1255

International Atomic Energy Agency

INDC(HUN)-020/G

INDC

INTERNATIONAL NUCLEAR DATA COMMITTEE

Progress Report

from Hungary to the IAEA

Submitted by

G. Kluge
for the Neutron Laboratory of Roland Eoetvoes University
and the Institute of Isotopes of Hungarian Academy of Sciences

and

J. Csikai
for the Institute of Nuclear Research of the Hungarian
Academy of Sciences "ATOMKI"

March 1983

IAEA NUCLEAR DATA SECTION, WAGRAMERSTRASSE 5, A-1400 VIENNA

Reproduced by the IAEA in Austria
March 1983
83-02022

INDC(HUN)-020/G

Progress Report

from Hungary to the IAEA

Submitted by

G. Kluge
for the Neutron Laboratory of Roland Eoetvoes University
and the Institute of Isotopes of Hungarian Academy of Sciences

and

J. Csikai
for the Institute of Nuclear Research of the Hungarian
Academy of Sciences "ATOMKI"

March 1983

PROGRESS REPORT

of the Institute of Isotopes of Hungarian Academy of Sciences

1. (n,n' gamma) Study of ^{138}Ba +

I. Diószegi and Á. Veres

Singles gamma-spectra and angular distribution of gamma-raye from $^{138}Ba(n,n'\gamma)$ reaction induced by reactor fast neutrons were measured using Ge/Li/ detectors.

In the proposed level scahme several new unique spin values were introduced (in comparison with [1]): 2415.2 keV 5^+, 2851.5 keV 4^+, 2991.0 keV 3^+ and 3049.8 keV 2^+.

Although the low lying 0^+ states are generaly well excited in the $(n,n'\gamma)$ reaction, the second excited 0^+ state, predicted by the shell model [2] was not observed.

REFENCES

[1] C.M. Lederer and V.S. Shirley, Table of Isotopes 7th Ed. (Wiley New York, 1978)

[2] B.H. Wildenthal, Phys. Lett. 29B (1969) 274

+ To be published in ATOMKI Közlemények

2/ Investigation of the Transitional Nuclei ^{98}Mo and ^{100}Mo by /n,n'γ/ Reaction Spectroscopy

G. Molnár, B. Fazekas, I. Diószegi and Á. Veres
Institute of Isotopes, H-1525 Budapest

The transitional nuclei ^{98}Mo and ^{100}Mo were investigated in the /n,n'γ/ reaction induced by reactor fast neutrons at the 5 MW light water research reactor in Budapest. Nearly all the known states of both nuclei up to 2.8 MeV energy were observed via their gamma decay; moreover, even some new levels such as the 2286.5 and 2369.6 keV levels in ^{100}Mo and the 2418.0 and 2619.8 keV levels in ^{98}Mo were introduced. From the analysis of the gamma-ray angular distributions several new level spin and multipole mixing ratio values were determined.
The results were compared with a recent proton-neutron interacting boson model calculation which took into account the mixing between spherical and deformed configurations and was able to give a qualitative description throughout the transitional region, including the drastic lowering of the first excited 0^+ state [1].

Preliminary results can be found in ref. [2] while full publication of the ^{98}Mo /together with beta-decay data from the LLL, Livermore/ and ^{100}Mo results will be given in refs. [3] and [4], respectively.

[1] M. Sambataro and G. Molnár, Nucl. Phys. A376/1982/201
[2] G. Molnár, I. Diószegi, B. Fazekas, Á. Veres and M. Sambataro, in: Neutron-Capture Gamma-Ray Spectroscopy and Related Topics, The Institute of Physics, Bristol/1982/
[3] R.A. Meyer, J. Lin, G. Molnár, B. Fazekas, Á. Veres and M. Sambataro, to be published.
[4] G. Molnár, I. Diószegi, Á. Veres and M. Sambataro, Nucl. Phys. A, to be published.

Progress Report

of the Neutron Laboratory of the Department of Atomic Physics, Roland Eötvös University
H-1088 Budapest, Puskin utca 5-7.

