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USSR STATE COMMITTEE ON THE UTILIZATION OF ATOMIC ENERGY

NUCLEAR DATA INFORMATION CENTRE

NUCLEAR PHYSICS RESEARCH IN THE USSR

(Volume of Abstracts)

No. 3

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USSR STATE COMMITTEE ON THE UTILIZATION OF ATOMIC ENERGY

NUCLEAR DATA INFORMATION CENTRE

Nuclear Physics Research in the USSR

(Volume of Abstracts)

No. 3

Edited by A.E. Saveliev

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This volume presents the abstracts of work on the experimental and theoretical analysis of nuclear reactions involving particles with energies up to about 20 MeV and also on nuclear fission. It covers work carried out at a number of institutes in the Soviet Union during the first half of 1966.

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INSTITUTE OF PHYSICS AND ENERGETICS
(F.E.I.)

DETERMINATION OF LEVEL DENSITIES AND OF THE PARAMETER a FROM DATA ON AVERAGED CAPTURE CROSS-SECTIONS

S.P. Kapchigashev and Yu.P. Popov

Cross-sections for the radiative capture of neutrons with energies less than 50 keV, averaged over many resonances, were analysed with a view to obtaining the parameter $\left\langle \frac{\Gamma_\gamma}{D_0} \right\rangle$.

From this parameter, using radiation widths measured for individual resonances, the authors calculated the level densities for nuclei with mass numbers in the range 51-205 and the values of the parameter a, signifying the density of single-nucleon states near the Fermi surface. The results coincide essentially with data obtained from calculations of low-lying resonances. The general shape of the a(A) curve agrees with the theoretical curve of Abdelmalek and Stavinsky. The level density parameter a is shown as a function of the nuclear mass number in Table 1, which also gives the corresponding nuclear excitation energies (E).

Table 1

Target nucleus	E (MeV)	a (MeV^{-1})
^{51}V	7.30	6.5 ± 0.5
^{63}Cu, ^{65}Cu	7.64	5.6 ± 0.4
^{69}Ga, ^{71}Ga	7.44	9.0 ± 0.7
^{75}As	7.30	10 ± 1.0
^{79}Br, ^{81}Br	7.86	11.0 ± 0.5
^{85}Rb, ^{87}Rb	7.94	8.5 ± 0.7
^{89}Y	6.63	7.0 ± 1.0
^{90}Zr	6.20	8.0 ± 0.3
^{91}Zr	6.49	9.7 ± 0.3
^{92}Zr	5.80	9.75 ± 0.3
^{94}Zr	5.50	9.0 ± 0.3
^{93}Nb	7.20	11.5 ± 0.3
^{95}Mo	6.41	12.5 ± 0.6
^{96}Mo	5.46	11.7 ± 0.3
^{97}Mo	6.0	13.0 ± 0.5
^{98}Mo	5.0	13.0 ± 0.5
^{100}Mo	4.6	14.5 ± 0.5
^{103}Rh	6.80	15.5 ± 0.4
^{107}Ag, ^{109}Ag	6.85	15.5 ± 0.5
^{115}In	6.60	16.2 ± 0.3
^{116}Sn	5.65	13.2 ± 0.5
^{117}Sn	6.4	14.0 ± 0.6
^{119}Sn	6.18	13.5 ± 0.6
^{122}Sn	4.45	13.2 ± 0.5
^{124}Sn	4.54	13.0 ± 0.5
^{121}Sb, ^{123}Sb	6.67	15.5 ± 0.5
^{127}I	6.57	15.5 ± 0.3
^{133}Cs	6.77	14.2 ± 0.5
^{139}La	5.03	12.6 ± 0.5
^{141}Pr	5.85	12.5 ± 0.5
^{147}Sm	5.14	22.5 ± 0.5
^{149}Sm	5.27	23.5 ± 0.5
^{151}Eu	6.50	22.0 ± 0.5
^{153}Eu	6.20	22.2 ± 0.3
^{159}Tb	6.10	21.0 ± 0.5
^{165}Ho	5.80	20.5 ± 0.3
^{175}Lu	5.80	19.5 ± 0.5
^{181}Ta	6.03	20.0 ± 0.5
^{183}W	6.00	19.0 ± 1.0
^{184}W	5.25	19.0 ± 1.0
^{186}W	4.93	20.5 ± 0.5
^{191}Ir, ^{193}Ir	5.80	21.5 ± 0.5
^{197}Au	6.42	16.5 ± 0.5
^{203}Te Tl	6.53	11.0 ± 0.5
^{205}Te	6.15	9.0 ± 1.0

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POLARIZATION OF 3.25-MeV NEUTRONS IN SCATTERING

L.Ya. Kazakova, V.E. Kolesov, V.I. Popov,
V.M. Sluchevskaya and V.I. Trykova

The authors measured the polarization that accompanies the elastic scattering of 3.25-MeV neutrons through 120° by the nuclei of twenty light and medium elements. The measurements were carried out with the help of a collimated neutron beam and a threshold scintillation detector. The measured polarization values are shown in Table 1.

Table 1

Element	P
Lithium	−0.43 ± 0.28
Beryllium	−0.07 ± 0.12
Boron	−0.04 ± 0.16
Carbon	−0.20 ± 0.08
Oxygen	0.45 ± 0.18
Sodium	−0.58 ± 0.24
Magnesium	−0.55 ± 0.34
Aluminium	−0.35 ± 0.16
Silicon	−0.32 ± 0.13
Phosphorus	−0.42 ± 0.17
Sulphur	−0.56 ± 0.25
Titanium	−0.48 ± 0.19
Chromium	0.0[illegible] ± 0.26
Manganese	−0.34 ± 0.14
Nickel	−0.18 ± 0.07
Copper	−0.45 ± 0.18
Zinc	−0.22 ± 0.10
Strontium	−0.25 ± 0.19
Antimony	−0.50 ± 0.20
Barium	0.25 ± 0.14

Polarization calculations based on the optical model with the Björklund-Fernbach potential are not in agreement with the values given in Table 1.

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SCATTERING OF NEUTRONS WITH AN INITIAL ENERGY OF 2 MeV

L.Ya. Kazakova, V.E. Kolesov, V.I. Popov, V.M. Sluchevskaya,
V.I. Trykova and O.A. Salnikov

Using a collimated neutron beam and a threshold scintillation detector, the authors measured differential cross-sections for the elastic scattering of neutrons. Twenty-four elements, from sodium to thorium, were considered. The experimental results were compared with calculations based on the optical model. The agreement between the theoretical and experimental values was found to be satisfactory. The integral elastic scattering cross-sections obtained experimentally are presented in Table 1.

