INDC(POL)-2

INDC-„G"

INDC-297

INDC(POL)-2/G

Not for quotation or publication
without author's permission

PROGRESS REPORT
ON NUCLEAR DATA RESEARCH IN POLAND

/May 1968 - April 1969/

Edited by
Tomasz Niewodniczański

The Government Commissioner for the Use of Nuclear Energy
Warsaw, Poland
1969

Zam. Nr. 307/69 RC/344/59 nakład 80 egz.
Oddano do druku 25.06.69 r.

Editor's Note

This Progress Report on nuclear data research in Poland /May 1969 - April 1969/ contains only information on research, which is closely related to the activities of the International Nuclear Data Committee of the International Atomic Energy Agency in the field of neutron physics. It does not include any information about other nuclear research as for example in the field of charged particles nuclear physics or the use of neutrons for solid state physics studies.

The individual reports are not intended to be complete or formal, and must not be quoted in publications without the permission of the authors.

C O N T E N T S

1. (n,d) reactions on ^{23}Na, ^{35}Cl, ^{39}K, ^{41}K, ^{89}Y, and ^{141}Pr at 14.1 MeV.

M.Dąbrowska, B.Sikorska, J.Toke, E.Wesołowski

Institute for Experimental Physics, Warsaw University, Warsaw,

Angular distributions of the deuteron groups corespondïng to the reactions:

$^{35}Cl(n,d_0)^{34}S$ g.s.
$^{39}K\ (n,d_0)^{39}A$ g.s.
$^{39}K\ (n,d_1)^{39}A^{*}$ (2.16 MeV)
$^{41}K\ (n,d_0)^{40}A$ g.s.
$^{41}K\ (n,d_1)^{40}A^{*}$ (1.46 MeV)

were measured with a scintilation counter telescope in order to obtain estimated values of spectroscopic factors in the region of 2 s 1/2, 1 d 3/2 proton shells. The data are shown in fig. 1, 2 and 3 together with results of preliminary DWBA calculations and the resulting spectroscopic factors. An over all good agreement was found between these values and the predictions of the refined shell model of Glaudemans at al./1/. Additionaly the $^{23}Na(n,d_{0,1})^{22}Ne$ g.s.,1 st.exc. $^{89}Y(n,d_{0,1})^{88}Sr$ g.s 1 st. exc. and ^{141}Pr n,d_0 ^{140}Ce g.s. transitions were inwestigated with the aim to extend the experimental material of proton pick-up reactions. In the case of ^{23}Na /fig.1/ and for the ground state transitions of ^{88}Sr and ^{140}Ce /fig.4/ angular

distributions were obtained. The $^{141}Pr(n,d_o)\ ^{140}Ce$ reaction has an expected low cross section and the results yeald only the order of the cross section and the character of the angular distribution curve.

REFERENCE:

1. P.W.M. Glaudemans, G.Wiechers and P.J.Brussard. Nucl. Phys. 56, /1964/ 529.

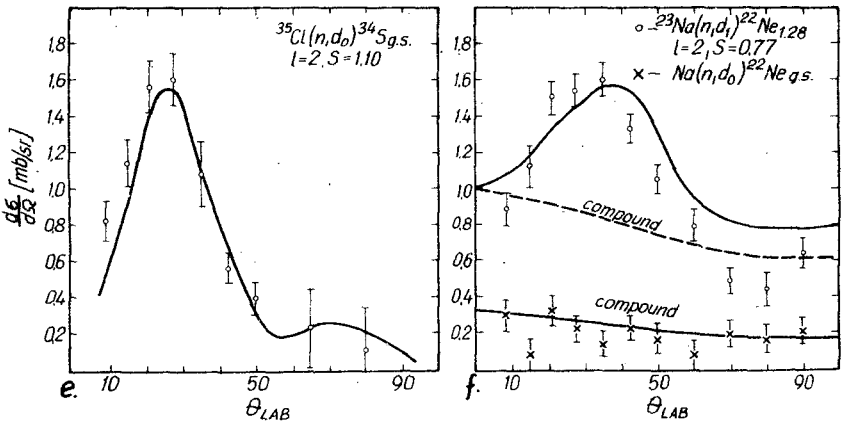


Fig.1.

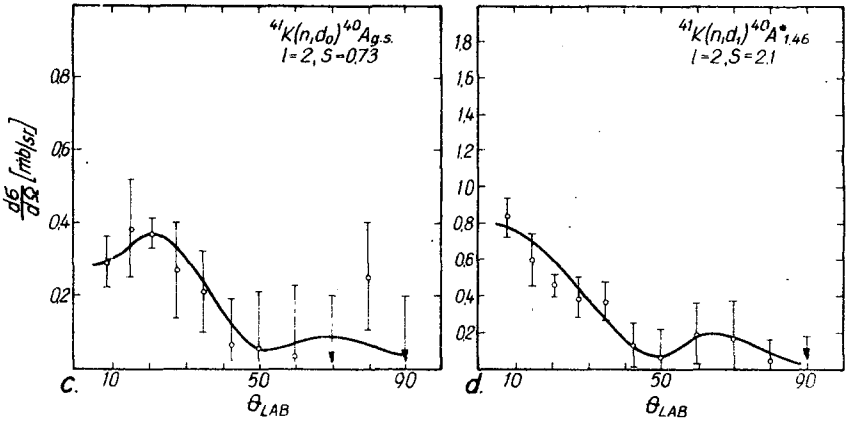

$^{41}K(n,d_0)^{40}A_{g.s.}$
$l=2, S=0.73$
$^{41}K(n,d_1)^{40}A^*_{1.46}$
$l=2, S=2.1$
$\frac{d\sigma}{d\Omega}$ [mb/sr]
θ_{LAB}
c.
d.

Fig.2.

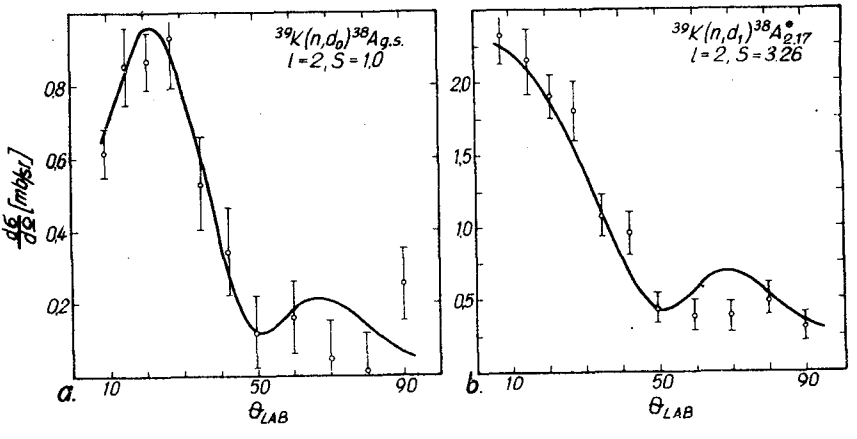

$^{39}K(n,d_0)^{38}A_{g.s.}$
$l=2, S=1.0$
$^{39}K(n,d_1)^{38}A^*_{2.17}$
$l=2, S=3.26$
$\frac{d\sigma}{d\Omega}$ [mb/sr]
θ_{LAB}
a.
b.