Staff: F. Deák, S. Gueth, Á. Kiss, V. Kovács, Cs. Pongrácz and Cs. Sükösd

1. Excitation Function Measurements of the ^{56}Fe (n,p), ^{58}Ni (n,p), ^{58}Ni (n,2n), ^{65}Cu (n,p) and ^{65}Cu (n,2n) Reactions in the Neutron Energy Range of 13,5-14,5 MeV

The excitation functions of the (n,p) and (n,2n) reactions have been determined in the neutron energy range of $13,5 \leq E_n \leq 14,7$ MeV for ^{56}Fe only for (n,p) / ^{58}Ni and ^{65}Cu nuclei. The results were successfully compared with Hauser-Feshbach calculations which had not contained any free parameters. The analysis did not reveal any direct appearance of shell effects. Evidence has been found that the gamma deexitation mode might successfully compete with particle emission in cases where only few levels of the finite nucleus could be populated after the emission of the last particle.

E_n (MeV)	Cross section (mb) $^{56}Fe(n,p)$	$^{58}Ni(n,p)$	$^{58}Ni(n,2n)$	$^{65}Cu(n,p)$	$^{65}Cu(n,2n)$
13,55±0,12	107,0±9,5	411±29	14,9±1,1	27,9±3,4	841±54
13,77±0,12	100,4±8,6	386±35	15,9±1,2	26,2±2,4	843±54
14,08±0,11	99,0±7,7	352±33	20,8±1,8	25,3±3,2	875±59
14,40±0,13	101,6±9,0	340±31	270,0±2,1	24,6±3,1	808±52
14,62±0,14	96,6±8,2	318±26	30,1±2,4	24,1±2,6	930±62
14,71±0,14	91,3±7,3	295±23	31,2±2,3	23,0±2,2	954±58

2. Energy dependence of the efficiency of organic scintillation detectors for fast neutrons.

A general purpose Monte Carlo computer code has been developed for the determination of the efficiency of organic scintillation detectors for fast neutrons. The calculated results were compared by experimental efficiency data for a NE 102/A type cylindrical scintillator (diameter 5 cm, length 10 cm) in the 500 keV to 14,7 MeV neutron energy range using a ^{252}Cf fisson source and neutrons from a 14 MeV generator scattered on hydrogen. A good agreement between the experimental and calculated values was established. The dependence of the efficiency on detector threshold, shape, measures and composition of the scintillator has benn investigated for NE 102/A and NE 213 detectors.

3. Application of radioisotopes in biological researches.

The x-ray fluorescence analysis method by isotope exciter system has been developed and applied for the investigation of trace elements:

a./ The concentrations of elements Fe, Cu, Zn, Pb, Br, Rb and Mo have been determined in human blood for a number of samples.

b./ The Laboratory is involved in an enviromental research work in which the concentration of Pb is determined for biological samples.

4. Investigation of the effect of selenomethionin for radiation protection

Research work has been done for the study of the metabolitic pathway of selenomethionin using the methods of radiometry, radiochromotography, proton magnetic resonance, ESR and chemoluminesce in the case of white rats. The results show evidences that appropriate doses of selenomethionin can decrease the demages caused by free radicals which were induced either in ionizing irradiations or in other pathological processes.

PROGRESS REPORT

LABORATORY: Institute of Experimental Physics, Kossuth University, Debrecen, Hungary

NAMES OF PARTICIPANTS: J.Csikai, G.Pető and F.Márkus

RANGE OF RADIOACTIVE RECOIL ATOMS[x]

The measurement of the range of radioactive recoil atoms can be performed at relatively low neutron flux density which gives the possibility to use small neutron generators to contribute to fusion researches. The low number of published mean ranges indicates the importance of further measurements. Experimental data on these processes are not only scare but contradictory, too. To investigate the influence of material surface and structural conditions on the recoil ranges the average ranges of ^{24}Na and ^{27}Mg recoil atoms produced in 14 MeV neutron reactions have been compared in hard and soft aluminium using the activation method. According to the first experimental results the ranges in both materials are in good agreement with the earlier measurement /1/. Further investigations are in progress.

