International Atomic Energy Agency

INDC INTERNATIONAL NUCLEAR DATA COMMITTEE

PROGRESS REPORT

ON NUCLEAR DATA ACTIVITIES

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Compiled by

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INSTITUTE OF EXPERIMENTAL PHYSICS,

KOSSUTH UNIVERSITY

DEBRECEN

NUCLEAR DATA PROGRAM AT THE
INSTITUTE OF EXPERIMENTAL PHYSICS,
KOSSUTH UNIVERSITY, DEBRECEN

EXPERIMENTAL FACILITIES

1. A ∼1 mg Cf^{252} /fission/ neutron source;
2. 200 kV /2 mA/ neutron generator /home made/;
3. 180 kV /1.2 mA/ Activatron-111 neutron generator, it can be pulsed, pulse period: down to 10 microsec,
4. associated-particle system for ^{3}He and ^{4}He; this can be mounted onto any of the neutron generators;
5. pneumatic transport system for quick /0.8 sec for 2.4 m/ automatic sample transfer;
6. Pu-Be neutron sources from 0.5 to 5 Ci;
7. 40 cm^3 Ge/Li/ detector with 3 keV FWHM at 1332 keV;
8. 4000 channel DIDAC /Intertechnique/ analyser; three 100 channel analysers;
9. Tally tape perforator, printer, tape-reader, X-Y plotter, spectrum-stabilizer;
10. Lorenz telex with tape-punching and punched tape reading units in five-hole CCIT code;
11. ^{6}LiJ /Eu/ crystal spectrometer;
12. ^{3}He proportional counter;
13. low-background proportional counter for measuring weak beta and /or gamma rays, e.g. tritium, with a sensitivity of a few pCi;
14. time of flight system with associated particle method for fast neutrons is under construction.

SEMI-CLASSICAL DESCRIPTION OF DIFFERENTIAL ELASTIC SCATTERING CROSS SECTIONS FOR 14 MeV NEUTRONS

I.Angeli, J.Csikai and P.Nagy

Previously, a simple semi-classical optical model was successfuly used to describe the mass dependence of total, integrated elastic and nonelastic neutron cross sections at 14 MeV. Further investigations have shown that the main features of absolute differential elastic scattering cross sections can also be described in a wide mass number range /from $A = 14$ to $A = 209$/. Considering the simplicity of the model, the agreement with experimental data is fairly satis-factory using the same parameter set that derived from the analysis of total cross sections; the only modification that had to be performed, was the introduction of a mass number dependent nuclear radius parameter $r_0/A/$ - as resulted from the nonelastic cross sections - instead of a constant value.

References:

Angeli,I., Csikai,J. and Nagy,P. to be published
Angeli,I. and Csikai,J. Nuclear Physics, A158 /1970/ 389
Angeli,I. and Csikai,J. Nuclear Physics, A170 /1971/ 577

COMPILATION AND EVALUATION OF FAST NEUTRON CROSS SECTIONS

Z.T.Bödy and J.Csikai

After a treatise of activation cross section measurements and classification of errors to make data handling easier [1,2] the /n,2n/ cross section data were collected in a compilation [3]. Using this and a new averageing procedure [4], the most probable /n,2n/ cross section values were calculated for every nuclide where data are available at all, without [1] and with [5] corrections to the flux standards. Further cross sections were obtained from these /experimental/ data and the N-Z trend [6]. In such a way we have /n,2n/ cross sections of either experimental or semi-empirical nature for almost every nuclide. For elements the /n,2n/ cross sections have also been calculated at 14.7 MeV using uncorrected [1,7] and corrected [5] values, respectively.

At the present similar work on /n,α/ cross sections is under progress.

