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INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

PROGRESS REPORT ON NEUTRON NUCLEAR DATA IN ARGENTINA 1972

Compiled by G.H. Ricabarra

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PROGRESS REPORT OF REACTOR PHYSICS DIVISION

1.- ^{74}Ge and ^{76}Ge activation resonance integral.- (M.D. Ricabarra, R. Turjanski and G. H. Ricabarra).-

Measurement and evaluation of the activation resonance integral for ^{74}Ge has been completed and is going to be published in the Candian J. Of Physics with the following abstract: "Values of the reduced activation resonance integral relative to the thermal cross section, I'/σ_o of ^{74}Ge and ^{76}Ge were determined relative to gold by measuring cadmium ratios in a reactor spectrum.

A lithium-drifted germanium gamma ray spectrometer was used to resolve the activities of the samples.

The results for ^{74}Ge are $I'/\sigma_o = 1.514 \pm 0.031$ and $I' = 0.681 \pm .123$ barn with an assumed $\sigma_o = 0.45 \pm 0.08$ barn; for ^{76}Ge $I'/\sigma_o = 12.00 \pm 0.16$ and $I' = 1.992 \pm 0.359$ with and assumed $\sigma_o = 0.166 \pm 0.030$ barn.

The values obtained for I' are in serious disgreement with the values calculated with neutron resonances parameters and confirm previous results obtained in similar keV average resonance spacing isotopes.

Due to this fact a careful evaluation of keV neutron radiative capture cross section and resonance integral for ^{74}Ge was undertaken.

The evaluation and comparison with the experimental value of the resonance integral shows first that for nuclides with an average resonance spacing of keV the unresolved resonan-

ce integral has been seriously underestimated in many evaluations and second that between 10 keV and 100 keV resonance integrals calculated with smooth low resolution activation cross section give a better calculation of neutron captures than that obtained with neutron resonance parameters.

A preprint of this paper has been distributed as INDC (ARG) - 2/G.

2.- ^{146}Nd, ^{148}Nd and ^{150}Nd activation resonance integral.- (M.D. Ricabarra, R. Turjanski and G.H. Ricabarra).-

In previous progress report (INDC(ARG)-1/G) has been pointed out the disagreement of our measurement with Breit-Wigner calculation made with resonance parameters of Karzhavina (Dubna). The evaluation has been enlarged now to include comparison and discussion with Alves (Saclay) Tellier (Saclay) and Migneco (Geel) resonance parameters obtained by time of flight measurements. Also a careful evaluation has been made of the unresolved resonance integral.

A preliminary report has been finished. The most important conclusion of this report is that first ^{148}Nd resonance integral is half of the previous recommended value and second that the radiative width which can be obtained of our resonance integral measurement is half of the value measured by Karzhavina TOF capture technique on enriched samples.

3.- Additional comments about anomalous neutron thermal absorption of a heavy isotope.- (M.D. Ricabarra, R. Turjanski and G.H. Ricabarra).-

A letter to the Editor of Nuclear Sci. and Eng. is transcribed for information of the International Nuclear Data Commitee.

Comment on a p-wave assigment to the 301 eV neutron resonance of Zirconium 96.

Fulmer et al [1] have arrived to the conclusion suggested by us in a previous work[2], that in order to explain the low thermal absorption cross section of ^{96}Zr the 301 eV neutron resonance will be required to be a p-wave resonance.

However Fulmer et al have overlooked that this p-wave assignement is not consistent with nuclear systematics. As this fact may have been overlooked by other readers of our previous paper, it is worthwhile to explain with more detail this point.

If we calculate the probable value of a neutron width for a p-wave resonance at 301 eV, using the values of-neutron widths measured for ^{94}Zr by Bartolome et al[3], we obtain Γ_{n_1} (301eV) = 0.0014 eV.

Then the 301 eV. resonance (Γ_n = 0.23 eV) must be around 100 times stronger of what would be expected in order to be a p-wave resonance.

This seems to be hardly possible from the point of view of current knowledge of experimental p-wave neutron widths and from theoretical estimation and only one clear example has been given in the literature which may support the p-wave assignement

to the 301 eV. resonance of ^{96}Zr. According to Harvey and Fuketa[4] the 62 eV neutron resonance of ^{124}Sn is a p-wave resonance 100 times stronger than what would be expected for a p-wave resonance. Harvey and Fuketa suggested that the 62 eV resonance of ^{124}Sn is a 2p-1h doorway p-state resonance and found that its neutron width was comparable to those calculated by Shakin[5].