Table 1

Element	σ_{el} (barn)	Element	σ_{el} (barn)
^{23}Na	2.6	^{93}Nb	3.3
^{31}P	3.3	^{96}Mo	3.5
^{35}Cl	3.1	^{108}Ag	3.2
^{48}Ti	3.0	^{112}Cd	3.9
^{52}Cr	2.5	^{122}Sb	5.2
^{55}Mn	3.2	^{127}I	5.0
^{56}Fe	2.3	^{137}Ba	6.6
^{59}Ni	2.5	^{181}T	4.1
^{64}Cu	2.1	^{181}W	4.4
^{65}Zn	2.6	^{201}Hg	4.1
^{80}Br	2.1	^{209}Bi	6.3
^{88}Sr	4.7	^{232}Th	5.0

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DETERMINATION OF THE RADIATION WIDTHS OF ^{58}Ni, ^{56}Fe AND ^{40}Ca LEVELS FROM TOTAL NEUTRON CROSS-SECTION MEASUREMENTS

E.Ya. Doilnitsyn

The author describes a method of determining the radiation width of nuclear levels from the measured total neutron cross-sections of ^{58}Ni, ^{56}Fe and ^{40}Ca. The values obtained by the author in this way are as follows:

^{58}Ni: $\Gamma_\gamma = (0.3 \pm 0.1)$ eV

^{56}Fe: $\Gamma_\gamma = (0.9 \pm 0.2)$ eV

^{40}Ca: $\Gamma_\gamma = (0.75 \pm 0.15)$ eV

Analysis of the values obtained for Γ_γ and of the total neutron cross-sections shows that, for neutron energies less than 5 keV, the radiative capture cross-section of the nuclei considered depends essentially on the negative levels.

MEASUREMENTS OF CROSS-SECTIONS FOR THE RADIATIVE CAPTURE OF FAST NEUTRONS BY $^{63}_{29}$Cu

V.A. Tolstikov, V.P. Koroleva, V.E. Kolesov
and A.G. Dovbenko

Using the relative activation method, the authors carried out exhaustive measurements of the cross-section for the radiative capture of neutrons in the 0.17-3.7 MeV energy range by $^{63}_{29}$Cu. The cross-sections for ^{235}U fission by fast neutrons, for thermal neutron capture by $^{63}_{29}$Cu and for ^{235}U fission by thermal neutrons were used as reference cross-sections. The results of the measurements were compared with calculations based on the statistical theory of nuclear reactions. Table 1 shows the cross-section for the radiative capture of neutrons by $^{63}_{29}$Cu as a function of neutron energy and the cross-section for ^{235}U fission, $\sigma_{f,5}(E_n)$, used as a reference.

Table 1

E_n (keV)	$\sigma_{(n,\gamma)}$ (mbarn)	$\sigma_{f,5}$ (barn)
1	2	3
171	35.3 ± 0.8	1.71
266	25.6 ± 0.5	1.40
303 ± 37	21.6 ± 0.3	1.37
377	19.6 ± 1.1	1.35
418 ± 35	21.2 ± 0.2	1.31
456	19.3 ± 1.0	1.27
529 ± 35	16.6 ± 0.4	1.26
536	16.8 ± 0.6	1.26
635 ± 34	16.1 ± 0.3	1.20
708	15.6 ± 0.6	1.17
741	14.1 ± 0.2	1.17
887	15.9 ± 0.5	1.22
949 ± 33	14.0 ± 0.2	1.26
1061	14.6 ± 1.1	1.27
1154 ± 33	14.8 ± 1.5	1.27
1157	12.8 ± 1.1	1.27
1356 ± 32	10.6 ± 0.6	1.25
1459 ± 34	10.8 ± 0.5	1.26

The results of the calculations based on the statistical theory of nuclear reactions are in satisfactory agreement with the $\sigma_{(n,\gamma)}$ values given in Table 1.

CROSS-SECTION FOR RADIATIVE NEUTRON CAPTURE AT STELLAR TEMPERATURES AND THE ABUNDANCE OF ELEMENTS

S.P. Kapchigashev and V.S. Shorin

On the basis of the most recent experimental values for the neutron capture cross-sections of separated isotopes the authors calculated the product of the abundance of screened nuclei, N_s, and the capture cross-section, σ_γ, at 25 keV. The $N_s\sigma_\gamma$ values obtained were found to be 2-3 times lower than the estimates made by Clayton and Fowler. The shape of the $N_s\sigma_\gamma = f(A)$ curve confirms the prediction of the s-process theory. With the help of the f(A) curve and on the basis of capture cross-section data, the authors calculated N_s and N_r for the isotopes formed in the mixed chain (Fig. 1). The results of the calculations show a larger contribution by the r-process to the formation of heavy elements than had been expected. The $N_s(A)$ and $N_r(A)$ curves demonstrate the effects of closed shells, spheroid deformation and an even number of nucleons in the nucleus.

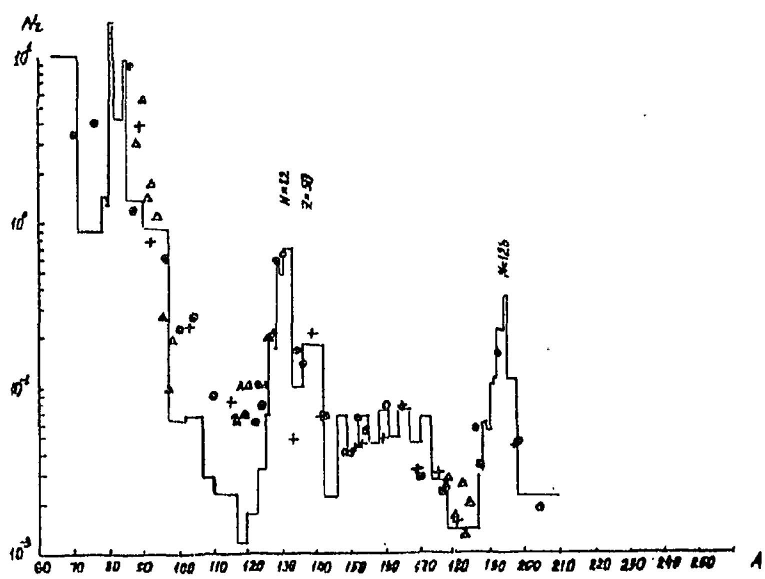

Fig. 1

● – only the r-process

▲ Δ – the r-process; estimated for even-odd and even-even isotopes

\+ – the r-process, for monoisotopic elements.

NEUTRON CAPTURE CROSS-SECTIONS FOR YTTRIUM IN THE ENERGY REGION UP TO 50 keV

A.A. Bergman, S.P. Kapchigashev and A.V. Shapar

Using a spectrometer for measuring slowing-down time in lead, belonging to the USSR Academy of Sciences, P.N. Lebedev Physics Institute, the authors measured the cross-sections for the radiative capture of neutrons by yttrium in the energy range 0.2 eV-50 keV.

The averaged cross-section at 30 keV and the calculated total resonance integral are in good agreement with the results of Macklin and other authors.

Fig. 1 shows the cross-section for radiative neutron capture in yttrium as a function of neutron energy. The circles indicate the results of the present work, the dots denoting the results of other authors.