References:

[1] Bödy,Z.T., Thesis, Kossuth University, Debrecen /1972/
[2] Bödy,Z.T., Csikai,J. and Angeli,I., IAEA-153 Techn. Report, p. 173., Vienna /1973/
[3] Bödy,Z.T. A compilation of /n,2n/ cross sections measured at about 14 MeV for nuclides 6<Z<93, Supplement to the Thesis 1 ; INDC/HUN/-10 /Jan. 1973/, report available from Nuclear Data Section, /IAEA/, Vienna
[4] Bödy,Z.T. and Dede,K.M., Acta Phys.Hung. 28, /1970/ 155
[5] Bödy,Z.T. and Csikai,J., Atom.Energy Rev. 11, /1973/ 153
[6] Csikai,J. and Petö,G., Phys.Lett. 20, /1966/ 52; Acta Phys.Hung. 23, /1967/ 87
[7] Csikai,J., Angeli,I. and Bödy,Z.T., IAEA-153 Techn. Report, p. 155., Vienna /1973/

/n,t/ CROSS SECTION MEASUREMENTS FOR LIGHT AND MEDIUM-HEAVY
ELEMENTS WITH 14 MeV NEUTRONS

T.Biró, S.Sudár and J.Csikai

Tritium produced in metallic samples by /n,t/ reaction at
14 MeV neutron energy was extracted by inductional heating.
Tritium beta activity was measured by internal gas proportional
counting. Low background was achived by anticoincidence guard
ring and /or by pulse shape discrimination [1]. Cross sections
for Be, B, C, Al, K, Ti, Fe, Co, Ni, Cu, Zn and Rh have been
determined [2,3].

References:

[1] Sudár,S., Vas,L. and Biró,T., Nucl.Instr. and Meth. /in press/.
[2] Biró,T., Sudár,S. and Csikai,J., Conference on nuclear struc-
      ture study with neutrons, Budapest 31 July - 5 August, 1972.
      p. 130
[3] Biró,T. Sudár,S., Csikai,J. and Dezső,Z., Soviet National
      Conference on Neutron Physics, Kiev, 28 May - 1 June, 1973.

CROSS SECTION FOR THE ^{103}Rh/n,n' /^{103m}Rh REACTION

A.Pázsit, J.Csikai, G.Pető and J.Bacsó

Using new decay scheme data published recently in literature and a high resolution Si/Li/ spectrometer the ^{103}Rh/n,n'γ/^{103m}Rh reaction cross section has been remeasured. This value is important for neutron spectrum measurements with threshold detectors. The measurements were performed at 2.8 and 14.8 MeV neutron energies; average cross sections for Pu-Be and Cf^{252} neutron sources were also determined. The knowledge of these data renders it possible to check excitation functions and spectra of neutron sources, respectively [1].

Reference:

[1] Pázsit,A., Pető,G., Józsa,I., Csikai,J. and Bacsó,J., Soviet National Conference on Neutron Physics, Kiev, 28 May - 1 June, 1973.

LOW-ENERGY CROSS SECTIONS FOR ^{10}B/p,α/^{7}Be

J.Szabó, J.Csikai and M.Várnagy

Cross sections were determined for the ^{10}B/p,α/^{7}Be reaction between 60 and 180 keV proton energies using activation method as well as direct alpha detection by solid state track detector. In the energy region investigated, the influence of the 8.694 MeV state of ^{11}C on S/E/ has been observed. The cross section for the Gamow energy is given. The half-width of this level and the branching ratio ^{7}Be/ε/^{7}Li were found to be Γ ≈ 300 keV and R = 0.104 ± 0.003, respectively [1].

Reference:

[1] Szabó,J., Csikai,J. and Várnagy,M., Nucl.Phys. A195 /1972/ 527

RADIATIV CAPTURE OF 14 MeV NEUTRONS

G.Pető and J.Csikai

The aim of this work is to find the origin of dis-
agreement between /n,γ/ cross sections measured by different
techniques. According to the measurements performed hitherto
there is an appreciable effect due to the neutrons scattered
from the target-holder [1]. So, further investigations are
needed to prove the assumption that the results from prompt
gamma measurements are the cross section for production
gammas with energies higher than 14 MeV, only.

References:

[1]   Pető,G. and Csikai,J., Soviet National Conference on
      Neutron Physics, Kiev, USSR, 28 May - 1 June 1973

INVESTIGATION OF FAST NEUTRON INDUCED FISSION AND RELATED TOPICS

S.Daróczy, S.Nagy, P.Raics and J.Csikai

We have dealt with the measurement of fission fragment yields in the 14 MeV neutron induced ^{238}U fission using a new technique, namely the direct Ge/Li/ γ-spectrometry of the sample without any chemical separation or application the recoil effect. In order to determine absolute yields, we have investigated the absolute efficiency curve of the Ge/Li/ detector [1] and the self-absorption corrections for the thick sources.

