INDC(POL)-10/G

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ИНСТИТУТ ЯДЕРНЫХ ИССЛЕДОВАНИЙ
INSTITUTE OF NUCLEAR RESEARCH

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MAY 1978 - APRIL 1979

Compiled by
A. Marcinkowski

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Editor's Note

This Progress Report on nuclear data research in Poland /May 1978 - April 1979/ 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 charged particles and neutron physics. It does not include any information about other nuclear research as for example the use of neutrons for solid state physics studies.

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Uwagi od wydawcy

Raport ten zawiera informacje o badaniach w zakresie fizyki jądrowej średnich energii przeprowadzonych w Polsce /maj 1978 - kwiecień 1979/ i związanych z działalnością Komitetu Danych Jądrowych Międzynarodowej Agencji Energii Atomowej.

Pominięto wyniki badań w innych dziedzinach fizyki jądrowej, w tym również badań w zakresie fizyki ciała stałego przy użyciu neutronów.

Poszczególne prace zawierają wstępne omówienie wyników badań nie wyczerpujące poruszanych tematów i nie powinny być cytowane bez zgody autorów.

Замечания от редакции

Этот сборник содержит сообщения о проведенных в Польше в период от мая 1978 до апреля 1979 исследованиях в области физики средних энергии, связанных с деятельностью Комитета по Ядерным Данным Международного Агенства Атомной Энергии. Не включены результаты исследований с области применения нейтронов в физике твердого тела. Доклады не являются полными и не рекомендуется ссылаться на них без согласия авторов.

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INDC(NDS)-103

CROSS-SECTIONS FOR FAST NEUTRON CAPTURE ON Ir AND Os

M.Herman and A.Marcinkowski
Institute of Nuclear Research, Warsaw

Activation cross sections for fast neutron capture were measured, at four energies 0.53 MeV, 0.86 MeV, 1.20 MeV and 1.31 MeV, on ^{191}Ir, ^{190}Os and ^{192}Os. Enriched samples of ^{191}Ir (98.17%) and ^{190}Os (98.06%), supplied by the IAEA in the frame of the target and sample programme, as well as high purity natural material have been irradiated with neutrons from the ^{3}H(p,n)^{3}He reaction. Tritium absorbed targets were bombarded with protons accelerated to 2.2 MeV energy.

The product nuclei were measured by their characteristic γ-decay. The γ-activity induced by neutron irradiation was then measured with a 60 cm^3 Ge(Li) spectrometer. The relative detection efficiency of the crystal has been determined with help of ^{75}Se, ^{113}Ba and ^{226}Ra sources. The details of the decay of the investigated nuclei, adopted in the present data analysis were taken from refs. [1,2].

The measured reaction yields were referred simultaneously to the capture cross section of ^{115}In ref. [3] and to the cross section of the ^{115}In(n,n') ^{115m}In reaction [4]. The differences in the shapes of the two reactions allow to control the effects of low energy background neutrons if present.

The results of cross section measurements are presented in Table 1. These cross sections have been corrected for the attenuation of the

γ -rays in the samples and for summing of cascading γ-rays in the Ge(Li) detector. The errors attached contain statistical and systematic uncertainties, including the error of the cross section of the reference reaction.

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4. M.Herman and A.Marcinkowski, Progress Report INR 1773/1/PL/A, 1978.

TABLE 1

Neutron Capture Cross Sections in mb

Reactions	Neutron Energy - MeV			
	0.53 ± 0.14	0.86 ± 0.21	1.20 ± 0.15	1.31 ± 0.07
$^{190}Os(n,\gamma)\ ^{191m}Os$	4.14 ± 5.66	2.85 ± 4.21	2.84 ± 4.07	3.08 ± 3.84
$^{190}Os(n,\gamma)\ ^{191g}Os$	147.8 ± 16.6	142.4 ± 16.8	119.6 ± 13.4	113.6 ± 12.2
$^{192}Os(n,\gamma)\ ^{193}Os$	51.4 ± 5.6	53.3 ± 5.8	47.3 ± 4.8	41.8 ± 4.0
$^{191}Ir(n,\gamma)\ ^{192g+m1}Ir$	333.2 ± 36.3	266.0 ± 28.9	224.5 ± 23.9	180.3 ± 19.4
Reference				
$^{115}In(n,\gamma)\ ^{116m}In$	180	200	176	170