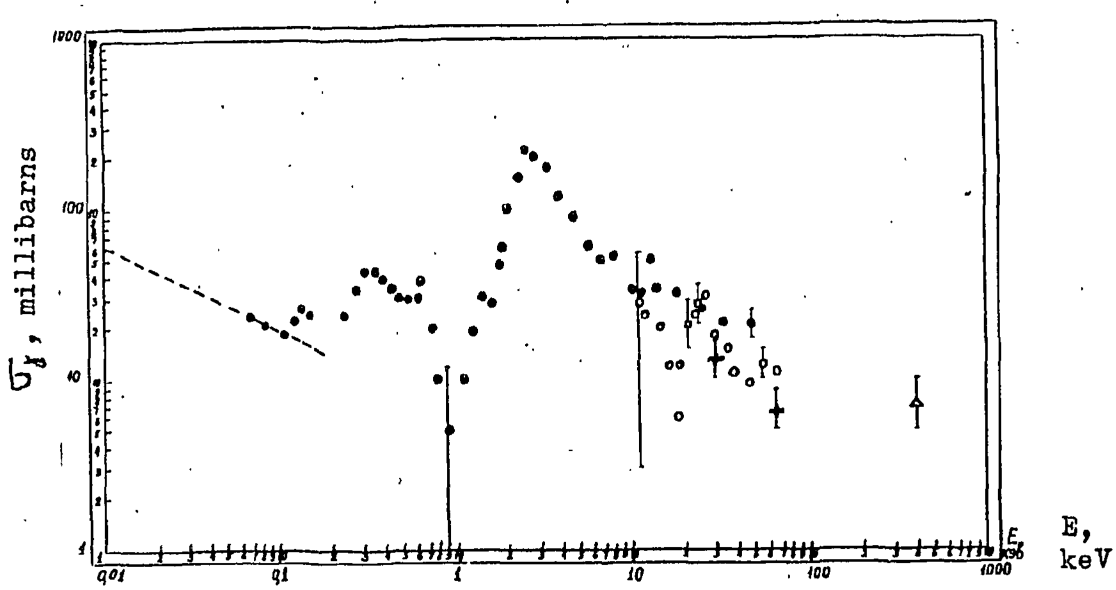

Fig. 1 - Neutron capture cross-section for yttrium up to 50 keV.

E2-TRANSITIONS AND THE EFFECTIVE QUADRUPOLE CHARGE ON ODD NEAR-MAGIC NUCLEI

S.P. Kamerdzhiev (In press)

Using the theory of finite Fermi systems, the author calculates the probabilities of low-energy transitions and the effective quadrupole charges on nuclei having one nucleon in excess of the doubly filled core. He also calculates the quadrupole moments of these nuclei. Taking for his constants values that accord with those of other authors, he obtains satisfactory agreement with existing experimental data.

EFFECT OF GROUPING DEGENERATE SINGLE-PARTICLE LEVELS ON THE DENSITY OF THE ENERGY STATES OF ATOMIC NUCLEI

Yu.N. Shubin and V.S. Stavinsky

On the basis of an analysis of experimental data relating to the level density of nuclei with an excitation energy close to the neutron binding energy, it is shown that the grouping of degenerate single-particle levels into shells has a noticeable effect on a (a parameter of the equation of state of a strongly degenerate Fermi system). A semi-empirical formula is obtained for calculating a with a high degree of accuracy for a nucleus with given values of Z and N.

METHOD OF DETERMINING α-NEUTRON STRENGTH FUNCTIONS FOR EVEN-EVEN NUCLEI FROM RADIATIVE CAPTURE CROSS-SECTIONS

V.N. Kononov

(In press)

It is shown that, by measuring reductions in the radiative capture cross-section caused by competition from inelastic scattering at the 2^+ level, it is possible to obtain the partial cross-section for the capture of neutrons with orbital angular momentum $\ell = 2$ and the corresponding neutron strength functions.

NUCLEAR REACTION YIELDS IN THE CYCLOTRON PRODUCTION OF ^{22}Na

N.N. Krasnov and P.P. Dmitriev

(In press)

The authors determined experimentally the relationship between ^{22}Na yield and particle energy when a thick target of metallic magnesium is bombarded with 20-MeV deuterons and 22-MeV protons. The results are compared with those of other authors.

DETERMINATION OF THE HALF-LIFE OF MOLYBDENUM-93 FROM NUCLEAR REACTION YIELDS

P.P. Dmitriev, I.O. Konstantinov and N.N. Krasnov

(In press)

The half-life of ^{93}Mo was determined by comparing the yields of (d, 2n) reactions involving odd-even target nuclei with a mass number in the region of 100. The work was carried out on the F.E.I. cyclotron with a deuteron energy of 21 MeV. A half-life value of 2600 $\pm$ 600 years was obtained. Values are presented for the yields of the following nuclear reactions: ^{85}Rb(d,2n)^{85}Sr, ^{93}Nb(d,2n)^{93}Mo, ^{103}Rh(d,2n)^{103}Pd, ^{109}Ag(d,2n)^{109}Cd.

FISSION PRODUCT CHARGE DISTRIBUTION

A.V. Ignatyuk

The author studies the possibility of describing theoretically experimental data on the charge distribution of fragments produced by low-energy fission. He considers in particular various ideas concerning the most probable charge on fragments with a given mass number. It is shown that the rule whereby the beta decay chains following neutron emission by fission fragments have to be of equal length accords well with available experimental data for the reactions $^{235}U\ (n_T, f)$, $^{233}U\ (n_T, f)$ and $^{239}Pu\ (n_T, f)$, if experimental values or the mass formula with allowance for shell terms are used in determining the valley of the stable nuclei. The most probable charge on the fission fragments can also be derived fairly well from the condition that the potential energy of touching fragments has a minimum, if one takes into account the effects of shell structure on the "deformability" of the fragments (Fig. 1). The "deformability" of the fragments was found from the charge distribution for the reaction $^{235}U\ (n_T, f)$.

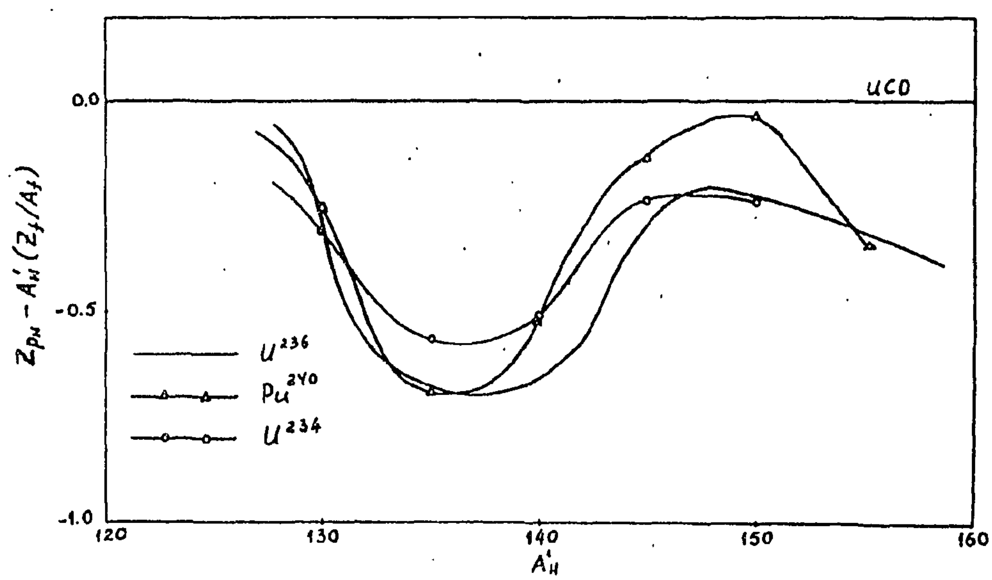

Fig. 1

SUB-THRESHOLD FISSION OF THORIUM-232 BY NEUTRONS

S.B. Ermagambetov, V.F. Kuznetsov and G.N. Smirenkin

(In press)

For the purpose of studying the $^{232}Th(n,f)$ reaction near the threshold, the authors measured the cross-section for this reaction as a function of neutron energy in the range 0.6-3.0 MeV.