The absolute cumulative yields for 17 fission fragments determined after 30 hour irradiation with 28 γ-lines are in good agreement with the results of earlier measurements, especially in the case of the yields determined by measurements of two or more γ-lines [2]. Determination of further cumulative yields from γ-spectra measured after 30 hours irradiation is in progress.

We have collected the fission fragment yield data for the 14-15 MeV neutron induced fission of ^{238}U. In a compilation [3] corrected and recommended values are proposed for the chain yields of fission fragments having mass number $66 \leq A \leq 172$ /also for masses with no published experimental data, by interpolation/. The available independent and fractional cumulative yields are presented, too.

The ^{238}U/n,2n/ reaction at 14 MeV gives a possibility for the nondestructive determination of the enrichment ratio in uranium fuel elements, with Ge/Li/ gamma-spectrometry [4]. The relative intensity of the 208.0 and 205.1 keV γ-lines of

^{237}U and ^{235}U, respectively, can be used to determine the $^{235}U/^{238}U$ ratio. Changes in γ-absorption, self-absorption and detector efficiency at the above energies do not effect the fast neutron activation differential analysis proposed. The control of the method for various practical configurations of uranium fuel elements is under progress.

References:

[1] Nagy,S., Sailer,K., Daróczy,S., Raics,P., Nagy,J. and German,E., to be published in Magyar Fizikai Folyóirat /in Hungarian/

[2] Daróczy,S., Germán,E., Raics,P., Nagy,S. and Csikai J., Soviet National Conference on Neutron Physics, Kiev, 28 May - 1 Juen, 1973

[3] Daróczy,S., Raics,P. and Nagy,S., contribution to J.G.Cuninghame's review of "Status of fission product yield data for energy dependent and fast neutrons", Panel on Fission Product Nuclear Data, 26-30 November 1973, Bologna.

[4] Raics,P., ATOMKI Közl. 13 /1971/ 165 /in Hungarian/

AVERAGE CROSS SECTIONS FOR LABORATORY NEUTRON SOURCES

J.Csikai, I.Józsa and G.Pető

After having determined average activation cross sections for a number of elements using unmoderated neutrons from Pu-Be and Po-Be sources [1], similar work are under progress with Cf^{252} /fission/ neutron source.

Reference:

[1] Pető,G., Csikai,J., Shuriet,G.M., Józsa,I. and Asztalos, V., Acta Phys. Hung. 33 /1973/ 363

INVESTIGATIONS ON NEUTRON REFLECTION

K.M.Dede, M.Buczkó, A.Demény and K.Erdei

Investigations on neutron reflection from hydrogeneous samples are carried out using Pu-Be neutron source. The practical aim of this work is the determination of hydrogen content of different rubble matrices. Neutron transport calculations are also carried on relating to the details of moderation and reflection in the presence of gaps in the moderator. The calculations are based on a special formalism of PN approximation [1], with modified boundary conditions [2], resulting more reliable angular distribution for the emerging neutrons.

References:

[1] K.M.Dede, Nukleonik, 8 /1966/ 383
[2] K.M.Dede, A.Demény and K.Erdei, to be published.

SOLID STATE DETECTORS FOR CHARGED PARTICLES: DETERMINATION
OF TRACK PARAMETERS BY DIFFRACTION METHOD USING LASER LIGHT

M.Várnagy, J.Szabó, S.Juhász and J.Csikai

In our Institute work has been done especially on the
detection problems of light charges particles [1-4], applica-
tion of plastic track detectors for cross section and angular
distribution measurements of nuclear reactions [5], [6-8] as
well as separation of charged paticles according to energy and
type by track parameters [1, 4]. Now, because the measurement
of track parameters demands difficult microscope work, we
determined the diameter of the tracks by the Frauenhofer-diffrac-
tion method. A ≈1 mW He-Ne gas laser as a light source as well
as cellulose acetate track detectors irradiated with alpha
particles at different energies were used. The diameter of tracks
determined by the diffraction method as well as those measured
by microscope are in good agreement with each other [9].