However an experimental value of I'/σ_o (ratio of reduced resonance integral to the thermal cross section) obtained by us and reported in the Helsinki Conference [6], showed that this ratio was in agreement with the ratio calculated assuming that the 62 eV resonance of ^{124}Sn is an s-wave neutron resonance.

Another alternative explanation may be given to the anomalous thermal cross section of ^{96}Zr in terms of the theory of radiative capture of Lane and Lynn[7], in whick there is a possibility of multilevel interference effects in the radiative channels. A similar anomaly in the thermal capture cross section has been shown to occur in very light elements, but unlike heavier nuclei, these nuclei have very few final states, then partial anomalies due to interference effects in the radiative channels may appear in the total capture cross section. However for a heavier element as ^{96}Zr it is difficult to understand how this destructive interference effect may depress the thermal cross section by a factor of ten and no example has been found in the literature to support this explanation.

Finally, it is rather curious to see that a simple thermal activation cross section may present problems of interpretation by present knowledge of neutron physics, and suggests that ^{96}Zr may become a particular interesting element for a deeper analysis by nuclear physicists.

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4.- Resonance Integral of ^{112}Sn, ^{116}Sn, ^{122}Sn and ^{124}Sn.

(M.D. Ricabarra, R. Turjanski, and G.H. Ricabarra).-

The ratio of resonance integral to thermal activation-cross section of the isotopes ^{112}Sn, ^{116}Sn, ^{122}Sn and ^{124}Sn has been determined by measuring cadmium ratios in the central reflector of the RA-1 reactor.

The flux in the RA-1 reactor where the irradiations were made was large enough to allow the use of thin samples.

The activities were resolved with a Li-drifted Ge gamma ray spectrometer working on line with a computer.

Preliminary evaluation of data has been finished and work on evaluation and calculation of resonance integral is in progress.

5.- ^{100}Mo Resonance Integral.- (M. D. Ricabarra, R. Turjanski, and G. H. Ricabarra).-

In our previous work (Can. J. Phys. 47, 2031 (1969) has been pointed out that the disagreement between measured and calculated resonance integral of ^{100}Mo could be explained if the radiative width recommended by BNL 325 or KFK 120 (EANDC) was too large by a factor of two or more.

However what could not be explained was the results of Baumann's boron filter experiments (AEC Research and Development Rept DP-817 Savannah River Laboratory) that showed that a significant fraction of the ^{100}Mo activation resonance integral was coming from energies much higher than that of the main captures resonance at 364 eV.

An estimation and calculation has been made of the resonance integral between 1 keV and 10 MeV using differential neutron capture or activation cross section and multigroup calculated reactor spectrum.

This preliminary evaluation confirms now the results of Baumann's boron filter experiments.

6.- Further experiments on a new epithermal foil detector.- (D. Waisman, M.D. Ricabarra, and G.H. Ricabarra).-

A report is in preparation for the calculation and self-shielding measurement of ^{96}Zr. This measurement was reported in previous progress report (INDC(ARG) - 1/G).

In addition bare and cadmium covered axial distribution of the activity of ^{97}Nb produced by neutron capture in ^{96}Zr has been determined inside the Reactor Argentino 1 (RA-1) together

with the distribution made with a conventional foil detector (Indium).

Also a sandwich type of measurement has been made with the same detector an a reasonable agreement has been found with calculations.

All this experimental results will permit to propose a novel epithermal foil detector which will be better than previously used in the the same energy range.

PROGRESS REPORT ON THE ACTIVITIES OF THE NEUTRON AND REACTOR PHYSICS GROUP AT THE CENTRO ATOMICO BARILOCHE.-

M. J. Abbate, H.M. Antúnez, c. Castro Madero, L. Gatto Cauterucci, F. Kropff Moreno, J. Lolich and L. A. Remez.

INTRODUCTION

The activities of the Neutron and Reactor Physics Group at the Centro Atómico Bariloche (CAB) are centered around the use of the 30 MeV electron linear accelerator (LINAC) as a high intensity pulsed neutron source.

Three main lines of research are being carried out:

1.- Neutron time of flight spectra measurements.

2.- Neutron total cross sections measurements by transmission method.

3.- Neutron Die away experiments.