MASS AND KINETIC ENERGY DISTRIBUTION OF FRAGMENTS RESULTING FROM FISSION OF URANIUM-233 BY THERMAL AND FAST NEUTRONS

V.I. Senohenko, M.Z. Tarasko, V.B. Mikhailov and B.D. Kuzminov

(Submitted to Jadernaja fizika)

The authors measured the mass and kinetic energy distribution of fragments resulting from the fission of ^{233}U by thermal neutrons and neutrons having an energy of 1 MeV, 5.6 MeV, 6 MeV and 7 MeV. In fission by fast neutrons, the kinetic energies of heavy fragments with mass numbers in the range 124-134 decrease, while those of fragments with a mass number of 144 increase, the maximum of the distribution of the kinetic energies shifting from mass number 120 to mass number 124. The ratio of the yield of symmetrical fragments in fission by 5.6-MeV neutrons to that for fission by thermal neutrons is about 7.

INSTITUTE OF THEORETICAL AND EXPERIMENTAL PHYSICS

INTERFERENCE EFFECTS IN THE CROSS-SECTION FOR RADIATIVE NEUTRON CAPTURE BY SAMARIUM-149

I.V. Kirpichnikov

The author measured the gamma-ray yield from a samarium sample (80 g of Sm_2O_3, ~ 1 g/cm^2) as a function of neutron energy. The measurements were made in the neutron energy range 0.35-1.1 eV with the neutron spectrometer of a pulsed cyclotron for a flight length of 2.5 m and a spectrometer time resolution of approximately 2 μsec/m. An NaI(Tl) crystal measuring 120 x 85 mm was used as gamma-ray detector. The author separated the portion of interest from the gamma-ray spectrum by means of a single-channel differential pulse-height analyser. To control the background level, cadmium (0.3 g/cm^2) and indium (0.07 g/cm^2) filters were placed in the neutron beam.

Fig. 1 shows the experimental results for two levels of discrimination corresponding to gamma energies in the ranges 2-2.5 MeV and 6.5-7.2 MeV. Fig. 2 shows for each level of neutron energy the ratio of the interference effect at a high level of discrimination, I_{hd}, to the effect at a low level of discrimination, I_{ld}. The point at a neutron energy of approximately 0.1 eV is obtained from special measurements, the results being arranged in groups corresponding to three neutron energy ranges: 0.48-0.12 eV, 0.05-0.03 eV, and 0.02-0.01 eV.

The ratio of the effects at high and low levels of discrimination is proportionate to the ratio of the transition abundances in the separate energy ranges. Curve 1 in Fig. 2 shows the I_{hd}/I_{ld} ratio to be expected when there is no interference between resonance levels. The value of the ratio $I_{hd}(0.9\ eV)/I_{hd}(0.1\ eV)$, which is needed for the calculations, is assumed to be 2.5. It is also assumed that, at a low level of discrimination, the effect is proportionate to the radiative capture cross-section.

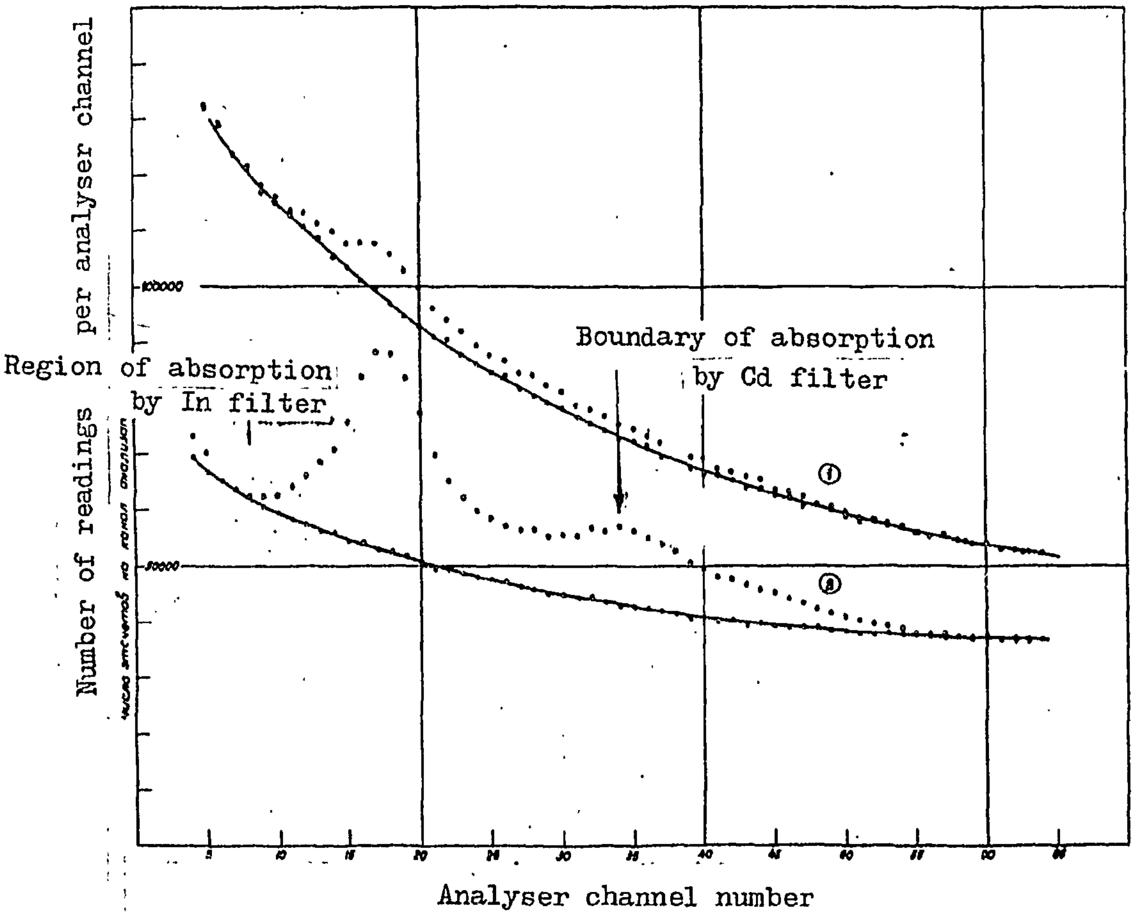
Number of readings per analyser channel
Region of absorption by In filter
Boundary of absorption by Cd filter
Analyser channel number

Fig. 1

From an analysis of the results, it may be concluded that there is "positive interference" between the 0.1-eV and 0.9-eV levels. The author compares the experimental data with the interference formula for the two levels. In his calculations the following ^{149}Sm resonance parameters were used:

E_{01} = 0.095 eV, $2g\Gamma_{n1}$ = 0.0746 meV, E_{02} = 0.872 eV, $2g\Gamma_{n2}$ = 0.127 meV and $\Gamma_1 = \Gamma_2$ = 0.063 eV.