References:

[1]   Somogyi,G., Várnagy,M. and Pető,G., Nucl.Instr. and Meth.
      59 /1968/ 299

[2]   Somogyi,G., Várnagy,M. and Medveczky,L., Radiation Effects
      5 /1970/ 111

[3]   Várnagy,M., Csikai,J., Szegedi,S. and Nagy,S., Nucl.Instr.
      and Meth. 89 /1970/ 27

[4]   Várnagy,M., Thesis, Kossuth Unviersity, Debrecen, 1970

[5]   Szabó,J., Thesis, Kossuth University, Debrecen 1971

[6]   Somogyi,G., Schlenk,B., Várnagy,M., Meskó,L. and Valek,A.,
      Nucl. Instr. and Meth. 63 /1968/ 189

[7]   Szegedi,S., Thesis, Kossuth University, Debrecen, 1970

[8]   Bartçugil,E., Juhász,S., Várnagy,M., Nagy,S. and Csikai,J.,
      Nucl. Phys. A173 /1971/ 571

[9] Várnagy,M., Szabó,J., Juhász,S. and Csikai,J., Nucl. Instr. and Meth. 106 /1973/ 301

A CALCULATION METHOD FOR DESIGNING ACCELERATOR TARGET COOLING SYSTEMS

J.Kas and D.Novák

A method for the calculation of the necessary water circulation in accelerator target-cooling systems is described. The transferred heat is supposed to consist of two components. Part of the dissipated heat is carried away directly from the ion-beam spot while the other part from a surrounding annular surface. Expressions are given for the calculation of each component. The relative weight of each component in the total heat transfer is evaluated at different spot diameters. A model experiment has been performed to check the validity of the calculation method [1].

Reference:

[1] Kas,J. and Novák,D., Nucl. Instr. and Meth. 99 /1972/ 359

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RADIOCHEMICAL IDENTIFICATION OF ^{70}Cu

A. Szalay and K. Jost

By bombarding an enriched ^{70}Zn target with 14 MeV neutrons, ^{70}Cu was identified by means of an express radio-chemical separation method. The 42 ± 3 s activity observed already by Taff et al. /1/ belongs to ^{70}Cu. Systematic comparison of its half-life with those of neighbouring comparable /odd-odd/ nuclei demonstrates however that this is an isomeric state of ^{70}Cu. The activation cross section of the ^{70m}Cu state amounts to 4 ± 3 mb /max. error/.

INNER-SHELL IONIZATION BY ELECTRON IMPACT

S. Seif el Nasr, D. Berényi and Gy. Bibók

The cross-section of K and L shell ionization by electron impact was measured for different elements. The energies were 347, 487 and 666 keV, the elements: Ni, Y, Ag, Yb, Ta, Au and Pb. The evaluation of the rough experimental data is under way.

THE NEW ISOTOPE ^{198}Ir AND OTHER PRODUCTS OF THE FAST NEUTRON REACTIONS OF ^{198}Pt

I. Uray

In our studies on the fast neutron reactions of ^{198}Pt, the half-life of ^{197m}Pt was determined and found to be: $/94.4 \pm 0.8/$ min. The half-life of ^{199m}Pt is $/13.3 \pm 0.2/$s, the energy of the transition $^{13}/2^+ \longrightarrow {}^7/2^-$ was found as $/391.93 \pm 0.14/$ keV. The isomeric cross-section ratio, related to the $/n,\gamma/$ reaction at the given neutron energy, is 0.081 ± 0.037.

For the cross-sections of the $/n,d/ + /n,np/$ and $/n,\alpha/$ reactions an upper-limit extimation is given. The half-life of the new isotope ^{198}Ir is $/8 \pm 3/$s $/$max. error$/$. The energy of the transition $2_1^+ \longrightarrow 0^+$, belonging to ^{198}Pt and appearing during the decay of ^{198}Ir, is $/407.76 \pm 0.22/$ keV, the partial activation cross-section of the transition amounts to $/0.3 \pm 0.1/$ mb.

