Statistical Properties of the s- and p-Wave Resonances of ^{238}U

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INTRODUCTION

Since 1970 a huge effort at the Oak Ridge National Laboratory has been devoted to performing accurate neutron transmission and neutron capture measurements for ^{238}U using the Oak Ridge Electron Linear Accelerator to improve the accuracy of the neutron resonance parameters.[1-3]

The SAMMY[4] analysis of all these experimental data was recently performed in the neutron energy range 0 to 20 keV. The computer code SAMMY uses the Reich-Moore R-matrix formalism for the calculation of the cross sections. The aim of the present work is to present the statistical properties of the s- and p-wave resonance parameters obtained in the analysis of the experimental data.

RESONANCE PARAMETERS

The fits to the experimental data in the energy range 0 to 20 keV were obtained by using 932 s-wave resonances (J^{π}=1/2^{+}) and 2354 p-wave resonances (814 of J^{π} =1/2^{-} and 1540 of J^{π} =1/2^{+}). The identification of the largest s-wave resonances was possible from the asymmetry due to the potential resonance interference effect. All of the resonances that cannot be identified by shape as s-wave resonances had to be distributed among three families: small s-wave resonances, J=1/2 p-wave resonances, and J=3/2 p-wave resonances. According to the 2J+1 law of the level density spin dependence, the number of the J=1/2 p-wave resonances should be roughly the same as the number of s-wave resonances and the number of the J=3/2 p-wave resonances should be twice this number. In the present work we tried to assign the spin according to the 2J+1 law. The variation of the number of resonances versus neutron energy is given in Fig. 1 for both the s-wave and p-wave resonances. The observed average s-wave and p-wave spacings are 21.5 and 8.50 eV, respectively.

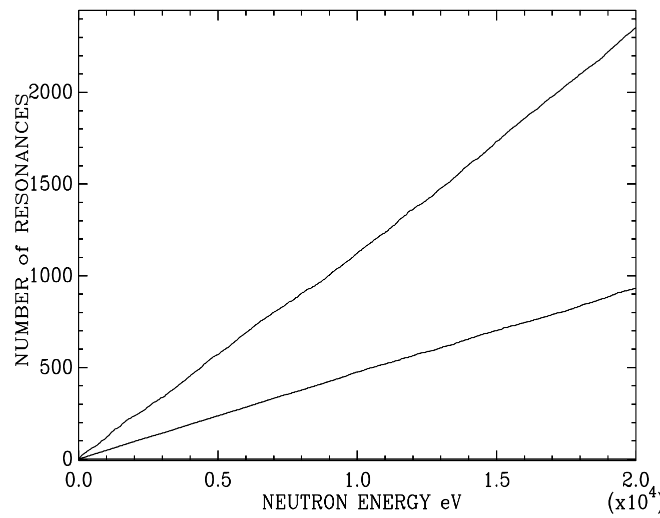

Fig. 1. Number of resonances versus neutron energy. The upper line represents the p-wave resonances; the lower line represents the s-wave resonances.

The Porter-Thomas distributions of the reduced neutron widths are shown in Figs. 2 and 3 for the s-wave and p-wave resonances, respectively. The agreement between the experimental and theoretical distributions is good. However, the theoretical distribution in Fig. 3 takes into account a possibly missing 15% of the p-wave resonances.

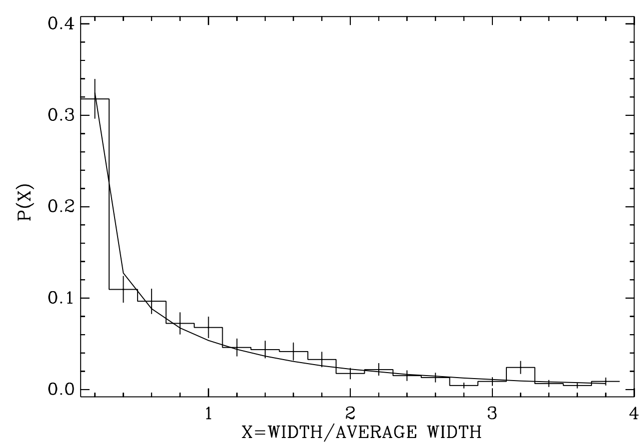

Fig. 2 Differential distribution of the s-wave reduced neutron widths. The histogram represents the experimental distribution. The solid line is the Porter-Thomas distribution.

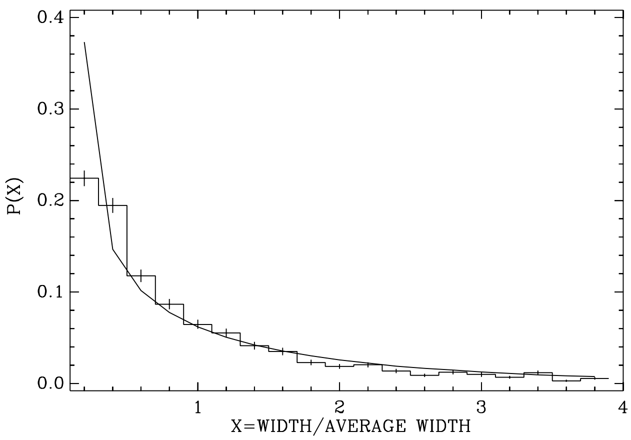

Fig. 3 Differential distribution of the p-wave reduced neutron widths. The solid line is the Porter-Thomas distribution, taking into account the 15% of missing small neutron widths.

CONCLUSIONS

In this analysis, it was important to identify most of the p-wave resonances in order to calculate accurate values of the average capture cross section. In the energy range 10 to 20 keV, the average value of the capture cross section obtained from our resonance parameters agrees with the results of the statistical evaluation in ENDF/B-VI.[5]

REFERENCES

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