The interference term was given in the form $\pm 2a\sqrt{\delta_1 \delta_2}$, where δ_1 and δ_2 denote the cross-sections for the first and second levels calculated by the Breit-Wigner formula.

Fig. 2 shows the theoretical results for a = 1, 0.33 and 0 (a = 1 corresponds to maximum possible interference).

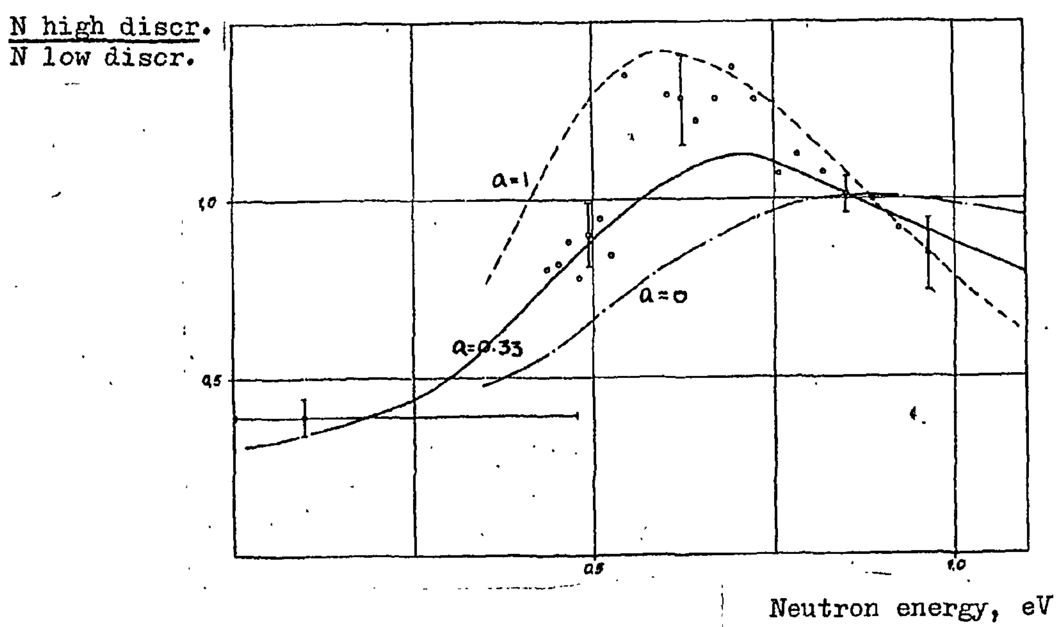

Fig. 2

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MEASUREMENT OF THE ENERGIES OF THE PRINCIPAL ALPHA TRANSITIONS IN ACTINIUM-225

B.S. Dzhelepov, P.B. Ivanov, L.N. Moskvin and V.F. Rodionov

(Submitted to Izv. Akad. Nauk, SSSR, fiz. ser.)

Using a magnetic alpha spectrometer capable of focussing particles through an angle $\pi\sqrt{2}$, the authors measured the energies of a number of transitions in the alpha decay of ^{225}Ac. The measurements were made by comparing the energies of these transitions with those of the principal alpha transitions of ^{244}Cm, ^{239}Pu and ^{238}Pu. The results are shown in the table:

Transition energy (keV)	Abundance (%)	Transition energy values obtained by Valli (keV)
5829 ± 2	51.6	5829 ± 5
5792 ± 3	26.7	5793 ± 5
5681 ± 3	1.4	5683 ± 5
5638 ± 3	4.5	5638 ± 5
5609 ± 3	1.1	5610 ± 10
5579 ± 3	1.2	5581 ± 10
5286 ± 3	0.23	5295 ± 10

From the data obtained it is also possible to determine with greater accuracy the energies of the other alpha transitions.

STRUCTURE OF THE KINETIC ENERGY SPECTRA OF FRAGMENTS RESULTING FROM URANIUM-235 FISSION BY FAST NEUTRONS.

Yu.M. [illegible]ev, I.A. Barkov, Yu.I. Belyanin,
A.V. Gromov, A.N. Protopopov and B.M. Shiryaev

(submitted to Jadernaja fizika)

Study of the kinetic energy spectra of fragments resulting from fission of ^{233}U, ^{235}U and ^{239}Pu by thermal neutrons has shown that the energy spectra of the heavy fragments possess a certain structure, which can be discerned if the energies of the light fragments are fixed.

The aim of the present work was to ascertain whether there existed a similar structure when compound nuclei were subjected to far greater excitation. The authors measured the energy spectra of the heavy fragments resulting from ^{235}U fission by 14.9-MeV neutrons.

The fission fragments were recorded by means of a double ionization chamber. With the help of a single-channel analyser the energies of the light fragments were fixed in one half of the chamber, while the spectrum of the complementary heavy particles was recorded by means of a multichannel analyser.

The heavy-fragment energy spectra corresponding to light-fragment energies of 99.2 MeV, 107 MeV and 109.5 MeV reveal a structure that reflects the preferential yield of fragments with mass numbers 139, 140, 145, 146, 150 and 151. This suggests that, in ^{235}U fission by 14.9-MeV neutrons, nucleon pair correlations continue to be of considerable importance and, as in low-energy fission, lead to the preferential formation of even-even fragments.

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RELATIONSHIP BETWEEN THE ANISOTROPY OF GAMMA RADIATION ACCOMPANYING THE FISSION OF URANIUM-235 BY THERMAL NEUTRONS AND THE MASS RATIO OF THE FRAGMENTS

G.V. Valsky, G.A. Petrov and Yu.S. Pleva

(submitted to Jadernaja fizika)

In a number of works on the gamma radiation accompanying fission it has been found that the probability of gamma emission is 12-15% greater when the angle to the line along which the fragments fly apart is 0° than when it is 90°.

The authors of the present work measured, for ^{235}U fission by thermal neutrons, the ratio of the intensities of gamma-ray emission at angles of 30° and 90° to the line along which the fragments fly apart, $N(30^{\circ})/N(90^{\circ})$, as a function of the mass ratio of the fragments.

They found that the ratio $N(30^{\circ})/N(90^{\circ})$ was weakly dependent on the masses of the fragments formed. However, in the region corresponding to a heavy fragment mass $M_h \simeq 133$, where there is a concentration of nuclei with closed shells, a slight minimum is observed.

The results of the two sets of measurements are presented in the form of histograms in Fig. 1, which also shows the experimental yield of fragments having different masses, B(%).