INTERNAL CONVERSION AT THE HIGHER SHELLS IN THE 80.2 keV
TRANSITION OF ^{131}I

D. Berényi, Á. Kövér, Cs. Ujhelyi and D. Varga

The ratios of the L-, M-, N- subshells and O-shell
internal conversion coefficients have been studied in the
80,2 keV transition of ^{131}I. The measurements were carried out
in a special semicircular magnetic beta-ray spectrograph of
75 cm maximum radius[1]. The separation of the not completely
resolved peaks and the determination of the intensity ratios
of conversion lines have been evaluated by computer. The recent
experimental and theoretical[2,3,4] results were compared. The
possible multipolarity mixture has been investigated.

REFERENCES

1/ F. Illés, D. Berényi and J. Schadek, Nucl. Instr. and
    Meth. 107, /1973/ 93.

2/ R.S. Hager and E.C. Seltzer, Nucl. Data A4, /1968/ 1.

3/ O. Dragoun, Z. Plajner and F. Schmutzler, MPIH-1969-V5.

4/ O. Dragoun, Z. Plajner and F. Schmutzler, Nucl. Data A9,
    /1971/ 119.

NEW ISOTOPE ^{189}Tl

T.B. Vandlik, J. Vandlik, N.G. Zaitseva, Z. Máté,

I. Mahunka, M. Mahunka, T. Fényes, H. Tyrroff, M. Jachim

Three gamma-lines /E = 216.3; 229.0; 335 keV/ have been observed in the decay of the new isotope ^{189}Tl. Its half-life was found to be $T_{1/2}$ = 1.4 $\pm$ 0.4 min.

The PbF$_2$ targets were irradiated with 660 MeV protons. After on-line gas-thermochromatographic and off-line isotope separation the gamma spectrum of thallium - 189 was measured with a Ge/Li/ spectrometer.

ROLAND EÖTVÖS UNIVERSITY

DEPARTMENT FOR ATOMIC PHYSICS,

BUDAPEST

INELASTIC SCATTERING OF 14.7 MeV FAST NEUTRONS ON LIGHT
NUCLEI

F. Deák, S. Gueth, Á. Kiss

The aim of this work is to investigate the collective
properties of light nuclei in the mass region of 12 < A < 30.
An associated particle - fast neutron time-of-flight spectro-
meter with the time resolution of about 1.2 nsec is used. The
angular distribution of the cross-sections are evaluated in the
framework of the collective model.

INVESTIGATION OF SHORT-LIVED ACTIVITIES EXCITED BY FAST
NEUTRONS

A. Kiss, F. Deák, S. Gueth

The production of short lived activities /10 nsec -
10 µsec/ is investigated by 14.7 MeV fast neutrons. A combined
alpha particle-pulsed-beam method is used to measure the dis-
tribution of γ-rays produced in the de-excitation process.
Properties of statistical nuclear processes are investigated
and the half- lives of isomeric levels can be deduced from the
measurements.

FAST NEUTRON ACTIVATION ANALYSIS

S. Gueth, F. Deák, A. Kiss

Some research work is made to find economical and simple methods for the determination of small quantities of the elements N, O, F and Si in samples of materials produced in industrial processes.

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Special facilities:

1. Station for irradiation with 80000 Ci ^{60}Co
    activity.

2. 6 MeV transportable betatron.

POSSIBILITIES OF PHOTO-EXCITATION OF EVEN-EVEN NUCLEAR ISOMER

Á. Veress, I. Pavlicsek, M. Csürös

Inelastic resonance scattering of γ-rays was measured on even-even nuclei, using a 2500 Ci ^{24}Na source. Experimental results suggested that the upper limits of the photoactivation cross section per primary γ-quantum were 2.10^{-5} µbarn for $^{90}Zr^m$, 10^{-5} µbarn for $^{180}Hf^m$, 2.10^{-4} µbarn for $^{190}Os^m$, 8.10^{-5} µbarn for $^{204}Ob^m$.

