Nuclear Data Measuring Facilities and Acitivities in the Institute of Nuclear Research in Świerk (Warsaw) and the Institute of Nuclear Physics in Cracov

Poland

Preliminary information submitted to the International Nuclear Data Scientific Working Group.

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Swiork by Otwock -

Institute of Nuclear Research

Director of the Institute: Dr. P. Nowacki

Department I A

Head of Department: Dr. W. Kusch

Nuclear Spectroscopy Group

Experimental facilities

a) $\pi\sqrt{2}$-beta-ray spectrometer, iron cored, 220 mm mean radius

b) long-lens beta-ray spectrometer for beta-gamma coincidence work

c) six-gap orange-type spectrometer with high luminosity (under construction)

d) 2 ordinary fast-slow coincidence circuits

e) fast-slow coincidence circuit with time-to-pulse height converter for nanosecond life-time measurements

f) A loop inside a reactor channel for continous flow experiments with gazeous sources. Short-lived reactor-produced isotopes (half-lifes down to some seconds) can be studied

g) Radiochemical laboratory specialized mainly in the ion exchange work with rare earth elements

Activities

a) Studies of short-lived reactor-produced isotopes (1,2)

b) Studies of neutron deficient isotopes in the rare-earth region (3,4,5)

c) Studies of the internal bremsstrahlung accompanying electron capture (3,6,7)

Some recent publications

(1) Measurement of the mean life-time of the first excited state of ^{23}Na
B. Ambroży, A. Fandrowicz, A. Jasiński, J. Kownacki, H. Lancman, J. Ludziejewski, Acta Phys. Pol. 20, 537 (1961)

(2) The decay scheme of ^{23}Ne
H. Lancman, A. Jasiński, J. Kownacki, J. Ludziejewski, Nucl. Phys. (in press)

(3) Experimental matrix element for the electron capture transition $^{165}Er - ^{165}Ho$

J. Zylicz, Z. Sujkowski, J. Jastrzebski, O. Woczek, S. Chojnacki, I. Yutlandov, Nuclear Phys. 42, 330 (1963)

(4) The mean number of conversion electrons per one decay of ^{166}Tm

S. Chojnacki, I. Jarosiewicz, Z. Frejbisz, J. Zylicz, Acta Phys. Pol. (in press)

(5) Contribution to the decay scheme of ^{166}Tm

Z. Frejbisz, K. Pawlak, K. Stryczniewicz, Bull. Acad. Sci. Pol. (in press)

(6) Internal bremsstrahlung accompanying the electron capture decay of medium-heavy nuclei

J. Jastrzebski, Z. Sujkowski, J. Zylicz, Proc. Conf. Role of Atomic Electrons in Nuclear Transformations, Warsaw 1963 (in press)

(7) Internal bremsstrahlung accompanying the electron capture decay of ^{197}Hg (ibid ref. (6))

Proton Linear Accelerator Group

Design and development group

Design specifications:

a) Injector system:

Cockcroft-Walton 510 keV

HF pulsed ion source (polarized proton source under construction)

Beam output in pulse 5 mA

b) RF system:

Frequency 193 M Hz, RF power up to 1000 kW

RF pulse duration 1 msec, Pulse repetition rate 15c/sec

40 drift tubes

c) Beam characteristics:

Accelerated particles: protons 10 MeV

Average beam output: probably 4 μA (300 μA in pulse) at first

d) Present status of work:

All parts are finished.

Setting to motion

First beam in the middle of 1964

Main purpose

The measurements of elastic and inelastic scattering of protons.
Polarisation experiments.
The measurements of isomeric states in milisecond region (with help of magnetic beta spectrometer)

Nuclear Reaction Group

Experimental facilities

a) 200 keV kaskade neutron generator (home made)
Accelerated particles: protons or deuterons
Maximum beam current: 300 μA
Main purpose: neutron production from DD and DT reaction
Main equipment:
Time-of-flight spectrometer working with associate particle (time resolution 2 nsec for 14 MeV neutrons, 100 nsec time range),
beam bunching system of klystron type under construction
three crystal pair spectrometer (energy resolution 4 % for 4,43 MeV gamma ray),
Micro- and mili-second time analyzer for measurements of short-lived isomeric states.
The equipment for pick-up (n,d) reaction is under construction

b) Charged particles semiconductor spectrometer: (1,2)
resolution for 6,05 MeV alpha particles - about 16 - 30 keV,
mass resolution for heavy fission fragments (peak to valley ratio) 1/400 - 1/500,
linearity better than 1 % up to 12 MeV protons,
possibility of particle identification using different barrier widths