Fig.3.

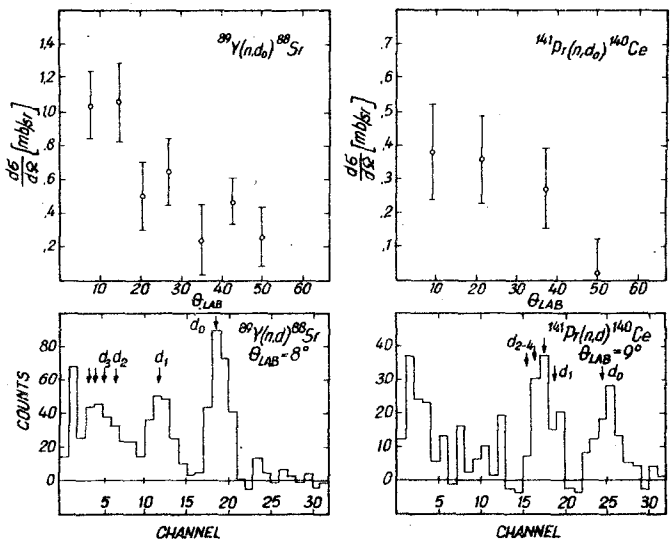

$^{89}Y(n,d_0)^{88}Sr$
$^{141}Pr(n,d_0)^{140}Ce$
$\frac{d\sigma}{d\Omega}$ [mb/sr]
θ_{LAB}
COUNTS
CHANNEL
d_0
d_1
d_2
d_3
d_{2-4}
$\theta_{LAB}=8°$
$\theta_{LAB}=9°$

Fig.4.

2. Cross Sections for the $^{89}Y/n,n'/^{89m}Y$ and $^{89}Y/n,2n/^{88}Y$ reactions

A.Abboud*, P.Decowski, W.Grochulski, A.Marcinkowski, I.Turkiewicz, K.Siwek, Z.Wilhelmi

Institute of Nuclear Research, Warsaw,

and

Institute for Experimental Physics, Warsaw University, Warsaw,

The excitation curves were measured for the $^{89}Y/n,n'/^{89m}Y$ and the $^{89}Y/n,2n/^{88}Y$ reactions. The experimental results are presented on Fig.1 and Fig.3 together with the theoretical predictions.

The theoretical calculations of the cross sections were performed according to the statistical formalism described in detail in our previous works [1], [2], [3]. Since the concept of level density is meaningless for excitation energies involved in the $^{89}Y/n,n'/^{89m}Y$ reaction for the low neutron energy range as well as in the $^{89}Y/n,2n/^{88}Y$ reaction for neutron energies just above the threshold, the individual levels as far as they are known with theirs spins and parities were taken into calculations.

---

* On leave from Atomic Energy Establishment, Cairo, U.A.R.

For excitation energies above the highest known level, the level density with no free parameters as described in [1], [3] was assumed. The importance of the separate levels was neglected for the $^{89}Y/n,n'/^{89m}Y$ reaction for neutron energies higher as 13 MeV.

The competition of the proton emission was taken into account on each step of the reactions considered. The α-particle emission was assumed to be neglegible.

The solid lines on figures 1, 2 and 3 present the results of our calculations. A rough approximation in accounting for the competitive gamma rays emission with respect to the evaporation of the second neutron [4], [5], which involves an effective increase in the binding energy, in our case that of the neutron in ^{89}Y nucleus by ΔS_n, is marked by $\Delta S_n = 1,2,3$ in MeV. This treatment is equivalent to assuming that in the energy interval ΔS_n above the /n,2n/ reaction threshold, the /n,n'/ reaction predominates because of the spin forbiddeness of neutron emission.

From the comparison of the experimental and calculated values of cross sections for the $^{89}Y/n,2n/^{88}Y$ reaction (fig.1) it is seen that over the whole range of the incident neutron energies the experimental cross sections lie much below the theoretical ones. This systematical deviation was observed in all cases investigated by us [3], [2]. According to the explanation of this effect suggested, we can expect that the measured cross sections for the $^{89}Y/n,n'/^{89m}Y$ reaction will exceed the calculated values. From fig.3 it is visible that

this is the case. However the quantitative description of this effect is unsatisfactory. As it was shown in [2] and [3], the isomeric ratios are well described by the theoretical model used in calculations. Taking this into account a following summe-rule can be written

$$\int\left[\sigma^{theor.}(n,2n)-\sigma^{exper}(n,2n)\right]dE_n=\int\left(1+\frac{\sigma_g}{\sigma_m}\right)\left[\sigma^{exper}(n,n')-\sigma^{theor.}(n,n')\right]dE_n$$

From the results presented in Fig. 1,2,3 we obtain

$$1920\ \text{MeV}\cdot\text{mb} \neq 995\ \text{MeV}\cdot\text{mb}\ .$$

This means that the disagreement between experiment and theory for the $^{89}Y/n,2n/^{88}Y$ reaction, can be ascribed only in part to gamma decay competition.

REFERENCES

1. P.Decowski et al. Nucl. Phys. A 110, 129 /1968/
2. P.Decowski et al. Nucl. Phys. A 112, 513 /1968/
3. A.Abboud et al. /published in this issue/
4. J.R.Grover, Phys. Rev. 123, 267 /1961/
5. J.R.Grover, Phys.Rev. 127, 2142 /1962/

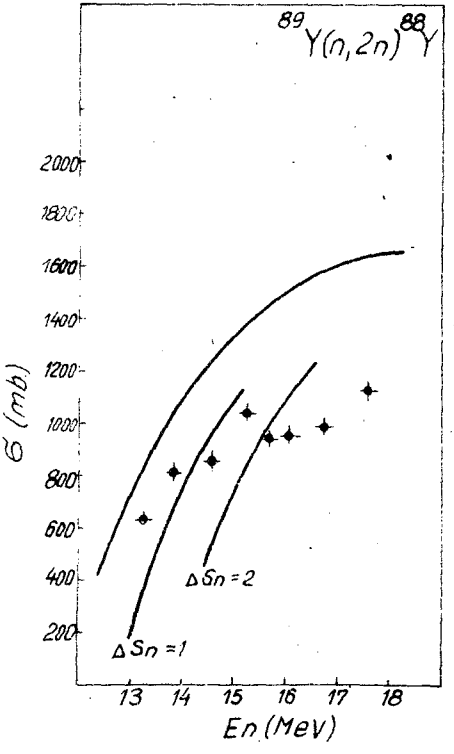


Fig.1.

Total cross section for $^{89}Y/n,2n/^{88}Y$ reaction. The solid line represents the theoretical calculations.