RAPID DETERMINATION OF ERBIUM USING γ-RAYS OF ^{24}Na RADIATION SOURCES

Á. Veres

The ^{167}Er nucleus may be excited by nuclear photo-effect to a metastable state. This effect can be utilized for the determination of Er in rock samples using γ-rays of a ^{24}Na radiation source. A detection limit of 1 µg erbium in 10 g samples can be achieved using a 200 Ci ^{24}Na source.

ACTIVATION EXPERIMENTS OF PHOTO-NEUTRONS BY USING ^{24}Na-Be SOURCE

L. Lakosi, Á. Veres

Photo-neutron cross sections of Mn, Ag, Cd, In, I, Sm, Fr, Lu, Ir, and Au were measured by using a ^{24}Na-Be source. The photo-neutron flux was 2.1×10^4/cm^2. sec.Ci. At the begining of the experiments the activity of the ^{24}Na source was 750 Ci.

The measured cross-section values are shown in

Table 1

Reaction	cross-section /mbarn/
^{55}Mn /n,γ/ ^{56}Mn	4.4 $\pm$ 0.7
$^{107+109}$Ag /n,n'/ $^{107m+109}$Ag	570 $\pm$ 20
^{111}Cd /n,n'/ ^{111}Cd^m	66 $\pm$ 9
^{114}Cd /n,γ/ ^{115}Cd	38 $\pm$ 6
^{116}Cd /n,γ/ ^{117}Cd	86 $\pm$ 25
^{115}In /n,n'/ ^{115}In^m	38 $\pm$ 6
^{115}In /n,γ/ ^{116}In^m	109 $\pm$ 15
^{127}I /n,γ/ ^{128}I	77 $\pm$ 11
^{152}Sm /n,γ/ ^{153}Sm	130 $\pm$ 25
^{154}Sm /n,γ/ ^{155}Sm	53 $\pm$ 8
^{167}Er /n,n'/ ^{167}Er^m+ + ^{166}Er /n,γ/ ^{167}Er^m	170
^{167}Er /n,n'/ ^{167}Er^m	750
^{170}Er /n,γ/ ^{171}Er	18.4 $\pm$ 2.2
^{175}Lu /n,γ/ ^{176}Lu^m+ + ^{176}Lu /n,n'/ ^{176}Lu^m	235
^{191}Ir /n,γ/ ^{192}Ir	360 $\pm$ 70
^{193}Ir /n,γ/ ^{194}Ir	52 $\pm$ 8

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N-d ELASTIC SCATTERING AND POLARIZATION CALCULATIONS

P. Doleschall

In order to determine the cross section and polarization of elastic neutron scattering on the deuteron, the approximation of a non-local, separable nucleon-nucleon interaction was used to solve the Faddeev equations. Since earlier calculations had established that a tensor force on its own is unable to account for the polarization, allowance was made, apart from the $^1S_0$ and $^3S_1$, $^3D_1$ components, for two-nucleon interactions in the $^1P_1$, $^3P_0$, $^3P_1$ and $^3P_2$ states. The differential scattering cross sections and the polarizations especially for /n,d/ elastic scattering at E_n = 14.1 and 22.7 MeV show a much better agreement with experiment in this treatment.

MEASUREMENT OF GAMMA-RAY SPECTRA· FROM THE SPONTANEOUSLY FISSIONING ISOMER OF ^{236}U

A. Lajtai, L. Jéki, Gy. Kluge, I. Vinnay, F. Engard
Yu.P. Gangrsky,* B.N. Markov*

The aim of the reported experiments is the observation of single lines corresponding to prefission gamma-decay in the energy spectrum from 150 keV to 1.5 MeV of the gamma rays from ^{235}U/$n_{th}\gamma f$/ reaction. Using a fast-slow coincidence set-up the gamma rays are detected with a 10 cm^3 Ge/Li/ detector, the fission fragments are counted with a gas scintillation counter. The energy distribution of the prefission gamma rays is evaluated from counts taken simultaneously in four 100 nsec wide intervals before the fission event.

In this way both the cross section for isomeric fission and the lifetime of the fissioning isomeric state can be evaluated.