ANGULAR DISTRIBUTIONS OF ALPHA PARTICLES FROM THE $^{149}Sm(n,\alpha)^{146}Nd$ REACTION INDUCED BY 14.1 AND 18.2 MeV NEUTRONS

W.Augustyniak, L.Głowacka, M.Jaskóła, Le Van Khoi*,
J.Turkiewicz, L.Zemło
Institute of Nuclear Research, Dept. of Nuclear Reactions, Warsaw

Angular distributions of α-particles emitted in the $^{149}Sm(n,\alpha)^{146}Nd$ reaction at E_n = 14.1 and 18.2 MeV were measured by direct registration of α- particles. The experimental arrangement used in the measurements was described in our earlier work [1]. The neutrons were obtained from the $^{3}H(d,n)^{4}He$ reaction with deuterons accelerated up to 2 MeV in the Van de Graaff accelerator "LECH". The neutrons energy was selected by a suitable choice of the emission angle. The neutron energy spreads due to the deuteron energy loss in the ^{3}H-Ti target and geometrical conditions were 120 and 140 keV for 14.1 and 18.2 MeV neutrons, respectively. The neutron flux was measured by counting the recoil protons from a thin polyethylene foil. The recoil protons were registered by a thin CsI(Tl) scintillator followed by photomultiplier and standard electronics. The absolute calibration of the neutron monitor was performed by measuring of the 847 keV γ-transition in ^{56}Fe produced in $^{56}Fe(n,p)^{56}Mn$ reaction with successive β-decay of ^{56}Mn. The cross sections for the $^{56}Fe(n,p)^{56}Mn$ reaction were taken as 110 mb and 57 mb for neutron energies 14.1 and 18.2 MeV respectively [2]. Uncertainty of the monitor calibration amounts to about 15%.

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* on leave from University of Hanoi, Vietnam

The investigated targets were made of samarium oxide enriched with ^{149}Sm to about 96.9%. The Sm_2O_3 layers of about 3.0 mg/cm^2 were deposited onto thick carbon backings by means of sedimentation from suspensions in isopropyl alcohol.

The energy calibration of the alpha spectrometer was performed with employment of alpha from ThC and ThC′ and from the reaction $^{28}Si(n,\alpha)^{25}Mg$ produced in the silicon detector by the incident neutrons.

The angular distributions of α-particles emitted in the $^{149}Sm(n,\alpha)^{146}Nd$ reaction at 14.1 and 18.2 MeV neutrons are listed in tables 1 and 2 and also presented in Fig.1. These distributions contain all α-particles with energies corresponding the excitation of the final nucleus up to 5 MeV. In the bottom of the tables the angular spreads of the measurements are also shown. These spreads were calculated by Monte-Carlo method [3]. The errors indicated in the tables are only statistical.

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TABLE 1

Angular distribution of α-particles for $^{149}Sm\,(n,\alpha)\,^{146}Nd$ reaction at $E_n = 14.1$ MeV

$\bar{\Theta}$ [deg]	$d\sigma/d\Omega$ [mb / sr]
26	0.94 ± 0.08
46	0.63 ± 0.08
63	0.26 ± 0.06
90	0.19 ± 0.04
118	0.10 ± 0.07
135	0.06 ± 0.07
156	0.05 ± 0.06