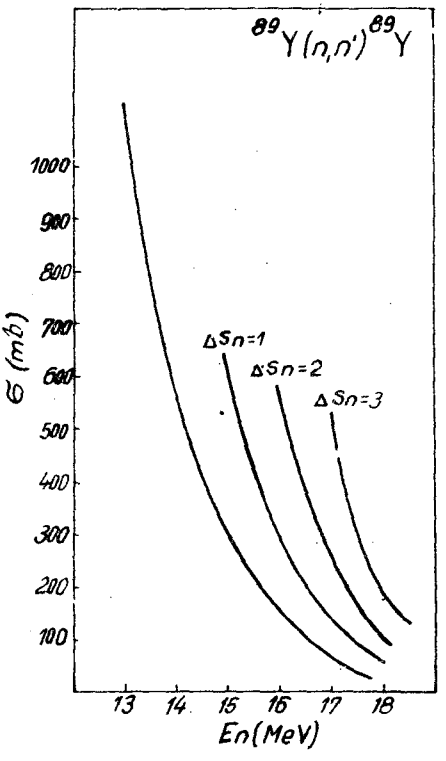


Fig.2.

Theoretically predicted total cross section for $^{89}Y/n,n'/^{89}Y$ reaction.

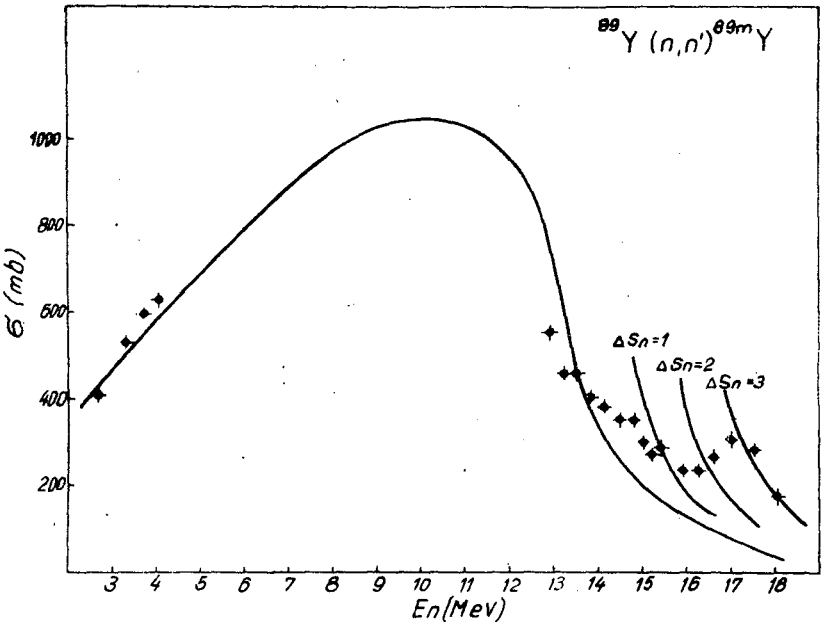


Fig.3. Experimental and theoretical cross sections for $^{89}Y/n,n'/^{89}Y$ reaction

♦ - experiment ———— - Theory

3. Isomeric ratios and total cross sections for the ^{74}Se n,2n $^{73g,m}Se$ ^{90}Zr n,2n $^{89g,m}Zr$ and ^{92}Mo n,2n $^{91g,m}Mo$ reactions.

A.Abboud[x], P.Decowski. W.Grochulski, A.Marcinkowski,
J.Piotrowski, K.Siwek, Z.Wilhelmi
Institute for Experimental Physics, Warsaw University,
Warsaw, and
Institute of Nuclear Research, Warsaw,

The excitation curves and the isomeric ratios for ^{74}Se n,2n $^{73g,m}Se$, ^{90}Zr n,2n $^{89g,m}Zr$ and ^{92}Mo n,2n $^{91g,m}Mo$ reactions have been measured in the neutron energy range 12.6 - 18.2 MeV.

The activation method with the use of fast-slow coincidence spectrometer was applied.

Experimental results presented in Figs 1-6 are compared with the predictions of the statistical model based on the developed superconductor level density /1/. The calculations account for the changes in the level density in the vicinity of the closed shells.

In the case of the $^{90}Zr(n,2n)^{89g,m}Zr$ and $^{92}Mo(n,2n)^{91g,m}Mo$ reactions the calculated isomeric ratios show good agreement with experimental data (Figs 1,2.) The calculations for these

---

[x] On-leave from Atomic Energy Estabilishment Cairo, U.A.R.

two reactions were performed for the real levels of final nucleus.

In the case of ^{74}Se n,2n ^{73g,m}Se reaction Fig.3 the divergence between theory and experiment is pronounced. This divergence may be ascribed to incorrect spins assignment in the decay scheme of ^{73}Se /2/.

In all investigated reactions the calculated total cross sections (dashed lines Figs 4,5,6) do not agree with the measured values. The divergence may be caused by the fact that no account was taken for the gamma-neutron competition. A rough method of providing for this process, consisting in increasing the meutron binding energy by the value Δ Sn has been applied.

Figs 4,5,6 show the excitation curves for ^{74}Se(n,2n)^{73g,m}Se, ^{90}Zr(n,2n)^{89g,m}Zr, ^{92}Mo(n,2n)^{91g,m}Mo reactions respectively our results ϕ. The curves ascribed as Sn + 0.5, Sn + 1, Sn + 2 and Sn + 3 are the results of calculations for Δ Sn = 0.5, 1,2,3 MeV.

REFERENCES

1. P.Decowski et. al. Nucl.Phys. A 110, 129 /1968/
2. B.S.Dżelepow, L.B.Peker.
   Decay Schemes of Radioactive Nuclei /1968/ - Academy of Sciences of ZSSR Press.
3. J.Mattauch, W.Thiele, A.Wapstra,
   Nucl.Phys. 67, 1, /1965/.
4. W.D.Myers, K.J.Swiatecki, UCRL 11980, /1966/.

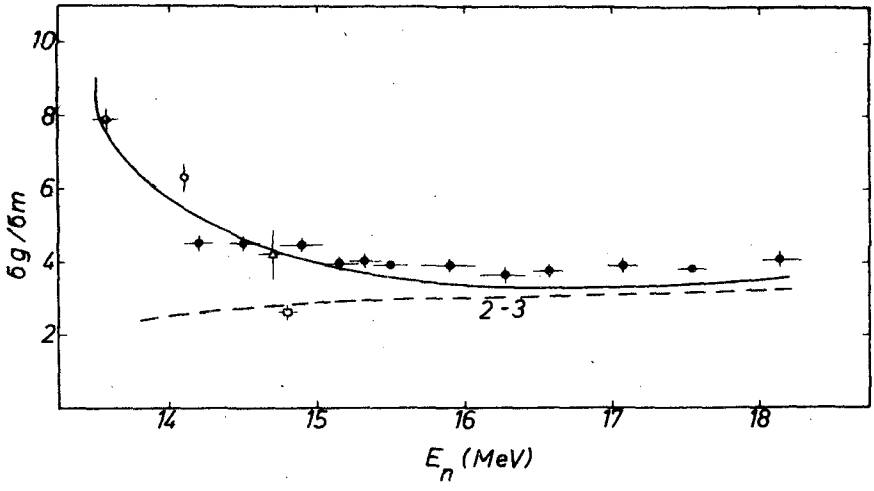


Fig.1. Isomeric cross section ratios for $^{92}Mo(n,2n)^{91g,m}Mo$

● our results

Solid line presents the theoretical calculations for Q = 13,1 MeV /3/, and dashed for Q = 12.56 MeV /4/.