c) Fast chopper
Maximum rotational speed : 10000 rpm
4 curved slits 0,3 x 25 mm with a base of 13,8 m
Half width of neutron pulse : 2 μsec /7500 rpm/
Sample area 0,8 x 25 mm. Energy resolution /for 10 eV/ : 1 %
Energy limit : 0,45 eV /10 000 rpm/
Main purpose: total cross-section measurements in the resonance region

d) Slow chopper
Maximum rotational speed 6000 rpm
Half width of neutron pulse: 30 μsec /6000 rpm/
Energy resolution 3,5 % /6000 rpm/. Energy limit 0,006 eV

e) Fast chopper / under construction - will be ready during the first half of 1964 /
Maximum rotational speed : 12 000 rpm
8 curved slits 0,3 x 25 mm with a base of 25 m
Half width of neutron pulse : 0,8 μsec
Sample area : 0,3 x 25 mm

Activities

a) Studies of inelastic neutron scattering on light and medium elements through the measurements of neutron spectra and de-excitation gamma-rays. The angular distribution measurements for Si and Mn are performed now.

b) Activation analysis of the (n,p), (n,2n) and (n,) reactor for 14 MeV neutrons (at first $^{41}K(n,p)^{41}A$, $^{44}Ca(n,)^{41}A$ and $^{39}K(n,2n)^{38}K$).

c) Studies of short lived isomeric states produced in irradiation with fast neutrons are prepared.

d) Investigation of fission with emission of long-range alpha particles (measurements of cross-section, energy spectrum and angular distribution of long-range alpha particles). The neutrons are obtained from the horizontal channel of 2 MW reactor in Świerk.
Measurements of cross-sections and energy distribution for competitive to fission reaction (n,) for some elements and thermal neutrons (3).

e) Determination of isomeric ratios in /n, / reaction with thermal neutrons /in the milisecond region/

f) Measurements of total cross-section for some elements in the resonance region

Some recent publications

(1) Recent Results on Silicon Semiconductor Nuclear Particle Detectors

J. Chwaszczewska, Mr. Dakowski, W. Przyborski, M. Sowiński, A. Szechter, E. Kierek-Pecolt, Z. Weydman, E. Zalewski
Inst. Nucl. Research Int. Report No. 444 (1963)

(2) Silicon Surface-Barier Detectors with Guard-Rings and Their Possible Application
J. Chwaszczewska, M. Dakowski, A. Dabrowski, M. Stopa, M. Sowinski, Inst. Nucl. Research Int. Report No. 463 (1963)

(3) On the Possibility of a $^{235}U(n, \quad)^{232}Th$ Reaction for Slow Neutrons
M. Sowiński, M. Dakowski, H. Piekarz, Phys. Letters 6, 321 (1963)

Department I *

Head of Department: Dr. Z. Wilhelmi

Experimental facilities:

a) Van-de-Graaff electrostatic accelerator (home made, high pressure type)
Accelerated particles: protons, deuterons, electrons
Maximum high voltage: 3 MV
Maximum analysed beam intensity (p or d): 20 uA
Self-stability of the high voltage: better than 1 %
Main purpose: Neutron production from the DD and DT reaction, proton experiments and electron irradiation for medical and industrial aim.

b) Cockcroft-Walton accelerator /Häfely/
Accelerated particles: protons or deuterons
Maximum high voltage: 750 kV
Maximum beam current: 200 uA
Main purpose: Neutron production from the DD or DT reaction

c) Non-iron torroidal beta-ray spectrometer
Source diameter: 15 mm. Resolution: 1 % . Transmission: 12 %
Main equipment:
Apparatus for the measurement of the longitudinal polarization of gamma rays and for beta-gamma coincidence
fast-slow circuit of the usual type
Main purpose:

1) Measurements of the relative longitudinal polarization of gamma-rays /^{32}P, ^{56}Mn, ^{64}Cu, ^{166}Ho, ^{198}Au/
2) Studies of the decay scheme of the neutron defficient isotopes in the rare earth region
3) Identification of the (n,p), (n,2n) and (n,) reaction products

d) Short lens spectrometer:
Resolution: 1,5 % up to 4,5 %. Transmission: 1 %.

e) Analyzer of the longitudinal polarization of beta-rays /Wien type/

* Located in Warsaw and collaborating closely with the Warsaw University, Institute of Experimental Physics, Chair of Physics of the Atomic Nucleus - Warsaw