REFERENCES:

/1/ J.Csikai, P.Bornemisza, I.Hunyadi, Nucl.Instr. and Methods, 24,227 /1963/

/2/ J.Csikai and G.Pető, IAEA Training Course on Utilization of Neutron Generators, Laboratory Manual, p.185, Debrecen /1982/

x This work was supported by the State Office for Technical Development and the Hungarian Academy of Sciences

Removal cross sections for 14.8 MeV neutrons[x]

A. Boufraquech,[xx] G. Pető, J. Csikai

Institute of Experimental Physics, L. Kossuth University,

Debrecen, 4001, Pf. 105 Hungary

The attenuation of 14.8 MeV neutrons has been determined using the $^{63}Cu/n,2n/^{62}Cu$ threshold reaction for the detection of the primary neutrons. The microscopic removal cross sections determined for graphite, aluminium, steel and lead are as follows 0.73±0.04, 1.04±0.04, 1.41±0.02 and 2.63±0.12 barn, respectively. The dependence of secondary neutron spectrum on the thickness of slabs has also been investigated by threshold detectors. Nuclear temperatures estimated from the secondary neutron spectra are about 1 MeV.

[x]This work was supported in part by the Hungarian Academy of Sciences

[xx]On leave from University Mohammed V, Rabat, Morocco

Structure in the $^{27}Al/n,\alpha/^{24}Na$ cross section curve around 14 MeV

J. Csikai

Institute of Experimental Physics
Kossuth University, Debrecen, Hungary

The excitation function for the $^{27}Al/n,\alpha/^{24}Na$ reaction has been measured in 16 points of the energy range between 13.52 and 14.78 MeV. The measurements were carried out in a scattering free arrangement using 175 keV D$^+$ analysed beam. The cross sections relative to the $^{93}Nb/n,2n/^{92m}Nb$ and $^{197}Au/n,2n/^{196}Au$ reactions were measured by activation method. Fluctuations with magnitude of about 2% were observed in agreement with the literature data [1].

References:

1./ M.A. Gardner, D.G.Gardner, Nucl. Phys. A265/1976/77

LABORATORY: Institute of Experimental Physics, Kossuth University, Debrecen, Hungary and Fiziko-Energeticheskij Institut, Obninsk, USSR.

NAMES OF PARTICIPANTS: S.Daróczy, P.Raics, J.Csikai /IEP/, N.V.Kornilov, O.A.Salnikov /FEI/.

MEASUREMENT OF THE EXCITATION FUNCTION OF THE ^{232}Th/n,2n/ REACTION FROM 6.7 TO 10.5 MeV

Cross sections for the ^{232}Th/n,2n/ reaction have been measured by the activation method. Neutrons were produced by the reaction D/d,n/ on the tandem generator of the FEI /Obninsk/. Neutron flux density was determined by standard reactions: ^{238}U/n,f/, ^{56}Fe/n,p/, ^{27}Al/n,alpha/, ^{115}In/n,n'/, ^{64}Zn/n,p/. Evaluation of the measurements is in progress.

LABORATORY: Institute of Experimental Physics, Kossuth University Debrecen.

NAMES OF PARTICIPIANTS: Z.T. Bődy /IEP Kossuth Univ. Debrecen/
K. Mihály /Training Reactor, Technical Univ. Budapest/.

COMPILATION AND EVALUATION OF /n,t/ CROSS SECTION +

Values of /n,t/ cross sections were compiled and are to be evaluated for all isotopes and for energies from threshold up to 20 MeV. Till now preliminary results have been presented in two conferences for Z > 10 and energies around 14 MeV.

REFERENCES

[1] Z.T. Bődy, F. Cserpák, J.Csikai, S. Sudár, K. Mihály: Measurement and evaluation of /n,t/ cross sections. Presented in the International Conference on Nuclear Data for Science and Technology, 6-10 Sept. 1982. Antwerp / to be published in Proc.Conf./.