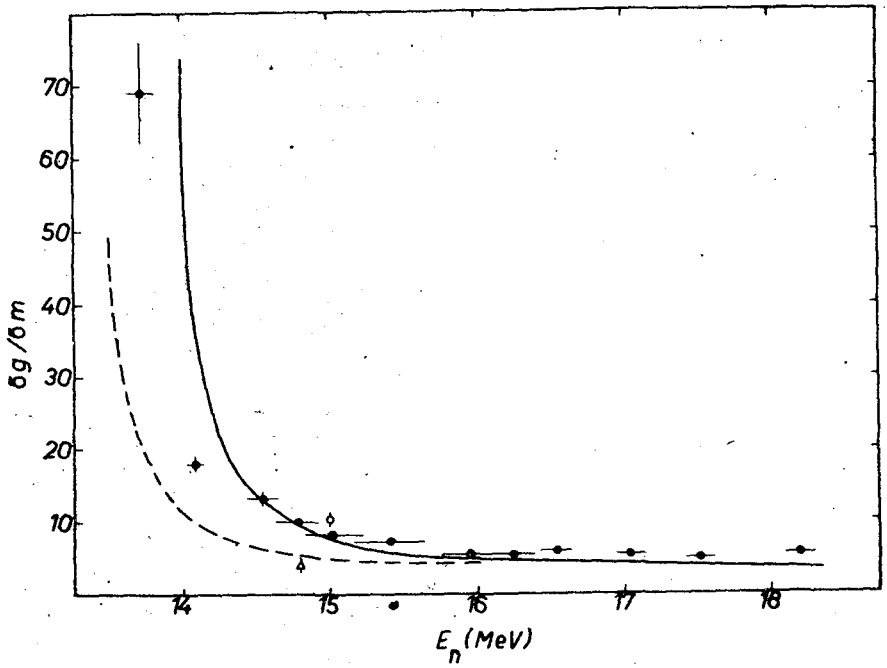


Fig.2. Isomeric cross section ratios for $^{90}Zr(n,2n)^{89g,m}Zr$

♦ our results.

– Solid line shows predictions of the statistical model, when the individual levels of final nucleus are taken into account. Dashed line coresponds to the prediction for the level density in the final nucleus.

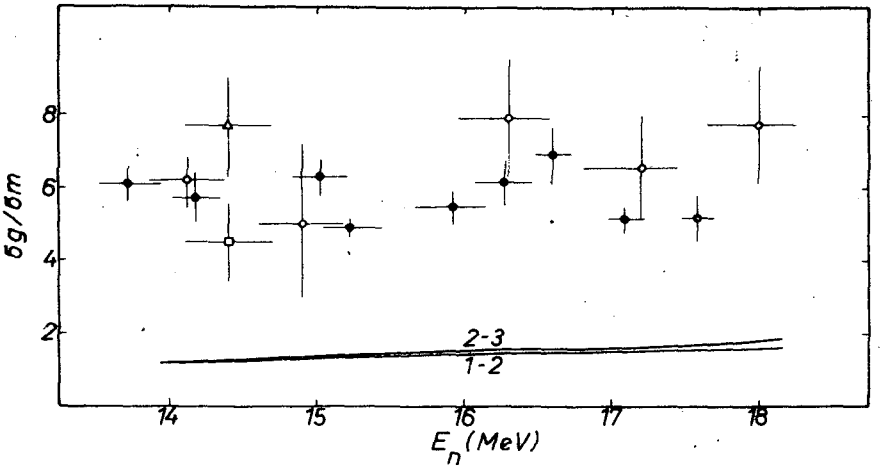


Fig.3. Isomeric cross section ratios for $^{74}Se(n,2n)^{73g,m}Se$

● our results

Solid line presents the statistical model predictions based on the superconductor level density.

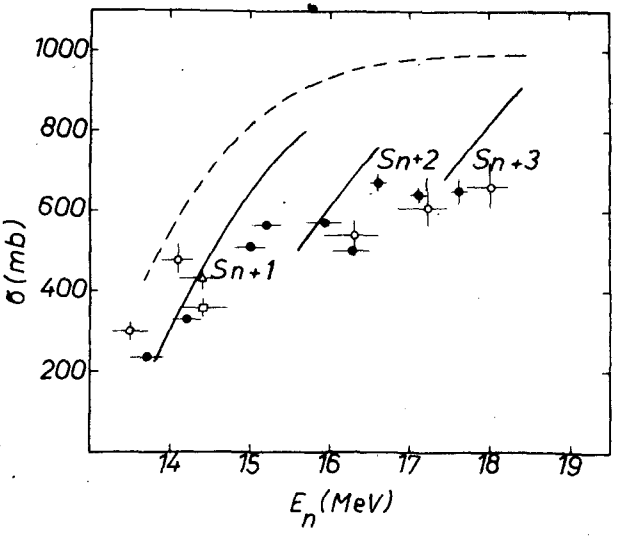


Fig .4 .

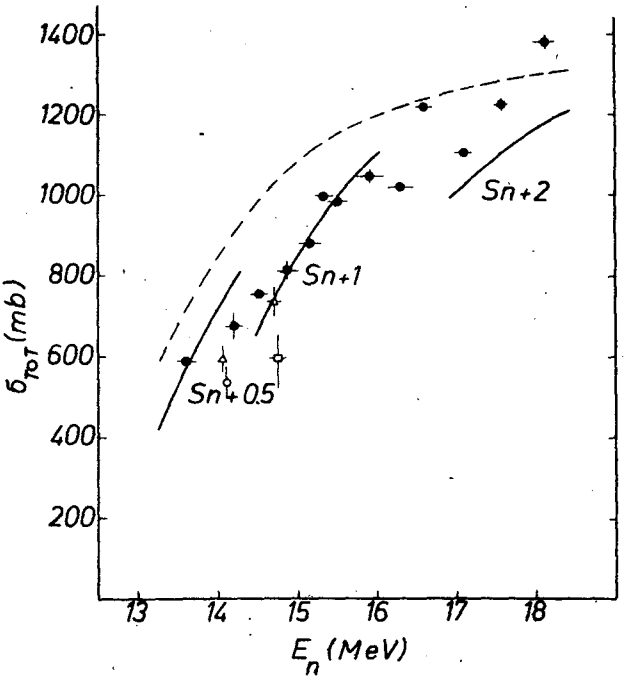
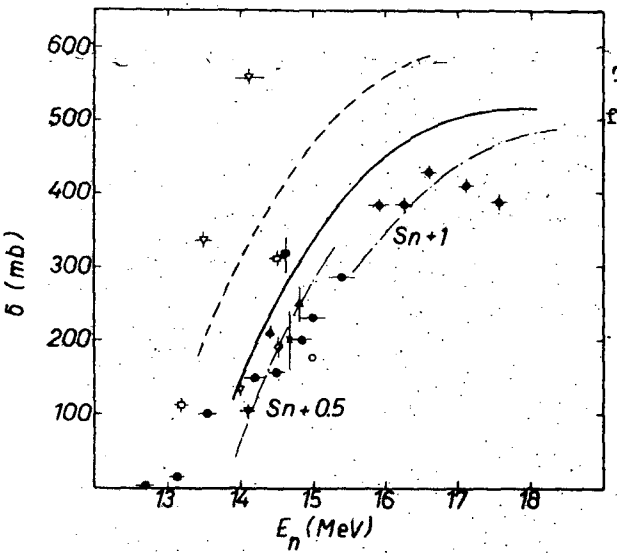


Fig. 5 .