Activities

a) Determination of the isomeric cross-section ratios for (n,p), (n,2n) and (n,α) reactions (1,2)

b) Measurements of the energy spectra of the (n,p) and (n,α) reaction products (3,4)

c) Measurements of the excitation curves for (n,p), (n,2n) and (n,α) reactions

Some recent publications

(1) The cross-sections of (n,p) reactions producing isomeric and ground states of indium and antimony isotopes
J. Brzosko, P. Decowski, Z. Wilhelmi, Nucl. Phys. 45, 579 (1963)

(2) Isomeric cross-section ratios for some reactions induced by neutrons in tin and tellurium isotopes
J. Brzosko, P. Decowski, K. Siwek-Diamant, Z. Wilhelmi, Nucl. Phys. (in press)

(3) Structure of the spectrum of protons from the $^{122}Te(n,p)^{122}Sb$ reaction at 14,1 MeV
J. Turkiewicz, Phys. Rev. 127, 570 (1962)

(4) Energy spectrum of alpha particles from the $^{139}La(n,\alpha)^{136}Cs$ reaction with 14,1 MeV neutrons
M. Jaskuła, W. Osakiewicz, J. Turkiewicz, Z. Wilhelmi, Nucl. Phys. (in press)

Institute of Nuclear Physics, Cracow

Director of the Institute: Dr. H. Niewodniczański

Nuclear Reaction Laboratories

Experimental Facilities:

a) 120 cm-cyclotron /USSR model U 120/
Accelerated particles: deutrons and alphas
Energy of accelerated particles: deutrons 13 MeV, alphas 26 MeV /can be varied in the limits of 10%/
Maximum extracted beams: deutrons 90 uA, alphas 50 uA.

b) 48 cm-cyclotron /home made/
Accelerated particles: protons, deutrons, alphas.
Energy of accelerated particles: protons 0,9 - 3,8 MeV, deuterons 2,8 MeV, alphas 5,0 MeV.

c) 250 keV kaskade neutron generator /under construction - will be finished in the middle of 1964/
Main purpose: production of the 14 MeV neutrons from the DT reaction

d) The broad range magnetic spectrometer for charged particles.
Range of energy: deutrons 3,0 - 13,0 MeV, protons and alphas 6,0 - 26,0 MeV, ^{3}He 8,0 - 35,0 MeV.
Energy resolution/limited by the energy spread of cyclotron/: 0,8%

e) Scattering chambers, the largest one with 160 cm diameter.

f) Arrangement for the polarization measurement of charged particles

g) Arrangement for the polarization measurement of neutrons /with the use of a high-pressure gaseous scintillator/

Nuclear Data available:

a) The angular distributions for the elastic scattering of 12,8 MeV deutrons on Be, C, Mg, O, Al, Si, S, Ca, Ti, ^{58}Ni, ^{60}Ni, Au, Bi, for 12,1 MeV deuterons on S, Ca, for 11,4 MeV deuterons on S, Al and for 9,8 MeV deuterons on Al /1, 2/.

b) The total reaction cross sections for the interaction of 12,8 MeV deuterons with C, ^{58}Ni, ^{60}Ni, Bi /3,4/.

c) The angular distributions for the inelastic scattering of 12,8 MeV deuterons on Al, for the excited levels 0,84 1,01 2,21 2,73 3,0 MeV and on Si for the excited levels 1,78 4,42 4,98 MeV /5,6/

d) The angular distributions for the elastic scattering of 24,7 MeV alpha particles on O, Mg, Al, Si, Ca, Mn, Co, Ni, Cu, Ge, Zr, Ag, In, Zn, Hf, W, Au, Bi, U/7/

e) The angular distributions of ^{3}He particles from the reaction /d, ^{3}He/ with 12,8 MeV deuterons on Al, and S /8,9/

f) The optical model parameters for elastic scattering of deuterons on some nuclei /10,4/.

Some recent publications

(1) H. Niewodniczański, J. Nurzyński, A. Strzałkowski, Journ. de Physique /in press/.

(2) L. Friendl, H. Niewodniczański, J. Nurzyński, M. Słapa, A. Strzałkowski, Acta Phys. Pol. 23, 619 /1963/

(3) A. Budzanowski, K. Grotowski, Phys. Letters 2, 280 /1962/

(4) A. Budzanowski, L. Freindl, K. Grotowski, M. Rzeszutko, M. Słapa, J. Szmider, P.E. Hodgson, Nucl. Phys. /in press/

(5) H. Niewodniczański, J. Nurzyński, J. Wilczyński, Proc. Int. Symp. on Direct Interactions, Padua 1962

(6) H. Niewodniczański, J. Nurzyński, A. Strzałkowski, J. Wilczyński, P.E. Hodgson, Nucl. Phys. /in press/