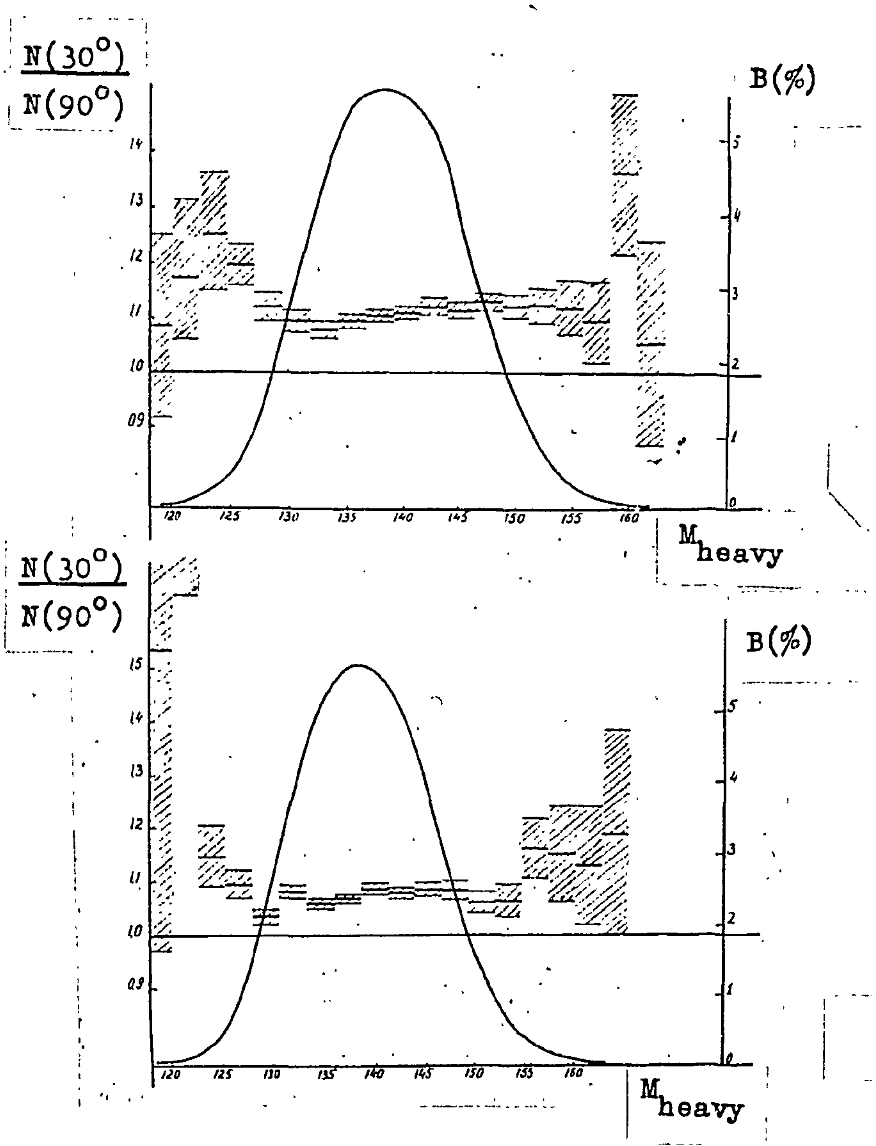

Fig. 1

MEASUREMENT OF CROSS-SECTIONS FOR NEUTRON CAPTURE BY RADIOACTIVE COBALT-58m AND SCANDIUM-46

I.A. Kondurov, A.I. Egorov, D.M. Kaminker,
E.M. Korotkikh and A.M. Nikitin

When nickel is irradiated with neutrons from a reactor in the $^{58}Ni(n,p)$ reaction, ^{58m}Co is formed. The resonance integral and the cross-section for the capture of thermal neutrons by this nucleus in the $^{58}Co(n,\gamma)^{59}Co$ reaction are found by measuring the burnup of ^{58m}Co in an intense neutron beam in a water-filled cavity of the Institute's water-water power reactor.

The upper limit of the cross-section for the $^{46}Sc(n,\gamma)^{47}Sc$ reaction was also found by measuring the accumulation of ^{47}Sc and comparing it with the amount of ^{46}Sc. The results were as follows:

1. ^{58m}Co burnup cross-section for a neutron velocity of 2200 m/sec
   $\sigma_{2200} = (136 \pm 10) \times 10^3$ barn;
2. Burnup resonance integral ($\frac{1}{v}$ part subtracted)
   $\Sigma' = (760 \pm 160) \times 10^3$ barn;
3. Reactor cross-section for the $^{46}Sc(n,\gamma)^{47}Sc$ reaction
   $\sigma \leq 2$ barn;
4. Relative yield of ^{58m}Co and ^{58}Co in the $^{58}Ni(n,p)^{58}$, ^{58m}Co reaction induced by fast neutrons from a reactor
   $\sigma_m/\sigma_o = 0.480 \pm 0.004$.

The fluxes at the point of irradiation were found from the activation of the ^{59}Co, for which the following values were taken: $\sigma_{2200} = 35.7 \pm 1.0$ barn and $S_o = 1.60 \pm 0.08$ barn (S_o - Westcott notation).

The authors evaluated the possibility of additional, transient reactor poisoning due to neutron capture by the ^{58m}Co nuclei formed in the nickel used for construction.

JOINT INSTITUTE FOR NUCLEAR RESEARCH
(J.I.N.R.)

EXPERIMENTAL SELECTION OF A PREFERRED SET OF SCATTERING LENGTHS FOR NEUTRON SCATTERING BY DEUTERIUM

V.P. Alfimenkov, V.I. Lushchikov, V.G. Nikolenko,
Yu.V. Taran and F.L. Shapiro

Using the pulsed fast reactor of the Institute's nuclear physics laboratory, the authors investigated the interaction of polarized slow neutrons with polarized deuterons. A neutron beam with polarization up to 70% was obtained by filtering the neutrons through a polarized proton target. The deuterons were polarized (to 15-20%) dynamically in a $(^{142}Nd_{0.005}La_{0.995})_2Mg_3(NO_3) \times 24\ D_2O$ crystal at a temperature of 1.3°K in a 17 000 oersted magnetic field. The measurements of transmission through the deuterium target showed that, in accordance with the results of most theoretical works on n-d interaction, the best set of scattering lengths is one in which the quartet length is greater than the doublet length.