Total cross section for ^{92}Mo n,2n ^{91g,m}Mo
● our results

Fig. 6.

The solid line presents theoretical calculations for Q = 13.2 MeV and dashed line for Q = 12.56 MeV.

4. Polarization of neutrons from the $^3H/d,n/^4He$ reaction at low deuteron energies

M.Siemiński, Z.Wilhelmi, W.Zych, P.Żuprański
Institute of Nuclear Research, Warsaw, and
Institute for Experimental Physics, Warsaw University
Warsaw.

Using the method of ref.[1] we have measured the angular distribution of neutron polarization for deuteron energy 1.4 MeV and the polarization of neutrons emitted at 60° and 90° /lab/ at several deuteron energies from 0.4 MeV up to 1.6 MeV. The results are shown in Figs 1,2a,2b.

The character of the angular distribution of polarization is quite similar to that obtained at deuteron energy 1.8 MeV by Levintov et al [2] and at 2.1 MeV and 2.9 MeV by Christiansen et al [3]. An approach to the theoretical explanation of the measured polarization either in terms of distant levels contribution or a resonance plus direct amplitudes is being carried out.

REFERENCES

1. M.Siemiński, Z.Wilhelmi, W.Zych and P.Żuprański
Nucl. Instr. and Meth. 64, 77 /1968/
2. I.I.Levintov, A.V.Miller, U.N.Shamshev
Nucl.Phys. 3, 221 /1957/
3. J.F.Christiansen, W.Büsser, F.Niebergall, G.Söhngen
Nucl.Phys. 67, 133 /1965/

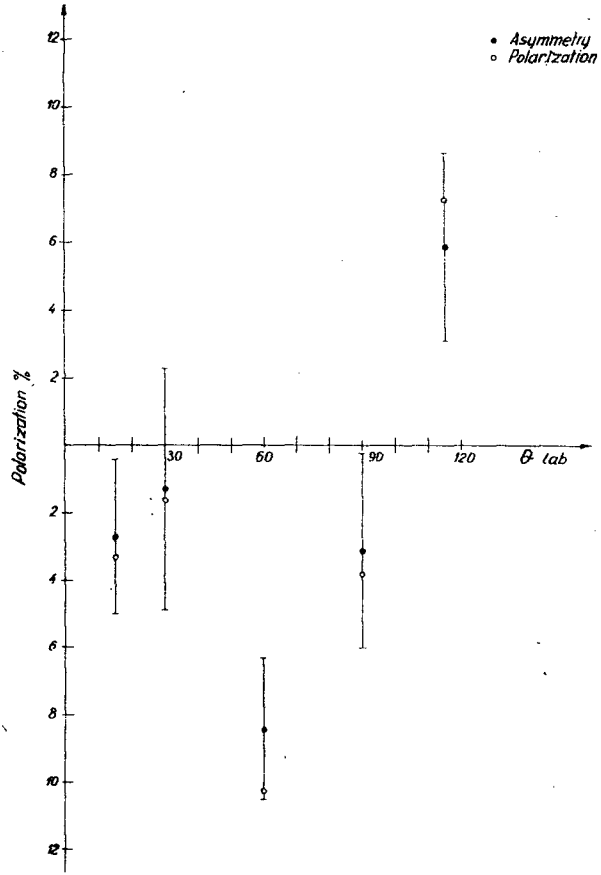


Fig.1. The angular dependence of neutron polarization at deuteron energy of 1.4 MeV.

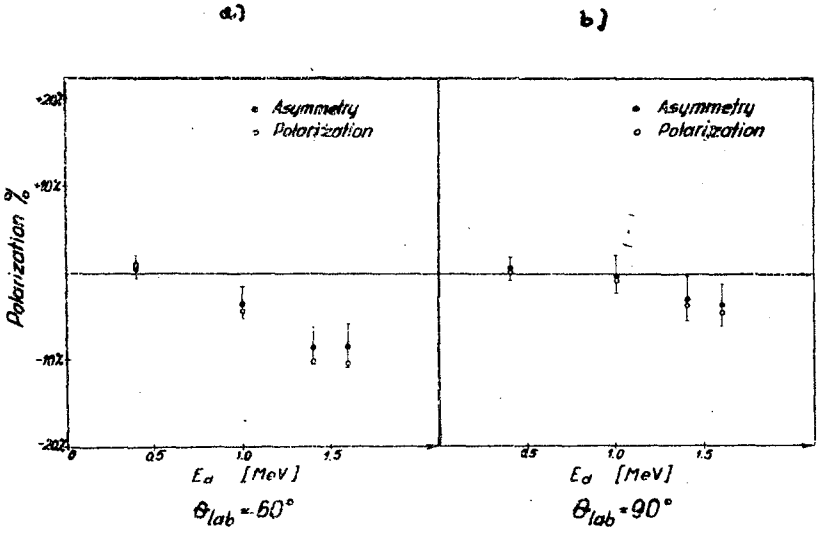


Fig.2a. The polarization of neutrons emitted at 60° degrees /lab/vs energy

Fig.2b. The polarization of neutron emitted at 90° /lab/ vs deuteron energy

5. Excitation of isomeric activities for some N=81 isotones using 14.5 MeV neutrons

E.Rurarz, Z.Haratym and A.Sulik

Institute of Nuclear Research, Świerk

During searches for short-lived nuclear species excited by 14,5 MeV neutrons we have observed many isomeric states, four of which are identified as ^{137m}Ba, ^{139m}Ce, ^{141m}Nd, and ^{143m}Sm.

There are marked disagreements by factors ranging from 2 to several orders of magnitude between published isomeric activities close to magic number N=82.

The cross-sections for the production of the isomeric states through the /n,2n/ reaction in the present work have been measured by the activation method.

The following cross sections /in mb/ have been found:

$^{138}Ba/n,2n/^{137m}Ba$ /153 sec/, 1105± 110

$^{140}Ce/n,2n/^{139m}Ce$/54.8 sec/, 1280± 130

$^{142}Nd/n,2n/^{141m}Nd$/60.3 sec/, 1069± 120

$^{144}Sm/n,2n/^{143m}Sm$/65 sec/, 564± 120

The experimental data of this work have been compared with the results obtained by other authors.

6. Excitation of isomeric activities in ^{71}Ge, ^{78}Br and ^{79}Br using 14.8 MeV neutrons

E.Rurarz, Z.Haratym, T.Kozłowski and J.Wojtkowska
Institute of Nuclear Research, Świerk

The cross section for the production of the isomeric states in ^{71}Ge, ^{78}Br and ^{79}Br have been measured using 14.8 MeV neutrons. The half-lives and energies of these isomeric activities were remeasured for checking the assignments. As a result of experiment the following values were obtained for the measured activities:

Target, reaction and isomeric nucleus	E /keV/	Half-life /sec/	Cross-sections /mb/
$^{72}Ge/n,2n/^{71m}Ge$	175	$/20.4\pm1/10^{-3}$	487 ± 50
$^{79}Br/n,2n/^{78m}Br$	150	$/111\pm10/10^{-6}$	$/220\pm40//1+\alpha_{tot}/$
$^{79}Br/n,n'/^{79m}Br$	208	5	230 ± 30

Experimental results for isomeric ratios in /n,2n/ reaction are compared with the atatistical theory predictions.

