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Neutron Widths In Slow Neutron Resonances and Effect of the Diffuse Nuclear Edge on Low Energy Nuclear Reactions [1]

Cetin Cansoy

(This work is based in part on a thesis submitted by Cetin Cansoy to the University of Ankara in partial fulfillment of the requirements for the ph D degree).

In this study the formulae giving the neutron widths for the cases of p, d, and f-wave resonances have been developed and in this way the discrepancy between the theoretical and experimental values of neutron widths has been removed.Using a new neutron width formulae the method of resonance analysis has been modified.In the modified form of analysis of the experimental data the value of g(J) is not needed. However, g(J) can be determined by using experimental total cross section values.

The total cross section of ^{169}Tm has been measured in the energy range 0.35 to 3.2 eV with the CNAEM crystal spectrometer using the Be(12$\bar{3}$1) crystal planes as a monochromator.Applying the modified form of the method of resonance analysis to these experimental data the value of g(J) has been found to be 7/4.

The total cross section of ^{159}Tb has also been measured in the energy range from 0.35 to 3.65 ev with the CNAEM crystal spectrometer using the Be(12$\bar{3}$1) crystal planes as a monochromator.The resonance at 3.34 ev was fitted to a Breit-Wigner single-level formulae by the method of least squares.Using the modified form of the method of resonance analysis the value of g(J) has been found to be 1/8.

In somewhat more detail, analysis for the parameters of the first resonances in ^{169}Tm and ^{159}Tb have been performed as follows: For the analysis of the left wing of the first neutron Resonance of ^{169}Tm only those points were used for which $4(E-E_o)^2 \geqslant 160\ ^2$. This condition gives $E \leqq 3.2$ and $E \geqslant 4.6$ ev for the 3.9 ev resonance in ^{169}Tm. Therefore, the left wing cross section of this resonance has been measured in the energy range from 0.35 to 3.2 ev. The results are indicated in TABLE I.

TABLE I

Breit-Wigner parameters for the Left Wing of Thulium-169

	Diffuse-Edge Parameters	Square Well Parameters
$\sigma_{0,2}\,\Gamma_2^2(bx(ev)^2)$	451∓20	395∓18
J_2(bxeV)	117∓16	91∓12
σ_p(b)	11.5∓2.7	9∓2
K_2	0.067∓0.009	0.060∓0.008
$A(bx(ev)^{\frac{1}{2}})$	4.9∓4.3	4.3∓3.8
R(F)	9.6∓1.1	8.5∓1.0
a(F)	0.31∓0.14	0.31∓0.14
f	1.132∓0.048	1.132∓0.048
J	3	3
g(J)	7/4	7/4

The method for the "straightforward" performance of resolution correction that we have used in this research has been described in detail in Ref. [2]

In the analysis of the first resonance of ^{159}Tb, doppler-broadening, second order and resolution corrections are applied.

Comparisons between the parameters E_o, $\sigma_{0,2}$, Γ_γ and Γ_2 in TABLE II and those in Ref [3] disclose an agreement for these parameters within experimental error.

TABLE II

Breit-Wigner parameters for the first Terbium-159 Resonance

E_o(eV)	3.34∓0.09
Γ_2(eV)	0.1005∓0.0088
Γ_γ(eV)	0.098∓0.009
$\Gamma_{n,2}$(eV)	(1.86∓0.21)x10^{-3}
$\Gamma^0_{n,2}$((ev)$^{\frac{1}{2}}$)	(1.02∓0.13)x10^{-3}
$\sigma_{0,2}$(b)	1808∓159
$\sigma_{0,2}\,\Gamma_2$(bxev)	182∓16
$\sigma_{0,2}\,\Gamma^2_2$(bx(ev)^2	18.3∓3.2
J_2(bxev)	2.08∓0.37
K_2	0.018∓0.004
J	0
g(J)	1/8

REFERENCES

[1] "Neutron widths in slow neutron resonances and effect of the Diffuse Nuclear Edge on low energy nuclear reactions" by Cetin Cansoy, January 1970 to be published as CNAEM 76

[2] "Straightforward Performance of Resolution Correction" by Cetin Cansoy CNAEM 51, 1968.