(7) A. Budzanowski, K. Grotowski, S. Micek, H. Niewodniczański, J. Gliz, A. Strzałkowski, H. Wojciechowski, Nucl. Phys. /in press/

(8) F. Pellegrini, S. Wiktor, Nucl. Phys. 40, 412 /1963/

(9) A. Budzanowski, F. Pellegrini, S. Wiktor, Nucl. Phys. /in press/

(10) M.A. Melanoff, T. Sawada, N. Cindro, Phys. Letters 2, 98 /1962/

Laboratory of Gamma Ray Spectroscopy

Experimental Facilities:

a) Scintillation gamma-ray spectrometers with NaI/Tl/ crystals.

b) Fast-slow coincidence circuits with time-to-pulse-height converters for the nanosecond range /resolving time for 511-511 keV gamma coincidence 2,5 nsec/

c) Electromagnet for field intensities up to 35 kGs.

d) A coincidence set-up for Coulomb Excitation measurements.

e) Mössbauer-apparatus for the velocity range 0 - 15 mm/sec /common with the Department of Nuclear Physics, Institute of Physics, Jagellonian University.

Activities

1. Gamma-gamma angular correlation measurements
   a) Determination of gamma transition multipolarities and spins of nuclear states /1/
   b) Determination of interaction parameters of nuclear moments with extranuclear fields /2,3/
   c) Determination of magnetic moments for short-lived excited nuclear states with the integral and differential methods /4,5/
2. Life-time determinations for excited nuclear states in the nanosecond range /6/
3. Determination of reduced transition probabilities by coulomb excitation with alpha-particles /7/ and by heavy ions /planned/
4. Determination of the nuclear moments interactions with externuclear fields from the Mössbauer-spectra /8/

Some recent publications

(1) Gamma-gamma Directional correlation in ^{146}Eu
E. Bozek, H. Niewodniczański, S. Ogaza, M. Rybicka, J. Styczeń
Acta Phys. Pol., 24, 131 /1963/

(2) The Attenuation of the Angular Correlation of ^{181}Ta 133-482 keV cascade in liquids
E. Bozek, A. Hrynkiewicz, Z. Konieczny, S. Ogaza, M. Rybicka, S. Szymczyk, Physica, 28, 705 /1962/

(3) Magnetic Interaction of the ^{155}Gd nucleus in the 87 keV excited state
E. Bozek, A. Hrynkiewicz, S. Ogaza, J. Styczeń /in press/

(4) Nuclear g-factor of the 113 keV rotational state in ^{177}Hf
E. Bozek, A. Hrynkiewicz, Z. Konieczny, M. Rybicka, S. Szymczyk,
Acta Phys. Pol., 21, 307 /1962/

(5) g-factor of the 482 keV level of ^{181}Ta measured with the differential method
E. Bozek, A. Hrynkiewicz, J. Styczeń, Phys. Letters, 1, 126 /1962/

(6) The half-life of the 57 keV first excited state in ^{143}Pr
E. Bozek, A. Hrynkiewicz, S. Ogaza, M. Rybicka, J. Styczeń
Phys. Letters, 6, 89 /1963/

(7) Coulomb excitation of bismuth with alpha-particles
A. Hrynkiewicz, S. Szymczyk, T. Walczak, G. Zapalski, F. Baldeweg,
G. Stiller, Phys. Letters, 6, 326 /1963/

(8) Zeeman splitting of the 14,4 keV gamma line of ^{57}Fe in $CoFe_2O_4$
I. Dézsi, A. Hrynkiewicz, D. Kulgawczuk, Acta Phys. Pol.,
24, 283 /1963/

Laboratory of Beta-Ray Spectroscopy

Experimental Facilities:

a) Permanent magnet beta-ray spectrograph with flat-homogenous field (maximal radius of the electron path 420 mm, resolution up to 0,05 %)

b) Non-iron torroidal beta-ray spectrometer under construction.

Activities:

a) Determination of energy of the gamma transition with accuracy of order 0,03 %.

b) Determination of transition intensities, multipolarity and spin-asignements, admixture ratios by means of relative intensities measurements for internal conversion lines in K, L, and M sub-shells, and external conversion methods

Recent publications:

(1) Permanent Magnet Beta Ray Spectrograph with Flat Homogenous Field J. Kormicki, H. Niewodniczański, Z. Stachura /to be published/

(2) Electron Conversion Spectrum of ^{153}Tb /in press/

Note:

In the Research Center at Świerk there exist in addition several neutron crystal spectrometers and slow choppers (belonging to the Institute of Nuclear Research and the Institute of Nuclear Physics). They are not listed because they are used for solid and liquid state studies only.