7. Investigation of prompt neutrons accompanying spontaneous ternary fission of ^{252}Cf [x/]

H.Piekarz, J.Błocki, T.Krogulski, E.Piasecki
Institute of Nuclear Research, Świerk

The properties of prompt neutrons accompanying the spontaneous ^{252}Cf ternary fission with α-particle as a third fragment have been examined. The angular distributions of neutrons with respect to the direction of fission fragment flight were measured for the ternary and binary fission. The average number of neutrons and the relative yield of neutrons emitted from the light and heavy fragments in the ternary fission were determined by comparison with those observed in binary fission. The neutron yield as a function of the α-particle kinetic energy was also found.

The kinetic energy of the single fission fragment was measured in coincidence with neutrons and the alpha particle. The neutron counter consisted of a stilbene ceystal 40 x 40 mm and 56 AVP photomultiplier. A pulse-shape discriminator allowed to separate the neutrons from γ-rays. Silicon surface barrier detectors registered fission fragments and alpha particles from tripartition (the last in the energy interval 10-30 MeV).

A typical fast-slow coincidence system was applied.

[x/] The measurements were taken at The Nuclear Chemistry Group of CERN in Geneva.

We can conclude that:

1. The angular distribution of neutrons with respect to the fission fragments is quite similar in the binary and ternary fission. (see Fig.1)
2. $\langle \nu \rangle_{ternary} = 3.10 \pm 0.08$.
3. The ratio of the number of neutrons emitted from the light fragment to that emitted from the heavy one is similar in the binary and ternary fission $((\tilde{\nu}_L/\tilde{\nu}_H)_B/(y_L/y_H)_T = 1.1 \pm 0.1)$
4. The neutron yield decreases with increasing alpha particle energy: $\langle \frac{\partial \nu}{\partial E_\alpha} \rangle = -0.042 \pm 0.01$ MeV^{-1}.
5. The total kinetic energy released in ternary fission is higher by 3.8 ± 1.3 MeV than that in binary fission.

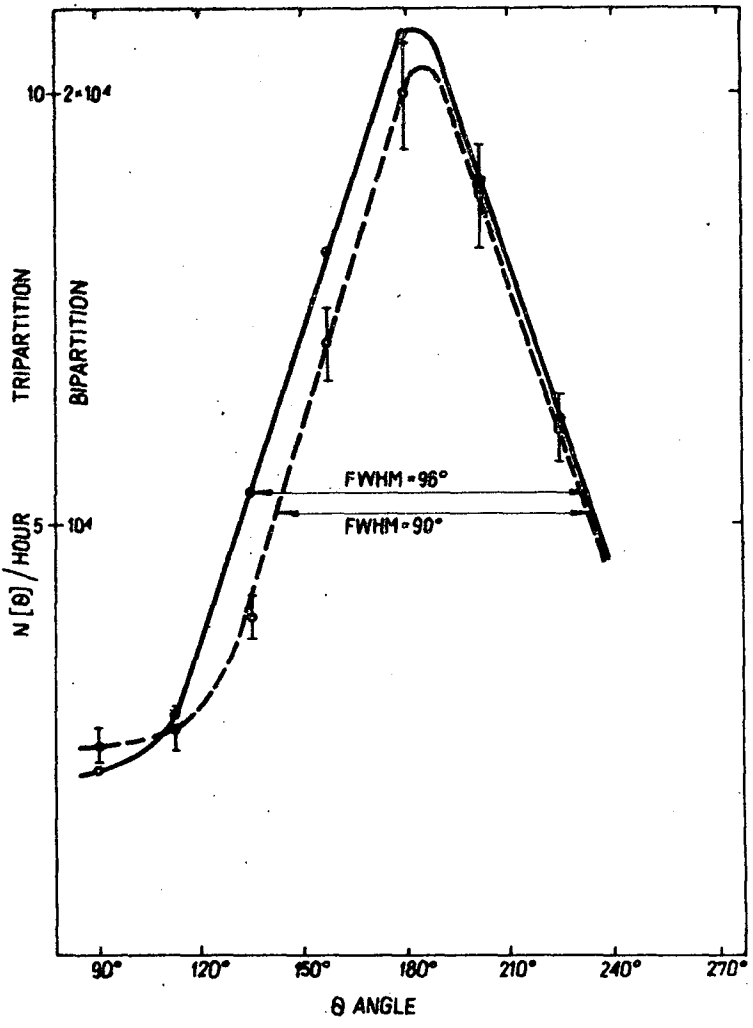

10 - 2·10⁴
5 - 10⁴
N [θ] / HOUR
TRIPARTITION
BIPARTITION
FWHM = 96°
FWHM = 90°
90°
120°
150°
180°
210°
240°
270°
θ ANGLE

Fig. 1.

8. Correlated emission of light nuclei and neutrons in fission of ^{235}U and ^{252}Cf [x]

J.Błocki, J.Chwaszczewska, M.Dakowski,
T.Krogulski, K.Piasecki, H.Piekarz and J.Tys.
Institute of Nuclear Research, Świerk

The relative yields of protons and tritons with respect to the α-particle yield were measured in coincidence with prompt neutrons from thermal neutron - induced fission of ^{235}U and spontaneous fission of ^{252}Cf.

We used the telescope counter and applied the two-parameter analysis for particle identification. The neutron counter consisted of a stilbene crystal 30 x 5 mm coupled with a 56 AVP photomultiplier. Separation of the neutrons from gamma rays was realized by a pulse-shape discriminator. A typical fast-slow coincidence system was used. The random coincidences did not exceed 5% of the true ones.

Several runs with and without coincidence with the neutrons were performed. For both kinds of measurements the relative yields of tritons and protons with respect to the emission of 100 α-particles were measured. The results are presented in the second and third column of Table 1.

---

[x] A part of the measurements was carried out at the Nuclear Chemistry Group of CERN in Geneva.

Table 1

	Particle	Relative yield /%/ without coincidence	with coincidence non corrected	with coincidence corrected
^{252}Cf	protons	2.5 ± 0.15	2.3 ± 0.3	2.6 ± 0.3
	tritons	9.3 ± 0.3	8.2 ± 0.6	8.3 ± 0.6
^{235}U	protons	0.96 ± 0.02	0.77 ± 0.10	0.86 ± 0.10
	tritons	8.0 ± 0.5	7.3 ± 0.3	7.4 ± 0.3
α - particle		100	100	100

The resultats with corrections providing for the finite sizes of the target and both detectors, and for the differences between the angular distributions /with respect to the heavy fragments/ of α - particles, tritons and protons /1/ are shown in the last column of Table 1. The angular and energy distributions of prompt neutrons was assumed to be independent of the type of particle.