[3] Phys.Rev., 99, 10 (1955)

A Code in Fortran II for Mono-Energetic Neutron Activation of Filtered Foils

Cetin Ertek

The code is based on the calculation of S.Pearlstein and E.V.Weinstock for foil activation measurements.A code "AYTEK-I" is generated for mono-directional flux in slab geometry for mono-energetic neutrons and it is applicable for all kinds of detectors and covers provided that the front and back cover thicknesses are the same.The term primary activation is used for the activation by the neutrons that have not collided previously, and the term secondary activation is used for activation by the neutrons that have scattered only once either in the foil or the filter.The detailed correlation between energy and angle of scattering is not retained, instead two different average energies, one for forward scattering the other for backward scattering are distinguished.

A large number of calculations have been carried out for different thicknesses of cover and detector to see the secondary activation due to the resonance scattering in the resonance energy.Most calculations have been carried out for indium covered indium foils, and for comparative purposes the incident flux for all energies have been given the value of unity.The detailed report is in publication as CNAEM report no.70

Measurement of ^{116}In Resonance Parameters by Activation Technique

Cetin Ertek, Salih Zeki Coskun

An attempt has been made to measure some of the resonance parameters of $^{116}_{49}$In by the monoenergetic neutron beam activation technique instead of the usual transmission method. The activation technique does not involve estimation of the interference parameter, J, and the potential scattering cross section σ_p. It was designed to find the total radiation width, Γ, the resonance energy, E_o, σ_o value at the first resonance (1.456 ev) provided the absolute monoenergetic neutron flux is accurately known.

To perform the experiment, a very thin, pure indium foil was located inside the BF_3 counter shield just after the second collimator. Twenty neutron energies around the 1.456 ev resonance of indium were selected from the crystal spectrometer using beryllium's (1231) plane for activation. Before each irradiation a rocking curve was obtained and the flux normalization and monitoring performed before, during and after the irradiation. Irradiation time for monoenergetic neutrons was exactly 4 h. For each energy, a beta self-absorption and self-scattering factor was experimentally determined for the same counting geometry since it is also a function of counting geometry. The experimental α values depending on the neutron energy were corrected for neutron degradation inside the indium foil during irradiation. The corrected experimental values $\alpha(E)$ were then introduced to the first term of the single Breit-Wigner formula and the results for the radiation width, Γ, as a function of the total number of analyzing points are tabulated in TABLE III. The resonance energy, E_o, was obtained with exactly the same accuracy as obtained in the transmission method. The Doppler-broadened value from the transmission experiments is given as 0.1091 ev, Ref [4].

TABLE III

Total Width by Activation Depending on the Total Number of Analyzing Points Around the 1.456 ev Resonance

No.of Energy Points	Radiation Γ Width (ev)
16	0.0832 $\mp$0.0163
17	0.0841$\mp$0.0162
18	0.0865$\mp$0.0196
19	0.0857$\mp$0.0188
20	0.0849$\mp$0.0199

Discrepancy between transmission and activation results may be due to the underestimation of the interference parameter and potential scattering cross section.If this is the case, further experiments at higher neutron flux levels should verify these preliminary results which is presented at the ANS, Los Angeles, Nov.1969 meeting and to be prepared as CNAEM report no.71.

Activation measurements attract the interest of our cross-section group C.Cansoy and Hamit Atasoy, and the experiments will be performed together with C.Ertek with somewhat more repetition steps.

REFERENCE

[4] H.H.Landon and V.L.Sailor, Phys.Rev.98, 1292 (1955).

The Remeasurement of Slow Neutron Reflectivity of Sodium Chloride Single Crystal

F.Bayvas

In this experiment, the ratios of the reflected and incoming neutron intensities ($R=I/I_o$) have been measured using a rectangular prism of sodium chloride single crystal. The study has been done in the energy region of 0.02-0.1 ev, and the results are presented in graphical form. The results show that the formula $R=CE^a$ does not coincide with the experimental results along the whole energy range. On a log-log plot of R versus E the curve shows almost a plateau behaviour in the low energy region (0.02-0.05 ev) while in the high energy region it fits the formula given above. Some further investigations have been done which effect reflectivity of the crystal such as mosaic spread.

X-Ray Investigations of o-dinitrobenzene single crystal

F.Bayvas

Along c-axis zero-level Weissenberg photographic data: F_{ob} values are found and B factor is calculated.