[2] Z.T. Bődy, K. Mihály: Compilation and evaluation of /n,t/ cross sections. Presented in the XII. International Symposium on Nuclear Physics - Heavy Ion Collisions and Nuclear Fission - 22-26 Nov. 1982. Gaussig near Dresden /to be published in a ZfK Report/.

+ Supported in parts by the International Atomic Energy Agency, Vienna.

LABORATORY: Institute of Experimental Physics,
Kossuth University, Debrecen

NAMES OF PARTICIPANTS: K.M. Dede, A. Demény, L. Vas

DIFFUSION PARAMETER MEASUREMENT BY NEUTRON PULSE METHOD

Measurement of thermal diffusion parameters in non-thermalizing media /structural metals and rocks/ will be carried out by neutron pulse method. Theoretical problems relating to the evaluation of this type of measurements will also be investigated.

LABORATORY: Institute of Experimental Physics, Kossuth University, Debrecen, Hungary.

NAMES OF PARTICIPANTS: S. OUICHAOUI /Institute de Physique Nucleaire Commissariat aux Energies Navella, Algerie/
S. Juhász, M. Várnagy, J. Csikai /IEP Kossuth Univ. Debrecen/

ANGULAR DISTRIBUTIONS OF FISSION FRAGMENTS FROM ^{235}U, ^{238}U, ^{237}Np NEAR THE /n,2nf/ THRESHOLD+

The angular distributions of the fission fragments from fast neutron induced fission on ^{235}U, ^{238}U and ^{237}Np were measured near the /n,2nf/ threshold by polycarbonate nuclear track detector. Neutrons were produced by the reaction D/T,n/ using Cockcroft-Walton generator of 200kV. The anisotropy parameters /R=W/0°//W/90°/ / and differential cross cross sections were determined for ^{235}U, ^{238}U and ^{237}Np at E_n=14.1, 14.45 and 14.8 MeV.

+Supported in part by the IAEA, Vienna.

LABORATORY: Institute of Experimental Physics, Kossuth University, Debrecen

NAMES OF PARTICIPANTS: T.Sztaricskai, G.C.Pető, L.Vasváry

DEVELOPMENT OF A TIME OF FLIGHT SPECTROMETER FOR THE MEASUREMENT OF SECONDARY NEUTRONS AND GAMMAS

A time of flight spectrometer based on the PNG-300 nonasecond pulsed neutron generator has been developed. The generator is a klystron bunched system with 2 nsec neutron pulses at a repetition rate of 2.25 Mcps. The average neutron yield is about 10^9 n/sec. The neutron detector is a NE 218 -XP 2041 based one with a time resolution of 1.5 nsec in a dynamic range of 1:50. The gamma branch of the spectrometer is under development. The spectrometer has been used during the Training Course on Utilization of Neutron Generators in 1982, in Debrecen. Some preliminary results have been published in 1982.

REFERENCES:

1./ L.Vasváry, T.Sztaricskai, G.Pető and B.V.Devkin: INDC/GDR/-21/6/Spec. 88, /1982/

2./ B.V.Devkin, A.A.Lychagin, V.S.Nesterenko, N.N.Shadin, A.I. Gonchar, A.I.Suchin, T.Sztaricskai, G.Pető: INDC/GDR/-21/6/Spec.71. /1982/

3./ T.Sztaricskai, L.Vasváry, G.Pető: IAEA Training Course on Utilization of Neutron Generators, Laboratory Manual, 98 /1982/

4./ L.Vasváry, T.Sztaricskai, G.Pető: IAEA Training Course on Utilization of Neutron Generators, Laboratory Manual, 192 /1982/.

