New Evaluation of the ^{232}Th Neutron Resonance Parameters in the Energy Range 0 to 4 keV

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The neutron resonance parameters of ^{232}Th were reevaluated in the energy range 0 to 4 keV from a Reich-Moore SAMMY[1] analysis of the most recent experimental neutron transmission and neutron capture data. The experimental database was formed mainly by the transmission measurements performed at ORELA by Olsen et al.[2] in 1980, the effective capture cross section measurements performed at GELINA by Schillebeeckx et al.[3] in 2002, and the effective capture cross section measurements performed at nTOF by Aerts et al.[4] in 2003. The previous evaluation was performed by Olsen[5] for ENDF/B-VI in 1981. The evaluation by Olsen was not intended to be a comprehensive study. Olsen used smooth background cross sections to compensate for the inadequacy of the resonance parameters to reproduce the totality of the cross sections. The present evaluation brings important improvements concerning the following points:

1/ Two recent high-resolution effective capture cross section measurements (Geel and nTOF) were available for the present evaluation. By taking advantage of the ability of SAMMY to accurately calculate the multiple-scattering effects in the thorium samples, we were able to calculate the average capture cross section to better than 3% accuracy.

2/ In the energy range 1.0 eV to 10 eV the new resonance parameters reproduce the experimental capture cross sections inferred from the nTOF measurements in agreement with the early measurements of Lundgren;[6] the ENDF/B-VI evaluation added a smooth cross section to the contribution of the resonance parameters to agree with the measurements of Chrien et al.[7] The capture cross section calculated in the present evaluation is about half as large as the ENDF/B-VI value and is closer to the ENDF/B-V evaluation, which was based on Lundgren data in the energy range 0.1 to 3 eV.

3/ The contribution of external resonances is fully represented by two fictitious resonances at -2 eV and 6 keV; in the ENDF/B-VI evaluation this contribution (truncation compensation) was included as a smooth background cross section.

4/ The present set of resonances is complete in that the statistical properties of the parameters agree with the Wigner distribution of the level spacings and with the Porter-Thomas distribution of the reduced neutron widths. This, particularly, allows the p-wave neutron capture cross section to be fully calculated with the resonance parameters. In the ENDF/B-VI evaluation, compensation for the missing p-wave resonances was calculated from the p-wave strength function and added as a smooth background cross section.

5/ Average resonance parameters obtained from the present evaluation confirm the ENDF/B-VI values with improved accuracy, particularly with regard to the average capture width and the p-wave strength function.

The method of evaluation, the experimental database, and the statistical properties of the resonance parameters will be described in the full paper. The average cross sections calculated from the new resonance parameters will be compared with the experimental data and with the values obtained from ENDF/B-VI. The present evaluation contributes to improving the k_{eff} prediction in several benchmark calculations.

References

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