FACILITIES AND EQUIPMENT

The research work is performed using the following facilities:

1.- Electron linear accelerator, S-band, one section, 30 MeV energy, pulse width: 10nanosec - 1 μsec, peak current: 3Amp short pulse, 150 mA long pulse. Repetition rate up to 200 short pulses. It is being upgraded to two sections - 60MeV.

2.- An evacuated 17 m. flight tube in 4 sections with an adjustable diameter precollimator and a detector room. It is being extended to 65 m.

3.- An IBM/360 model 44 computer for on line data acquisition and processing, 128 Kbytes fast memory, two disc drives (1000 Kbytes capacity each), a 1627 plotter, a 2540 card punch and reader, a 1403 line printer, a high speed multiplexor channel with a 2701 data adapter unit with parallel data adaptors.

4.- A Laben TV60 time of flight coder with 125 μsec minimun channel width and 4096 channels, on-line with the IBM/360 model 44 computer.

5.- At present Li glass (6 and 7) detectors and miniature fission chambers are used. NE211 and He3 detectors are also available.

6.- Conventional instrumentations of the NIM type with several home-made special purpose units.

These facilities provide a present spectrometer resolution of approximately 7 nanosec/m. The extension of the flight path will improve it to 2 nanosec/m.

NEUTRON TIME OF FLIGHT SPECTRA MEASUREMENT.

Neutron spectra measurement in quasi infinite media of light water and pure and poisoned benzene are under way; the computational program system for on line data acquisition and "off line" data reduction has been developed. The experiments are to be compared with the DTF-IV transport code calculations.

NEUTRON TOTAL CROSS SECTION MEASUREMENTS.

Neutron total cross section measurements of Mylar ($C_{10}H_8O_4$) using the transmission method has been performed for energies between 0.007 eV and 20 eV with an accuracy less than 2%. The related computational program system has been developed. Similar experiment with heavy water is under way with an expected accuracy of less than 1%.

It is planned to start measurements in the KeV range in a near future.

NEUTRON DIE AWAY

Diffusion parameters of benzene for thermal neutron is almost through. The accuracy of the obtained values is higher than the previous published. The related computational program system has been developed.

The IALE Programme for Nuclear Spectroscopy Studies of Short-Lived Nuclei

Progress Report 1971

E.O.Achterberg, F.C.Iglesias, A.E.Jech[+], E.Kerner, J.Mónico, J.A.Moragues[+], D.Otero, M.L.Pérez[+], M.A.Pinamonti, A.N.Proto, R.Requejo, J.J.Rossi, W. Scheuer, J.F.Suárez.

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The on-line system described briefly in the previous Progress Report has continued operating during 1971. A complete description of the experimental facility is being published [1].

Some minor modifications have been made on the system. A new collection chamber has been installed at the mass-separator exit providing improved access for the collection of activities for later off-line measurements. A beam deflection system has been added to allow fast cut-off of the activity reaching the collector, for half-life measurements and to enhance the activity of short-lived parent nuclides as compared to their daughter activities.

Two new Si(Li) detectors have been added to our facility during this year, one with 2 cm^2 area and 3 mm depletion depth, with 3.0 keV resolution, and another one with 0.5 cm^2 area and 15 mm depletion depth, with 7 keV resolution.

The analysing system has been expanded by the addition of a magnetic tape unit. Software modules developed for the on-line computer include a megachannel coincidence routine for use with the magnetic tape and a program for the operation of an IBM 29 card-punch unit through an appropriate interface. Data handling was facilitated by the development of a small γ-ray spectrum analysis routine [2] to be used on our 16K computer. Accurate energy calibrations are also performed on this machine.

The evaluation of the results of our internal-conversion measurements on the "heavy" fission peak has been concluded and the results are being published [3].

The work on ^{138}Xe decay has been completed with the measurement of low-energy γ-ray and X-ray spectra, and of γ-γ coincidences. A

new level scheme was constructed and the results have been submitted for publication [4].

In the study of ^{86}Br decay several new transitions have been assigned to the ^{86}Kr level scheme. Based on energy-sum relations and some prior coincidence results [5] a level scheme for ^{86}Kr was constructed including ∿99% of the γ-intensity, in good agreement with the one proposed in ref. 5. The results are being published [6].

New investigation to be taken up include: a) Precise measurement of ^{138}Xe decay intensities to use this activity for on-line efficiency calibration purposes; b) 143 mass-chain decays; c) ^{139}Xe decay; d) ^{91}Kr decay, and e) ^{93}Kr decay.

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