PROGRESS REPORT

Institute of Nuclear Research of the
Hungarian Academy of Sciences (ATOMKI)
Debrecen, Hungary

Building of Facilities in ATOMKI:
PROGRESS REPORT OF THE CYCLOTRON
LABORATORY PROJECT

The realization of the cyclotron laboratory programme of the Institute is going on for many years. The final design of the building and of the equipments of a radiochemical laboratory was finished by June 1982 and the construction work started in October 1982.
The laboratory includes an accelerator department, a measuring center, a radiochemical laboratory, a department for medical applications and studies.
The total ground place of the building is about 5600 m^2. The programme is founded by the Hungarian Academy of Sciences and it is supported partly by the International Atomic Energy Agency in Vienna, the National Atomic Energy Comission and the National Committee for Technical Development.
The accelerator department will be equipped by a small sized, MGC type compact isochronous cyclotron. The cyclotron and its beam transport system are being manufactured by D. Efremov Scientific Research Institute of Electrophysical Apparatus in Leningrad. The cyclotron is designed to accelerate protons and α-particles up to 20 MeV, deuterons up to 10 MeV and He-3 particles up to 26 MeV.
The configuration of the measuring system is based on a TPA 11/440 type computer with 512 kbyte direct memory capacity, its data acquisition system uses CAMAC modules organized by micro-computers into subsystems with local intelligence. The developments on hardware and software on the system are also in progress.

Building of facilities in ATOMKI:

ISOTOPE PRODUCTION BY USING MGC CYCLOTRON

Small compact cyclotrons are very convenient for isotope production of medical interest. Isotopes to be produced first in our laboratory chosen and the radiochemical separation methods are planned to be investigated. The target chamber for the irradiation is under construction.

Building of facilities in ATOMKI:

NUCLEAR ANALYTICAL METHODS FOR INDUSTRY BY USING MGC CYCLOTRON

The good sensitivity of prompt and delayed nuclear analytical methods makes it possible to measure the trace elements in materials of high purity. A chamber for prompt analytical methods has been constructed and it is checked on the beam of the ATOMKI Van de Graaff generator. By using delayed CPAA method, the high-purity Al matrices, are investigated. These experiments are performed with the MGC cyclotron of Åbo Akademi (Turku, Finland).

LEVELS OF ^{14}N NEAR 13.7 MeV EXCITATION FROM THE ANALYSIS OF DOPPLER BROADENED γ-LINE SHAPES IN THE $^{10}B(\alpha,p\gamma)^{13}C$ REACTION

J. Cseh, Á.Z. Kiss, E. Koltay, B. Nyakó and E. Pintye

Angular distributions of the p_1 proton group from the reaction $^{10}B(\alpha,p\ )^{13}C$ in the alpha energy range 2.56-3.06 MeV have been deduced from the Doppler broadened line shape [1] of the 3.09 MeV γ-ray. Extensive R-matrix analysis of the 22 angular distributions resulted in 2^-, 3^+ and 1^+ spin-parity values for the 13.69, 13.75 and 13.77 MeV excited levels, respectively.

[1] Á. Kiss, E. Koltay, Gy. Szabó and L. Végh, Nuclear Physics A282 (1977) 44.

INVESTIGATION OF EXCITED STATES OF ^{23}Na IN (α,α), (α,p) AND (α,γ) REACTIONS

J. Cseh, E. Koltay, Z. Máté, E. Somorjai and L. Zolnai

Resonance levels of ^{23}Na were examined in $^{19}F(\alpha,\alpha)^{19}F$, $^{19}F(\alpha,p)^{22}Ne$ and $^{19}F(\alpha,\gamma)^{23}Na$ reactions for excitation energy region E_x = 11.5 - 13.5 MeV. The differential excitation functions of the reactions (α,α) and (α,p) were measured at five angles with surface-barrier detectors. Outside the scattering chamber an NaI crystal was used to measure the γ-ray excitation function simultaneously. For some resonance energies below the neutron threshold γ-ray spectra and angular distribution were measured with Ge(Li) detector and NaI crystal, respectively. By using R-matrix analysis resonance parameters are being deduced from the experimental data. Preliminary results have been published in [1].

[1] L. Zolnai, E. Koltay, Z. Máté, J. Cseh and E. Somorjai, Izv. Akad. Nauk SSSR, ser. fiz., 44(1980) 2281.