Basing on the results listed in Table 1 we can conclude that for ^{235}U as well as for ^{252}Cf the amount of prompt neutrons accompanying the proton and triton tripartition is smaller by about 10% compared with that in the α -tripartition. This difference lies within the limits of a single and two standard deviations for the protons and tritons, respectively. These results indicate that the amounts of excitation energy released by prompt neutrons do not differ very much, when the values of $\frac{\partial E^*}{\partial V}$ are similar for the various kinds of the triparititions investigated.

[1]. G.M.Raisbeck, T.D.Thomas, Phys.Rev. 172, 1272 /1968/

9. Emission of light nuclei in thermal neutron fission of ^{239}Pu

T.Krogulski, J.Chwaszczewska, M.Dakowski,
E.Piasecki, M.Sowiński and J.Tys.
Institute of Nuclear Research , Świerk

The relative intensities and energy spectra of ^{1}H, ^{2}H, ^{3}H, ^{4}He, ^{6}He and ^{8}He particles from the thermal neutron fission of ^{239}Pu have been measured.

The 6 mg/cm^2 thick ^{239}Pu target was irradiated in thermal neutron flux of 6×10^8 cm^{-2}sec^{-1}. The semiconductor counter telescope permitted to distinguisn between the registered particles so that the energy spectra of hydrogen and helium isotopes could be measured.

A Gaussian distribution was fitted to the spectra by the least-squares method. We conclude that all the spectra are sufficiently well described by a Gaussian distribution although there are small deviations from it. The most striking feature of measured spectra is almost the same energy distribution for all isotopes of hydrogen and regularly decreasing maximum of distribution with the mass of isotope in the case of helium.

The intensities relative to the emission of 100 alphas have been calculated by assuming that the low energy part of the spectrum which is not registered is symmetrical to the corresponding high-energy part.

The results are presented in Table 1 and Figs 1 and 2.

Table 1

Particle	Energy range of undistorted spectra [MeV]	Relative intensity /extrapolated/	E_{peak} [MeV]	FWHM [MeV]
p	4 ÷ 19	1.9 ± 0.1	8.40±0.15	7.2 ± 0.3
d	4.5 ÷ 19	0.5 ± 0.1	8.2 ± 0.3	7.2 ± 0.5
t	5.5 ÷ 20	6.8 ± 0.3	8.20±0.15	7.6 ± 0.4
^{4}He	10 ÷ 29	100	16.0±0.1	10.6± 0.2
^{6}He	11 ÷ 28	1.9 ± 0.2	11.8±0.4	10.6± 0.6
^{8}He	12 ÷ 23	0.08±0.02	< 12	>9

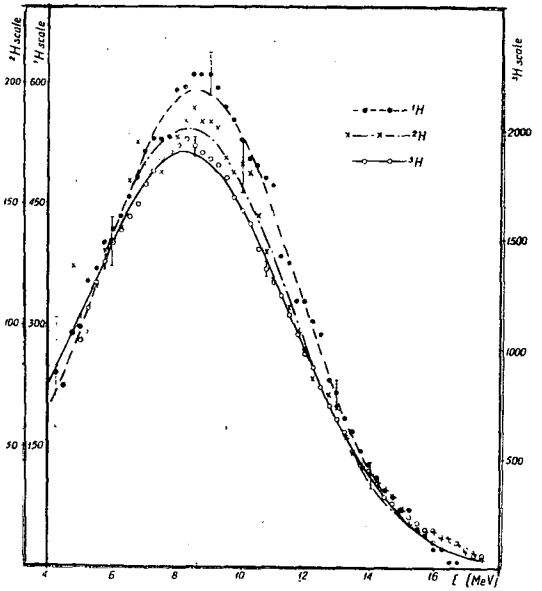

²H scale
¹H scale
³H scale
¹H
²H
³H
E (MeV)

Fig. 1

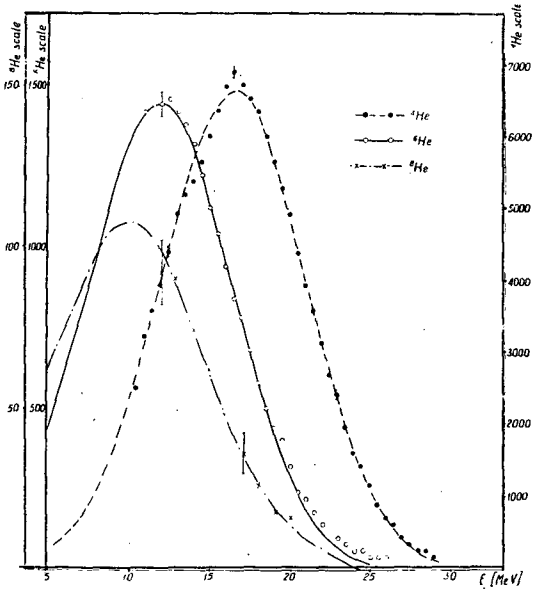

⁶He scale
⁴He scale
⁸He scale
⁴He
⁶He
⁸He
E (MeV)

Fig. 2

10. Energy spectra of alpha particles from the ^{166}Er /n, α / ^{163}Dy and ^{168}Er /n, α / ^{165}Dy Reactions with 14.2 MeV neutrons

M.Jaskóła, W.Osakiewicz, Z.Rogulski, J.Turkiewicz
L. Zemło

Institute of Nuclear Research, Warsaw, and
Institute for Experimental Physics of Warsaw
University, Warsaw

The energy spectra of alpha particles from the ^{166}Er /n, α / ^{163}Dy and ^{168}Er /n, α / ^{165}Dy reactions at 14.2 MeV have been studied using the semiconductor technique. Samples of ^{166}Er /3.1mg/cm^2 - Er_2O_3/ and ^{168}Er /6.1mg/cm^2 - Er_2O_3/ isotopically enriched to 96% were deposited onto thick aluminium backing.

The results of the alpha-particle spectra measurements are shown in fig.1. All the spectra were measured for the forward angle /0° ± 60°/. Fig.1 shows also the theoretical predictions /dashed lines/ obtained by applying the Weisskopf-Ewing formula. The values for inverse cross sections were taken from the calculation of Huizenga and Igo [1] . The energy level density was taken in the form

$$\varrho(U) \propto U^{-2} \exp(2\sqrt{aU})$$

with the level density parameter "a" taken from Erba et al. [2] . The calculated curves are not normalized.
The evaporation theory with reasonable a-value is completly inadequate to the description of the investigated reaction. The comparison of the a-values obtained from the statistical analyses with that given by Erba et al. [2] is shown in table 1.

Nucleus	level density parameter "a" (MeV^{-1})	
	present work	Erba et al. [2]
^{163}Dy	3.97	20.2
^{165}Dy	5.28	20.2

The existence of high-energy alpha particles in the experimental spectra suggest the presence of strong direct effects in investigated reactions. Similar conclusions have been drawn in the other papers [3,4,5] . Supposing the domination of the direct interaction mechanism with alpha particles emitted mainly in knock-out process, it seems reasonable to expect the single neutron levels to be strongly excited. The comparison of the results of the calculation of the single-neutron level density in ^{163}Dy and ^{165}Dy based on Nilsson work [6] with the experimental alpha spectrum for the ^{166}Er /n, α/ ^{163}Dy and ^{168}Er /n, α / ^{165}Dy reactions is presented on fig.2.