SCATTERING OF NEUTRONS IN THE KILOVOLT RANGE BY LEAD AND THE ELECTRIC POLARIZABILITY OF NEUTRONS

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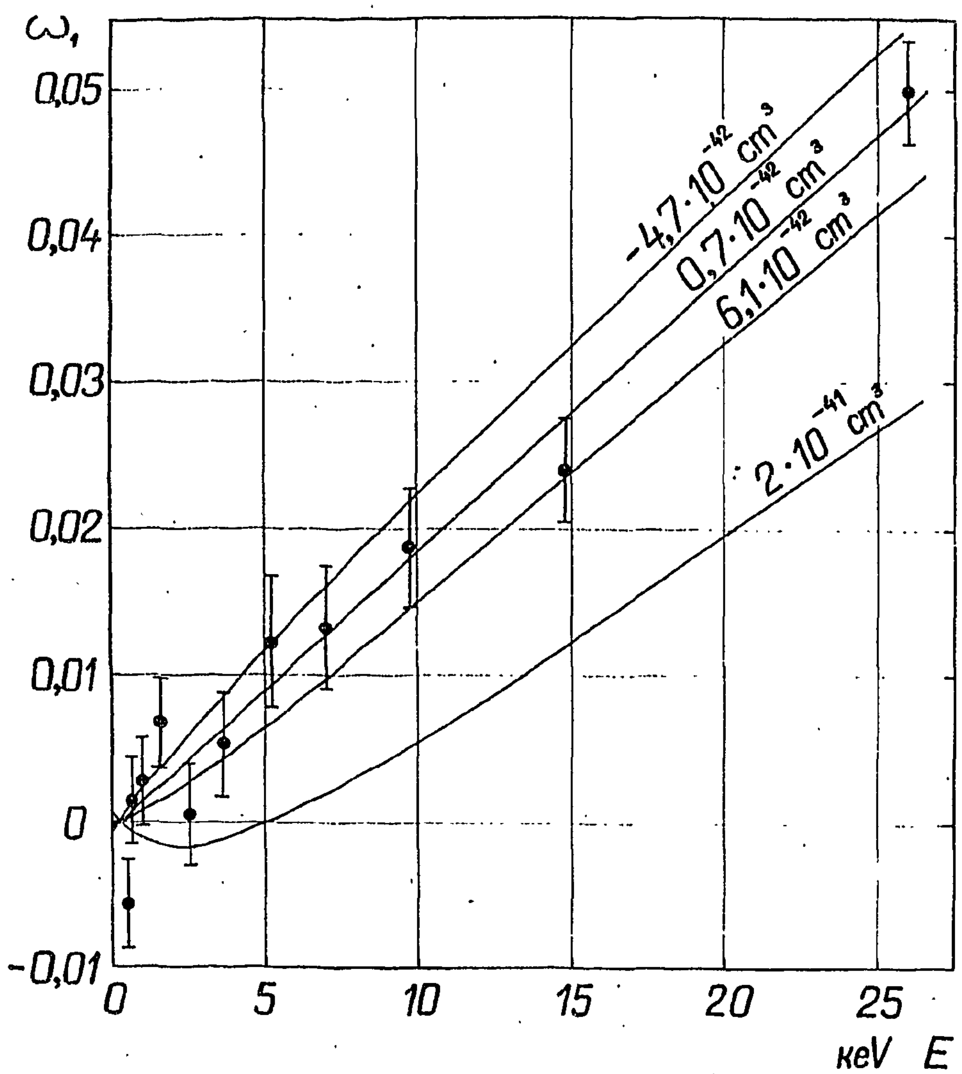
and Tsoy Gen Sor

Preprint P-2764, Dubna, 1966

The authors carried out precision measurements of the angular distributions of neutrons with energies up to 25 keV scattered in lead through angles varying from 30° to 150°. These distributions were approximated by the expression $y(\vartheta) = C(1 + \omega_1 \cos \vartheta)$. Fig. 1 shows the experimental values of the coefficient ω_1 for various neutron energies, E. Analysis of the results shows that the coefficient of electrical polarizability of neutrons α_n lies in the range $-4.7 \times 10^{-42} cm^3 < \alpha_n < 6.1 \times 10^{-42} cm^3$.



ω,
0,05
0,04
0,03
0,02
0,01
0
-0,01
0
5
10
15
20
25
keV E
-4,7·10^-42 cm^3
0,7·10^-42 cm^3
6,1·10^-42 cm^3
2·10^-41 cm^3

Fig. 1

INVESTIGATION OF THE NEUTRON RESONANCES OF HOLMIUM-165

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Preprint P-2593, Dubna, 1966.

The parameters of the neutron resonances of ^{165}Ho for neutrons with energies up to 500 eV were obtained by measuring transmission, self-indication (with a resolution of 0.06 μsec/m), and the gamma emission curves for neutron capture (with a resolution of 0.006 μ sec/m). The parameters of the observed resonances are given in Table 1. The strength function and mean radiation width for ^{165}Ho were found to be $S_o = (1.9 \pm 0.3) \times 10^{-4}$ and $\overline{\Gamma}_\gamma = (70 \pm 3) \times 10^{-3}$ eV respectively.

The resonance parameters were determined with the help of a computer, both by means of the area method and by analysing the shape of the transmission curves with allowance for the resolution function. With the programme devised and using the least squares method, it is possible to analyse simultaneously the transmission curves for several samples of different widths.

Table 1

No.	E_o (ev)	Γ (meV)	$g\Gamma_n$ (meV)	$2g\Gamma_n^o$ (meV)	No.	E_o (eV)	$g\Gamma_n$ (meV)	$2g\Gamma_n^o$ (meV)
1.	3.91	57±10	1.0 ±0.1	1.0 ±0.1	46.	260.9	20 ±2	2.5 ±0.3
2.	8.15	55±15	0.08±0.01	0.056±0.005	47.	272.5		
3.	12.6	65±10	9.0 ±1.0	5.1 ±0.05	48.	273.7		
4.	18.1	70± 5	0.55±0.02	0.26 ±0.01	49.	276.8	6.1±0.5	0.73 ±0.06
5.	21.0	83± 5	0.33±0.01	0.146±0.004	50.	280.8	8.7±0.6	1.03 ±0.07
6.	35.3	80± 5	3.20±0.14	1.08 ±0.05	51.	287.4	5.0±0.2	0.60 ±0.02
7.	37.0		0.30±0.03	0.10 ±0.01	52.	291.4	14 ±1	1.6 ±0.1
8.	39.4	86± 7	13 ±1	4.1 ±0.3	53.	297.0	13 ±1	1.5 ±0.1
9.	47.3	110±10	12 ±1	3.5 ±0.3	54.	300.0	(50)	(5.8)
10.	51.2	113±10	26 ±2	7.3 ±0.6	55.	306.6	3.3±0.6	0.37 ±0.07
11.	54.0	69± 8	1.8 ±0.1	0.49 ±0.03	56.	312.8	7.0±0.06	0.79 ±0.07
12.	64.7	86± 6	11.0 ±0.5	2.7 ±0.1	57.	320.3	8.3±0.7	0.93 ±0.08
13.	68.2	66±12	0.54±0.03	0.13 ±0.01	58.	323.4	19 ±2	2.1 ±0.2
14.	71.4	93± 3	11.4 ±0.2	2.70 ±0.05	59.	327.8	3.1±0.4	0.34 ±0.04
15.	79.4	54±16	0.64±0.04	0.14 ±0.01	60.	331.8	34 ±3	3.7 ±0.3
16.	83.9		7.8 ±0.5	1.7 ±0.1	61.	339.1	55 ±15	6.2 ±2
17.	84.8		2.4 ±0.2	0.52 ±0.04	62.	341.5	7.1±0.7	0.77 ±0.08
18.	85.7		(40)	(8.6)	63.	350.0		
19.	93.6	162± 8	45 ±2	9.3 ±0.4	64.	351.3		
20.	101.9	86± 4	10.6 ±0.2	2.11 ±0.04	65.	353.8	16 ±2	1.7 ±0.2
21.	106.3	72±13	4.4 ±0.2	0.86 ±0.04	66.	358.5	3.6±0.4	0.38 ±0.04
22.	117.8		6.3 ±0.3	1.16 ±0.06	67.	366.1	15 ±2	1.6 ±0.2
23.	120.6		2.9 ±0.2	0.52 ±0.3	68.	374.1	32 ±2	3.3 ±0.2
24.	124.7		26 ±3	4.6 ±0.5	69.	384.3		
25.	126.8		15 ±1	2.7 ±0.2	70.	400.5	9.4±0.8	0.94 ±0.08
26.	128.4		10.3 ±0.5	1.8 ±0.1	71.	404.4	37 ±4	3.7 ±0.4
27.	141.1		0.72±0.09	0.12 ±0.02	72.	414.7		
28.	149.2		1.6 ±0.2	0.26 ±0.03	73.	416.4		
29.	150.9		21 ±2	3.4 ±0.3	74.	422.4	12 ±1	1.2 ±0.1
30.	163.1		2.4 ±0.2	0.37 ±0.03	75.	429.8	45 ±5	4.3 ±0.5
31.	164.3		8.7 ±0.5	1.4 ±0.1	76.	433.6		
32.	169.7		9.9 ±0.4	1.50 ±0.07	77.	436.2		
33.	174.5		2.0 ±0.2	0.30 ±0.03	78.	438.2		
34.	180.8		22 ±2	3.3 ±0.3	79.	442.8	25 ±3	2.4 ±0.3
35.	188.7		10.2 ±0.6	1.5 ±0.1	80.	446.8		
36.	192.5		3.6 ±0.3	0.52 ±0.04	81.	450.2	38 ±4	3.6 ±0.4
37.	195.2		1.3 ±0.2	0.19 ±0.03	82.	454.4	5.2±0.9	0.49 ±0.08
38.	202.1		42 ±10	5.9 ±1.4	83.	460.8	5.8±0.9	0.54 ±0.08
39.	204.9		4.8 ±0.4	0.67 ±0.05	84.	474.2		
40.	214.6		20 ±2	2.8 ±0.3	85.	478.8		
41.	220.4		15 ±1	2.0 ±0.2	86.	485.2	24 ±3	2.1 ±0.3
42.	229.9		4.8 ±0.4	0.63 ±0.05	87.	487.6		
43.	232.4		4.1 ±0.3	0.54 ±0.04	88.	495.0	54 ±5	4.8 ±0.4
44.	239.4		16 ±1	2.1 ±0.1	89.	510.4		
45.	254.1		(70)	(8.8)				