It seems from the analysis of the measured gamma spectra that 5 peaks can be attributed to prefission gamma transitions. They appear at the 450, 475, 687, 808 and 882 keV. The ratio of the rate of isomeric fission events with prefission γ rays to the rate for prompt fission events $\frac{\sigma_i}{\sigma_f}$ is lower than 10^{-5} for each of these lines. The time behavior of the γ peak intensities was found to be consistent with a U^{236m} lifetime of about 100 nsec. It can be assumed that these peaks correspond to radiation transitions in the second potential well.

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ENERGY SPECTRA OF NEUTRONS FROM /n,n'/ AND /n,2n/ REACTIONS

Gy. Kluge and L. Jéki

Energy spectra of neutrons from /n,n'/ and /n,2n/ reactions induced by 14 MeV neutrons have been calculated in terms of the original Weisskopf model for a number of target nuclei. The results of the calculations which avoid the usual approximations show very good agreement with the experimental data on Na, Mg, S, K, Ca, Ti, In, Sb, I, Cs, Ce, Ta, Hg, Cr, Mn, Zn, Sr, Pb and Bi nuclei.

Niobium and molybdenum are key structural materials in proposed designs for a D-T fusion reactor blanket, but implementation of such plans is hindered considerably by the lack of accurate cross-section values and energy distributions of neutrons in the /n,n'/ and /n,2n/ reactions of these elements. These data have been obtained by recently advanced calculation methods.

MEASUREMENT OF PERTURBED ANGULAR DISTRIBUTION OF GAMMA-RAYS FROM THE SPONTANEOUS FISSION OF ^{252}Cf

A. Lajtai, L. Jéki, Gy. Kluge, I. Vinnay, F. Engard
P.P. Dyachenko,* B.D. Kuzminov*

The angular and energy distribution of the gamma-rays emitted from fission fragments on the spontaneous fission of ^{252}Cf were measured using platinum or iron source backing and NaI/Tl/ or Ge/Li/ detectors. The average anisotropy of the gamma rays relative to the direction of fragment flight, expressed as $A = \frac{I/180^{o}/ - I/90^{o}/}{I/90^{o}}$ is $11 \pm 1\%$ in the gamma energy interval from 120 keV - 1.5 MeV, and 18-22% at energies from 350 to 850 keV if platinum backing and NaI/Tl/ detector are used. For iron backing the anisotropy value decreases under the same conditions to $5.2 \pm 0.1\%$ at energies from 120 keV to 1.5 MeV and to $5.1 \pm 0.2\%$ if a magnetic field is applied in the direction normal to the plane of fission in which the fragments and gamma rays are being counted.

Assuming a set of most plausible values for the lifetime of fission gamma-rays and for the internal magnetic field at the iron site involved, average g-factor for the fission fragments were evaluated from the measured attenuation.

The measurements with Ge/Li/ detector show anisotropies which can be determined for about 30 gamma peaks and also the g-factors for specific gamma transitions seem to be evaluable. This work is still in progress.

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D/n,np/n REACTION

T.Czibók, J.Kecskeméti

Measurements were continued on the differential cross section of the D/n,np/n reacion. Determinations were made of the relative efficiency of the neutron detector in the range E_n = 1.9 - 13.5 MeV and the dependence on proton energy of the output signal from the Ne-231 liquid scintillator, and experiments to measure the differential cross section of the reaction $^{12}C/n,n'3\alpha/$, which appears as background in the above reaction, were completed. The data collected so far on the D/n,np/n reaction indicate that the contributions of n-n and n-p interactions to the cross section are readily resolvable. Work is now in progress to improve the statistics of the measurements.

/n, gamma/ REACTIONS

B.Kardon, I.B.A.Manuaba

In neutron-gamma reactions, the simplest kind of nuclear reaction, the nucleus picks up approximately 8 MeV of energy during its excitation, and this energy is lost mainly by a process of gamma-ray emission with excitation of the nuclear levels. A study of the process of radiative capture is thus able to provide important information on the characteristics of the nuclear levels.

Experiments to determine the spin of the 2560 keV level of ^{132}Xe by /gamma-gamma/ angular correlation measurements yielded the value 3^-.