The value of the deformation parameter δ in both cases were taken 0.3. As it can be seen for the ^{166}Er /n, α / ^{163}Dy reaction the agreement is quite good.

The measurements and the analyses are not yet complete.

References.

1. J.R.Huizenga and Igo, Nuclear Physics 29 /1962/ 462
2. E.Erba, U.Facchini and E.Saetta-Manichella, Nuovo Cim. 22, 1237 /1961/
3. U.Facchini, M.G.Marcazzan and Merzari, Phys. Lett. 1 6, /1962/
4. P.Kulisic, V.Ajdacic, N.Cindro, B.Lalovic and P.Strohal Nucl. Phys. 54, 17 /1964/
5. M.Jaskóła, W.Osakiewicz, J.Turkiewicz, and Z.Wilhelmi Nucl.Phys. A110- 11, /1968/
6. S.G.Nilsson Mat.Fys.Medd.Dan.Vid.Selsk. 29, No.16 /1956/

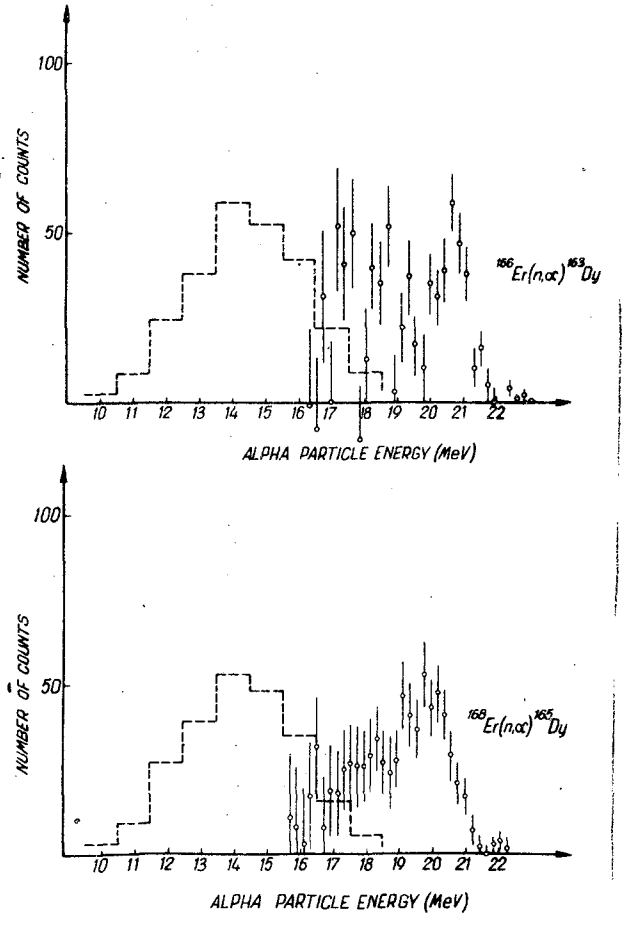


Fig.1. The experimental α-particle spectra from the ^{166}Er /n, α / ^{163}Dy and ^{168}Er/n, α / ^{165}Dy reactions and the predictions of the statistical theory /dashed lines/

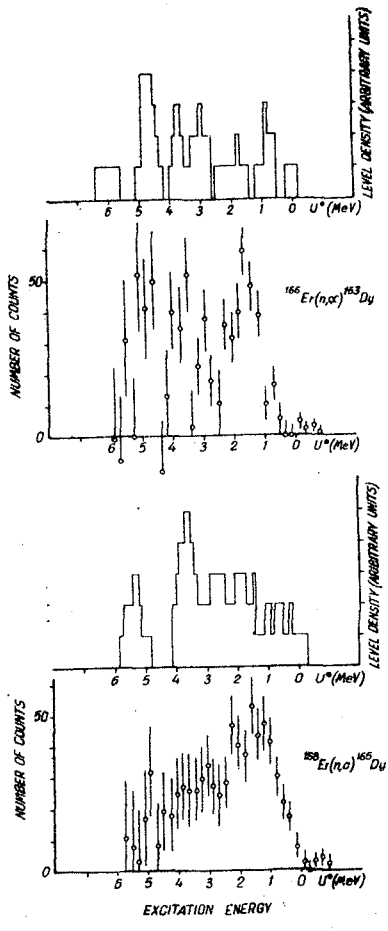


Fig.2. The comparison of the experimental α-particle spectrum with the single-neutron level density of the residual nucleus for the ^{166}Er /n, α / ^{163}Dy and ^{168}Er /n, α / ^{165}Dy reactions. The energy scale is the excitation energy of the residual nucleus.

11. The code MINIGASKET

J. Arkuszewski, Institute of Nuclear Research, Świerk

The programme calculates thermal neutron scattering function $S/\alpha,\beta/$ in incoherent approximation for any dynamical system that can be adequately described by a continnous phonon distribution function /e.g. a polycrystalline isotropic medium, free gas/. The algorithm is essentially based on the code GASKET /GA-7417/Rev/, however the employed method of numerical Fourier transformation is different becouse of some acceleration technique included. The phonon distribution function for hcp lattices /e.g. Bc/ will be calculated from first principles by another programme /czachor 13/.

The code written in GIER ALGOL IV for the GIER computer is being finally tested.

12. The code MIXER

J.Arkuszewski, Institute of Nuclear Research, Świerk

The MIXER code prepares the 26-group microscopic constants in a form suitable for direct use in the 1D criticality diffusion code EWA-TAPE. The programme library is based on the 26-group russian ABN set. The corrections to the cross sections from the self-shielding factors of ABN library are calculated for 300^{0} only, the fission spectrum iteration is also included. No corrections for

"non 1/E" spectrum behaviour were introduced for elastic scettering. The code can handle up to 15 nuclides in a mixture. It is written in GIER ALGOL III for the GIER computer.

13. ALGOL program for Computation of the frequency distribution function of crystals

A. Czachor - Institute of Nuclear Research, Świerk
A.Rajca - Institute of Experimental Physics, University of Warsaw.

A detailed knowledge of the frequency distribution function /FDF/ of reactor materials is necessary for the calculation of scattering matrix. An ALGOL program for computation of FDF, basing on the so called "sampling method" 1 has been elaborated. In this method the eigenvalues of dynamical matrix /DM/ of the crystal are calculated for a finite number of points in the "irreducible part of the Brillouin zone" /IPBZ/, and then selected with a proper weighting into the frequency intervals of desired width. The elements of the DM are assumed to be given.

1/ A.A. Maradudin, E.W.Montroll, G.H.Weiss, Theory of Lattice Dynamics in the Harmonic Approximation, Solid State Physics, Supplement 3, Academic Press, New York and London, /1963/.

The program may be used of any crystal structure. The shape and size of the IPBZ and the rank of DM must be specified. The accuracy of computation is limited by the time of computation of one set of eigenfrequencies at a given point of IPBZ. Using the GIER computer at Świerk, the time for a 6 x 6 matrix is 6 sec.

Program has been verified by computating the FDF for Bismuth.