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*Mainly review
of nuclear
- cooperation with
Obruski.*

PROGRESS REPORT ON NEUTRON PHYSICS EXPERIMENTS

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Progress Report on Neutron Physics Experiments

March 1970

Hungarian Academy of Sciences

Central Research Institute for Physics

Budapest, Hungary

STUDY OF GAMMA-RAY SPECTRA FROM THE $^{163}\text{Dy}(n, \gamma)^{164}\text{Dy}$ REACTION
ON RESONANCE NEUTRON CAPTURE

L.S. Danelyan, B.V. Efimov, S.K. Satnikov

I.V. Kurchatov Atomic Energy Institute, USSR

B. Kardon, D. Kiss, Z. Seres, L. Szabó

Central Research Institute for Physics, Budapest

Published in Neutron Capture Gamma-Ray Spectroscopy, IAEA,
Vienna, 1969

The partial radiation transitions to the rotational band levels from the $^{163}\text{Dy}(n, \gamma)$ resonance energies up to 150 eV were measured with the use of an anticoincidence scintillation gamma spectrometer. The spins of the neutron levels and the average values of the partial transitions were determined.

MEASUREMENT OF ISOMERIC CROSS SECTION RATIOS ON Xe ISOTOPES

B. Kardon, Z. Zámori, Z. Seres, P. Gróz

Central Research Institute for Physics, Budapest

Published in Jadernaja Fizika

The relative probabilities of the occurrence of metastable and ground states for the isomeric pairs $Xe^{125,125m}$, $Xe^{127,127m}$, $Xe^{133,133m}$ produced by (n, γ) reactions were studied and the isomeric cross section ratios were found to be 0,031, 0,062, 0,063 and 0,068, respectively.

THERMAL NEUTRON CAPTURE GAMMA-RAYS FROM SULPHUR

S. Egri, B. Kardon, L. Pócs, Z. Seres, Z. Zámori

Central Research Institute for Physics, Budapest

Published in Izv.An. USSR

Energies and intensities of the gamma-rays emitted on thermal neutron capture in sulphur were studied using coaxial type Ge(Li) detector. For the energy calibration the $^{59}\text{Co}(n, \gamma)^{60}\text{Co}$ reaction was used.

MEASUREMENT OF MEAN MULTIPLICITY IN (n, γ) REACTIONS INDUCED
BY THERMAL NEUTRONS

J. Kecskeméti, D. Kiss

Central Research Institute for Physics

Published in Jadernaja Fizika

Mean multiplicity, i.e. mean number of the γ quanta, is measured on 27 elements after thermal neutron capture. The experimental results are compared with those obtained by other authors.

OSCILLATIONS IN THE ENERGY DEPENDENCE OF THE n-p SCATTERING
CROSS SECTION

Gy. Hrehuss, T. Czibók

Central Research Institute for Physics, Budapest

Published in Physics Letters

A small but statistically significant periodical fluctuation was found in the energy dependence of the cross section for neutron-proton scattering at low neutron energies.

MEASUREMENT OF THE DIFFERENTIAL CROSS SECTION FOR n-p
SCATTERING BELOW 3 MeV

T. Czibók, Gy. Hrehuss, I. Kovács, L. Nagy, I. Vinnay

Central Research Institute for Physics, Budapest

Published in Physics Letters

The cross section ratio $\sigma(0^\circ)/\sigma(30^\circ)$ measured at neutron energies $E_n = 2,5, 2,7$ and $2,8$ MeV was found to be significantly larger than unity, thus inconsistent with the generally assumed isotropy at these energies.

ELASTIC AND INELASTIC SCATTERING OF 14 MeV NEUTRONS BY ^{32}S
AND ^{56}Fe

A. Ádám, F. Deák, J. Kecskeméti, P. Koncz, G. Pálla

Central Research Institute for Physics, Budapest

The differential cross sections for the elastic and inelastic neutron scattering of ^{32}S and ^{56}Fe are investigated using time-of-flight technique. The excitation of the collective 2^+ states (2,24 MeV in ^{32}S and 0,84 MeV in ^{56}Fe) is studied.