EXCITED STATES OF THE ^{70}Ga NUCLEUS

T. Fényes, J. Gulyás, T. Kibédi, A. Krasznahorkay,
J. Timár, S. Brant[x] and V. Paar[x]

The γ-spectrum of the ^{70}Zn(p,nγ)^{70}Ga reaction was measured with Ge(Li) spectrometer at 3; 3.5 and 4 MeV bombarding proton energies. 57 γ-rays were assigned to ^{70}Ga and the energies and relative intensities of the γ-rays were determined. The electron spectrum of the reaction was measured with a high transmission, superconducting magnet transporter Si(Li) spectrometer and internal conversion coefficients were determined for six ^{70}Ga transitions. The level scheme of ^{70}Ga, γ-branching ratios, multipolarity of transitions, level spins and parities were deduced. The experimentally observed energy splitting of several proton-neutron multiplets was explained on the basis of the parabolic rule derived from the cluster-vibrational model.

[x] Pridoslovno-matematički fakultet, University of Zagreb, Zagreb, Yugoslavia

EXCITED STATES OF ^{82}Br FROM (p,nγ) REACTION

T. Fényes, Z. Gácsi, J. Gulyás, T. Kibédi,
A. Krasznahorkay, S. László, D. Novák, S. Brant*
and V. Paar*

γ-ray and internal conversion electron spectra of the ^{82}Se(p,nγ)^{82}Br reaction were measured with Ge(Li) and superconducting magnet transporter Si(Li) spectrometers respectively, at 3.5 and 4 MeV-bombarding proton energies. The level scheme of ^{82}Br, multipolarities of 11 transitions, γ-branching ratios, level spin and parity values have been deduced. The energies of ^{82}Br levels were calculated on the basis of the parabolic rule derived from the cluster-vibration model. This calculation provided a simple classification of several multiplet states in ^{82}Br.

* Prirodoslovno-matematički fakultet, University of Zagreb, Zagreb, Yugoslavia

EXPLANATION OF ANOMALIES IN INTERNAL CONVERSION BY USING GENERALISED EXCHANGE CORRECTION

E. Vatai

Using the analogy with electron capture it is shown that the instantaneous state produced by dinamical correlations is frozen in following the internal conversion. Exchange correction in this approach is calculated by using the analytical Roothan-Hartree-Fock wave functions and first order perturbation theory with exchange potential included. The results explain the anomalies of K/L internal conversion ratios at low atomic numbers and those of the L-subshell ratios at medium and high atomic numbers. As this correction is independent from the nuclear structure, the reexamination of the conclusions drawn from L-subshell ratios has been desirable.

A STUDY OF THE ANGULAR DISTRIBUTION OF THE ELECTRONS IN THE PEAK NEAR $v_e = v_i$ IN THE ELECTRON SPECTRA FROM He^+, H_2^+ - Ar COLLISIONS

Á. Kövér, D. Varga, Gy. Szabó, D. Berényi, I. Kádár, S. Ricz, J. Végh and G. Hock

The peak near $v_e = v_i$ in the electron spectra from He^+ (0.8 MeV/amu), H_2^+ (0.8 MeV/amu; 1.995 MeV/amu) - Ar collisions was studied at thirteen angles from 0° to 180°. The experimental values for the position and half width (FWHM) of these peaks were compared with theoretical calculations. An example is given for the comparison of the actual shapes of the peak for different projectiles with the corresponding theoretical curves. The angular distribution of the electrons in the electron loss peak (i.e. the single differential cross section) was plotted together with the theoretical ones.

ANGULAR DISTRIBUTION OF ELECTRONS AND X-RAYS FROM HIGH ENERGY ION-ATOM COLLISIONS

D. Berényi

Angular dependence of the broad peak near $v_e = v_i$ and Auger electrons in the spectrum of electrons emitted in high energy ion-atom collisions are investigated for different projectiles (H^+, H_2^+, He^+, Ne^{3+}, Ne^{10+}, with impact energies from 0.8 to 112 MeV) and targets (Ar, Ne), respectively. The angular distribution of L_l X rays from H^+, He^+, C^+, N^+ and Ne impact (ion energies from 0.2 to 18.2 MeV, respectively) on Au was studied and the alignment parameter determined.