LEVEL PARAMETERS OF PLUTONIUM-239

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(submitted to Jadernaja fizika)

Preprint P-2713, Dubna, 1966.

Using the Institute's time-of flight neutron spectrometer, the authors obtained (with a resolution of 0.06 μsec/m) the fission and radiative capture cross-sections of ^{239}Pu for neutron energies in the range 6 eV-15 keV. The results were processed by computer using the area method. Table 1 shows the level parameters of ^{239}Pu for neutron energies up to 100 eV.

Table 1

E_0 (eV)	Γ_f/Γ	Γ_f (meV)	$2g\Gamma_n$ (meV)
7.84±0.01	0.52±0.03	44± 10	1.28±0.22
10.97±0.02	0.78±0.08	153± 75	2.7 ±0.5
11.5	0.73	110	0.41
11.91±0.02	0.41±0.03	28± 7	1.34±0.22
14.36±0.02	0.59±0.05	60± 16	0.90±0.14
14.75±0.03	0.43±0.03	32± 9	2.14±0.54
15.47±0.06	0.88±0.08	360±360	1.20±0.14
17.69±0.03	0.50±0.03	42± 13	1.9 ±0.3
22.33±0.04	0.55±0.04	52± 18	2.88±0.46
23.9 ±0.1	0.37±0.09	23± 9	0.21±0.05
26.37±0.06	0.45±0.03	34± 6	2.26±0.30
27.3	0.63	68	0.25
32.4 ±0.1	0.68±0.07	85± 21	0.48±0.06
35.6	0.23	12	0.71
41.64±0.12	0.34±0.02	22± 4	5.5 ±1.1
44.74±0.12	0.18±0.02	10± 3	5.96±0.84
47.92±0.15	0.67±0.07	88± 30	3.04±0.38
49.6	0.76	129	0.33
50.18±0.16	0.46±0.03	37± 10	4.8 ±0.8
52.9 ±0.2	0.21±0.02	13± 3	8.9 ±1.3
55.9 ±0.4	0.46±0.05	36± 10	2.6 ±0.5
57.8 ±0.2	0.66±0.06	91± 43	8.6 ±0.8
58.6 ±0.4	0.82±0.14	192±190	3.3 ±0.9
59.6 ±0.2	0.71±0.09	127± 60	12 ±4
61.7 ±0.2	0.74±0.08	116± 51	1.96±0.80
63.4 ±0.2	0.66±0.05	89± 36	6.3 ±2.3
66.2 ±0.2	0.62±0.05	86± 28	18.6 ±4.7
69.9	0.48	36	2.9
75.6 ±0.3	0.48±0.06	71± 23	36 ± 10
82.7 ±0.3	0.57±0.10	62± 26	7 ±1
85.7 ±0.4	0.88±0.10	540±240	30 ± 10
91.2 ±0.4	0.25±0.04	19± 6	17 ±4
96.8 ±0.4	0.36±0.04	37± 10	13 ±2
100.7 ±0.5	0.52±0.08	46± 18	2.5 ±0.4

ALPHA DECAY FOLLOWING CAPTURE OF RESONANCE NEUTRONS BY SAMARIUM AND NEODYMIUM NUCLEI

I. Kvitek and Yu.P. Popov

Using the time-of-flight method, with a resolution of 100 and 30 nsec/m, the authors investigated the (n,α) reaction resulting from the bombardment of samples of natural samarium, natural neodymium and ^{143}Nd with resonance neutrons.

Table 1 shows the alpha widths of the ^{143}Nd resonances investigated and the spin values suggested by the authors (the spins for $e_o = -6$ eV and 127 eV were already known).

In Table 2 the mean values of the alpha widths for ^{143}Nd, ^{145}Nd, ^{147}Sm and ^{149}Sm, calculated on the basis of statistical theory, are compared with the experimental values. The number of resonances over which the values were averaged is indicated in brackets.

Table 1

Alpha widths of ^{143}Nd resonances

E_o (eV)	$\Gamma_\alpha \times 10^5$ (eV)	$\Delta\Gamma_\alpha \times 10^5$ (eV)	I^π
- 6	0.59	± 0.12	3^-
55.5	≤0.2		4^-
127	3.0	±00.6	3^-
136	13.0	± 2.6	3^-
157	≤0.2		4^-
180	1.0	0.5	3^-
187	≤0.2		4^-
410	4.0	1.2	3^-

Table 2

Comparisons of experimental values of $\overline{\Gamma}_\alpha$ with calculations based on statistical theory

I^π	Nuclide	$\overline{\Gamma}_\alpha \times 10^7$	
		Experiment	Theory
3^-	^{143}Nd ^{145}Nd ^{147}Sm	430(5) 8(3) 19(5)	350 2.8 61
4^-	^{149}Sm	0.74(3)	0.83