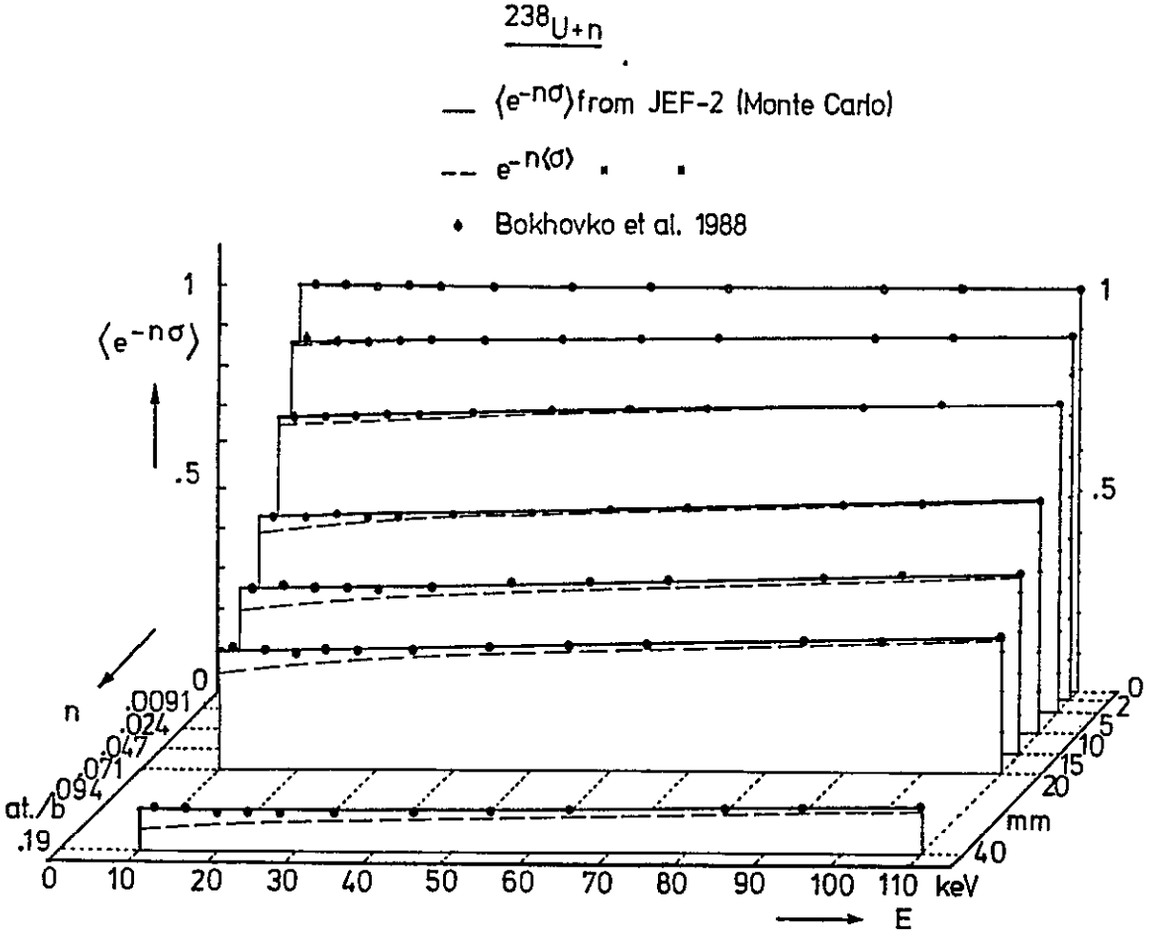
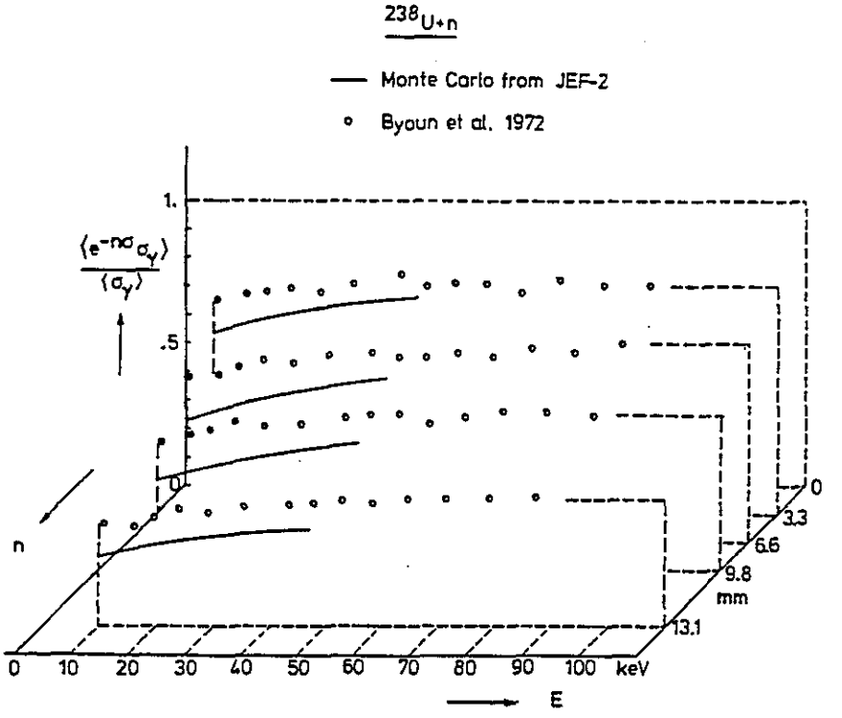


Fig. 1 – Comparison of calculated and measured thick-sample transmission data. Uncertainties of data points are about equal to point sizes.

Self-indication:

Byoun +	1972
Bokhovko +	1988
Georgiev +	1989
Grigoriev +	1990



measured: capture self-indication

$$\frac{\langle e^{-n\sigma}\sigma_\gamma\rangle}{\langle\sigma_\gamma\rangle} = e^{-n\langle\sigma\rangle}\left(1 - n\,\frac{\langle(\sigma-\langle\sigma\rangle)\sigma_\gamma\rangle}{\langle\sigma_\gamma\rangle} + - \ldots\right)$$

from JEF-2 $\langle\Gamma_\gamma\rangle/D$, $\langle\Gamma_n\rangle/D$ $\ell = 0,1,2$