The elastic and inelastic data are analysed in terms of Tamura's coupled channel formalism. The values of the dynamic deformation parameter β_2 are estimated.

INVESTIGATION OF SHORT-LIVED ISOMERIC LEVELS IN THE REGION
OF 100 nsec - 1 μ sec EXCITED BY 14,7 MeV NEUTRONS

A. Ádám, Á. Kiss, E. Mayr

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The excitation cross sections of isomeric levels with half-lives from 100 nsec to 1 μ sec in nuclei bombarded with 14,7 MeV neutrons are measured by combined recoil particle and pulsed beam method. The following levels are covered by the investigation: 1131 keV in ^{18}F , 583 keV in ^{22}Na , 1614 keV in ^{40}K , 514 keV in ^{85}Rb , 2795 keV in ^{92}Mo . The half-lives of the levels are also evaluated from the measured data. The cross section data are compared with the predictions of the statistical theory.

ON THE DETECTION OF SPONTANEOUSLY FISSIONING ISOMER STATES

L. Nagy, T. Nagy, I. Vinnay

Central Research Institute for Physics, Budapest

Published in Report of the Central Research Institute for Physics

An experimental arrangement was developed for the detection of spontaneously fissioning isomer states in ^{235}U and ^{238}U . A pulsed 14 MeV neutron source combined with time analyser method is used. An upper limit for the production cross section of such states with half-lives from 100 nsec to 10 msec was obtained by a preliminary measurement.

ANGULAR ANISOTROPY AND THE STRUCTURE OF FISSION BARRIER

Kh. D. Androsenko et al.

Institute of Physics and Power Engineering, USSR

I. Kovács

Central Research Institute for Physics, Budapest

Published in Proc. Sec. IAEA Symp. on Phys. and Chem. of Fission,
Vienna

The angular distribution of fragments from the neutron fission of ^{232}Th , ^{238}U , ^{237}Np , ^{238}Pu , ^{240}Pu , ^{242}Pu and ^{241}Am nuclei was measured with particular regard to excitation energies near the threshold of fission. The experimental data can be qualitatively explained in terms of the double-humped barrier model. The problem of the quasi stationary states in the second valley, the structure of the fission barriers, even-odd differences in the fission probability are considered.

These measurements were performed in the Institute of Physics and Power Engineering, Obninsk, USSR within the scope of a cooperation programme.

ANGULAR ANISOTROPY OF FRAGMENTS FROM THE TERNARY FISSION OF
 ^{235}U AND ^{238}U

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The angular anisotropy of fragments was compared for the ternary and the binary fissions of ^{235}U and ^{238}U induced by 14 MeV neutrons. The measurement on the latter was performed also for 2,5 MeV bombarding energy. Using semiconductor detectors the ternary to binary ratios were studied at both 0° and 90° to the neutron beam. The angular anisotropy of the fragments was found to be about the same for the two types of fission of ^{235}U bombarded with 2,5 MeV neutrons while the anisotropy of the ternary fission fragments was found to be significantly greater than that of the binary fission fragments in the case of 14 MeV neutron energy. This observation suggests that at a bombarding energy of 14 MeV the ternary fission occurs with higher probability from the states having lower values of K.

ON THE AVERAGE CHARACTERISTICS OF PROMPT NEUTRON EMISSION FROM
FISSION

Gy. Kluge, A. Lajtai

Central Research Institute for Physics, Budapest

Published in Physics Letters

The predictions obtained by using more accurate expressions for the average neutron energy in terms of a statistical model described earlier, are compared with the experimental data on the thermal neutron fission of ^{233}U , ^{235}U and ^{239}Pu and on the spontaneous fission of ^{252}Cf .