A collaborative project was set up with the Kurchatov Institute of Moscow to investigate the mechanism of slow neutron capture in the reactions ^{155}Gd/n,γ/^{156}Gd, ^{163}Dy/n,γ/^{164}Dy and ^{177}Hf/n,γ/^{178}Hf. Partial radiative widths for these ractions were determined from the gamma spectra measured at the neutron resonances. The correlation observed between the reduced neutron widths and radiative widths provides some insight into the effect of nuclear structure in the neutron capture mechanism.

ISOBAR ANALOGUE STATES IN THE $1f_{7/2}$ - $2p_{3/2}$ SHELL

I.Fodor, I.Szentpétery, J.Szücs

The collation of data gained from studies of the gamma spectra of isobar analogue states excited in /p,γ/ reactions with information from transfer reactions yielded a number of important results. It could be deduced that in the examined region of mass number:

1/ the principal mode of gamma decay of isobar analogue states is by electromagnetic radiation of the M1 type, and

2/ the intensest transition in the gamma spectrum corresponds to an analogues-antianalogue $\Delta T = 1$, M1 transition.

3/ Despite this, in the case of the $p_{3/2}$ analogue resonances that were studied, the strength of $\Delta T = 1$, M1 transitions in the $1f_{7/2}$ shell of ^{46}Sc, ^{49}V, ^{51}V and ^{55}Co nuclei falls to the order of 10^{-2} - 10^{-3} Weisskopf units.

4/ The explanation for this phenomenon lies in the breaking up of the single-particle strength, under the influence of core excitations, into several levels both for the parent and for the antianalogue state.

5/ Most of the analogue resonances examined possess fine structure in the /p,γ/ reaction too.

6/ With the $g_{9/2}$ analogue resonances observed in ^{59}Cu, ^{61}Cu, ^{63}Cu and ^{65}Ga nuclei, in contrast to the above, the analogue-antianalogue transition strengths drop to the order of one Weisskopf unit. Similar cases are encountered with the $\Delta T = 1$, M1 transitions of $f_{7/2}$ and $p_{3/2}$ analogue resonances in the 2s - 1d shell. In these instances, the parity of the final

states of the gamma decay is opposite to that
of other excited configurations lying close by,
which is a further obstacle to strong fragmenta-
tion of the single-particle strengths.

g-FACTORS AND HYPERFINE INTERACTIONS

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Earlier measurements of the perturbed angular distribution in FeRh alloys were supplemented by experimental checks on the "beam bending", and allowances were made in the evaluation for the branching ratios. The inclusion of this correction significantly alters the agreement of the preliminary results with measurements by other workers, all of whom neglect it. The g-factors obtained after correction are g(258) = 0.28(16) and g(360) = 0.54(3). That the experimental data cannot be interpreted in the frame of the prevailing, highly simplified model calculations draws attention to the importance of accounting exactly for the branching ratios.

Mössbauer technique was employed to measure the size of the hyperfine magnetic field at gold atoms in the alloy $Fe_{50}Au_{50}$. It was deduced from the measurements that the alloy is 75% magnetic, with this part containing the field strength measured in dilute alloys, while 25% is nonmagnetic. No hyperfine field was detectable by perturbed angular correlation, the reason for which, it was surmised, might be local heating caused by recoil during Coulomb excitation and the subsequent cooling and recrystallisation.

MULTIWIRE PROPORTIONAL COUNTER

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The group is working on the development and study of multiwire proportional counters with detector surfaces of various sizes. A counter of 300 x 400 mm^2 detector surface, with 200 wires along the X-coordinate and 150 along the Y-coordinate, was constructed. The planes of the signal wires, which are made of 20 μ diam. gold-plated tungsten filaments spaced 2 mm apart, are separated from the high-tension wire planes by a gap of 8 mm. The windows consist of 70 μ thick Mylar foil. The operating parameters of this counter were examined for several gas mixtures /argon, CO_2, propane-butane/, using the electron and gamma radiations of ^{90}Sr and ^{55}Fe. The tension required by the instrument for each particular gas mixture is adjustable to any desired value in the range 3600-5400 V, and signals of 40-80 mV can be produced.

The counter proved stable and gave reproducible results under constant conditions.