ANGULAR DISTRIBUTION OF GAMMA RAYS FROM THE FISSION OF ^{235}U
INDUCED BY 14 MeV NEUTRONS

L. Jéki, Gy. Kluge, A. Lajtai

Central Research Institute for Physics, Budapest

Published in Proc. of Second Symp. on Physics and Chemistry of
Fission, Vienna

Experiments are reported which were performed to study the angular distribution of the gamma radiation following fast-neutron-induced nuclear fission. The investigations were, in particular, focussed on the influence which the angular momentum imparted to the compound nucleus by the fast neutrons has on the angular distribution of the gamma-rays.

The fission fragments are detected by a gas-scintillation counter filled with a mixture of Ar and Ni gases, the gamma-rays by 5 cm x 5 cm NaI(Tl) crystal with an energy threshold of 120 keV. The intensity of the gamma-rays is measured at 90° and 174° to the direction of fragment motion.

The geometry is designed to keep the direction of the outflying fission fragments nearly the same as that of the incident fast neutrons. In this way the angular momenta of the fast neutrons are normal to the flight path of the fragments.

The measured gamma intensities are extrapolated to 180° on a computer using Strutinski's formula $n(\vartheta) \sim 1 + B \sin \vartheta$. On transformation of the measured data from the laboratory system to the system of fragments the anisotropy is found to be $A = I(180^\circ)/I(90^\circ) = 1,33 \pm 0,05$. The main angular momentum of fission fragments is calculated from the anisotropy as $15 \hbar$ units. As compared with the thermal-neutron-induced fission the present results indicate an additional contribution from the angular momentum of the compound nucleus to the anisotropy of the angular distribution attributed to the effect of the angular momentum imparted to the fission fragments by non-collinear scission.

ANGULAR DISTRIBUTION OF GAMMA RAYS FROM THE FISSION OF ^{232}Th ,
 ^{233}U , ^{235}U and ^{238}U INDUCED BY 14 MeV NEUTRONS

L. Jéki, Gy. Kluge, A. Lajtai

Central Research Institute for Physics, Budapest

Published in Reports of the Central Research Institute for
Physics

The intensity of the gamma radiation following the 14 MeV neutron induced fission of ^{232}Th , ^{233}U , ^{235}U and ^{238}U has been measured at angles 90° and 180° relative to the flight path of fission fragments. The uncertainty in the flight direction of the fission fragments was about $\pm 40^\circ$. The anisotropy was evaluated from the measured data as $A = I(180^\circ)/I(90^\circ)$ $1,00 \pm 0,07$ for ^{232}Th , $1,09 \pm 0,05$ for ^{233}U , $1,17 \pm 0,04$ for ^{235}U and $1,03 \pm 0,04$ for ^{238}U .

THE KINETIC ENERGY OF FRAGMENTS IN THE FISSION OF ^{235}U BY
NEUTRONS WITH ENERGIES FROM 0 TO 0,6 MeV

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Published in Physics Letters

The data on the kinetic energy and mass fragment distributions in the 0-0,6 MeV energy neutron induced fission of ^{235}U are analysed. It is shown that in terms of the energy balance no variation of charge distribution between individual fragments occurs in this range of bombarding neutron energies.

paper submitted to Helsinki

^{235}U FISSION NEUTRON SPECTRUM FROM 0,01 TO 1,0 MeV

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Submitted to the Second Conference on Nuclear Data for Reactors,
Helsinki

The results of the measurement by time-of-flight technique on the thermal neutron induced fission neutron spectrum of ^{235}U from 0,01 to 1,0 MeV are reported.

A ^6Li loaded glass scintillator and a gas scintillation detector (80 % Ar + 20 % Ni) are used for the detection of fission neutrons and fragments, respectively.

The results are discussed in terms of the evaporation model.

APPLICATION OF NUCLEAR DATA FOR REACTOR CALCULATION

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A reactor calculation model has been developed [1] in the Reactor Physics Department of the Central Research Institute for Physics. The successful operation of this model requires up-to-date nuclear data. The evaluated nuclear data files which are available at IAEA will serve for this purpose. Methods for transforming these data into micro-group constant sets and the related computer programs are under development in our laboratory.

- [1] Z. Szatmáry, J. Valkó, P. Vértes: International Conference on Research Reactors, Warsaw, 1968.