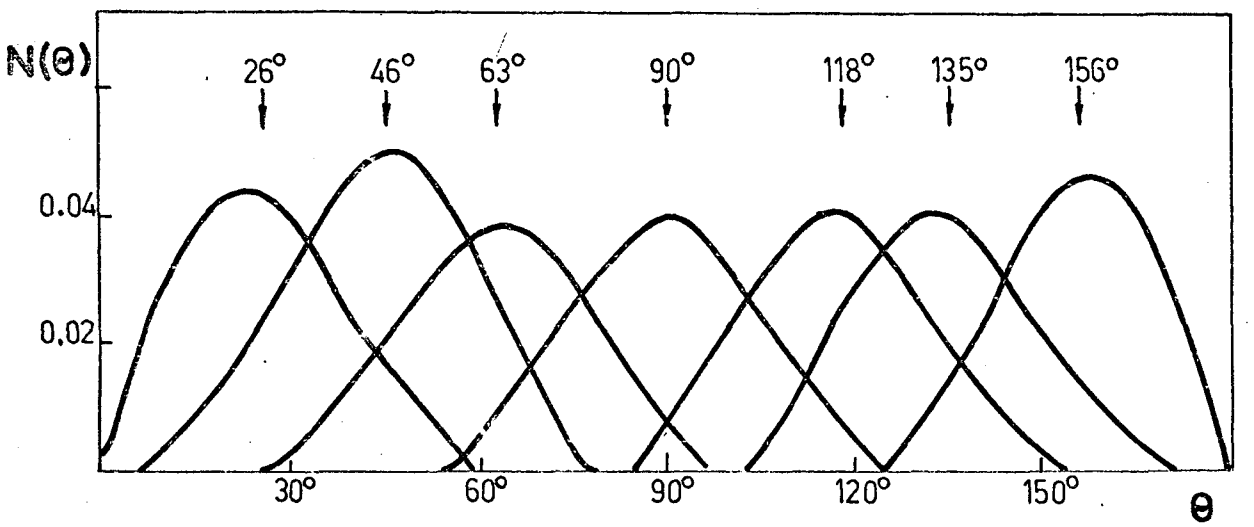
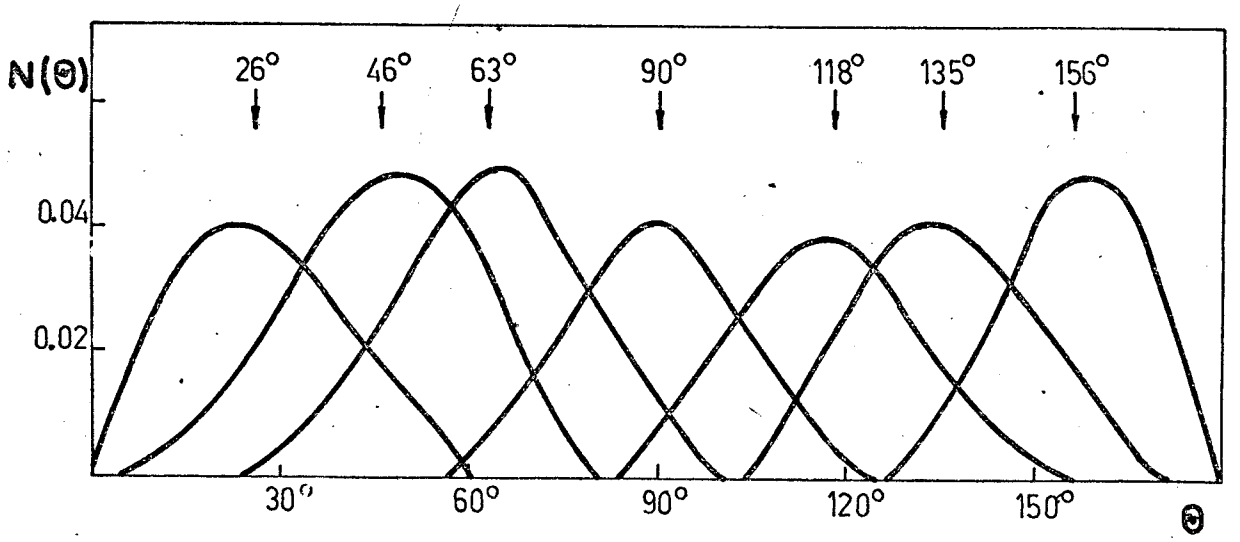


TABLE 2

Angular distributions of α- particles for $^{149}Sm(n,\alpha)^{146}Nd$ reaction at E_n = 18.2 MeV

$\bar{\Theta}$ [deg]	$d\sigma/d\Omega$ [mb/ sr]
26	0.95 ± 0.04
46	0.33 ± 0.06
63	0.23 ± 0.05
90	0.14 ± 0.06
118	0.12 ± 0.05
135	0.26 ± 0.10
156	$0.00 + 0.08$



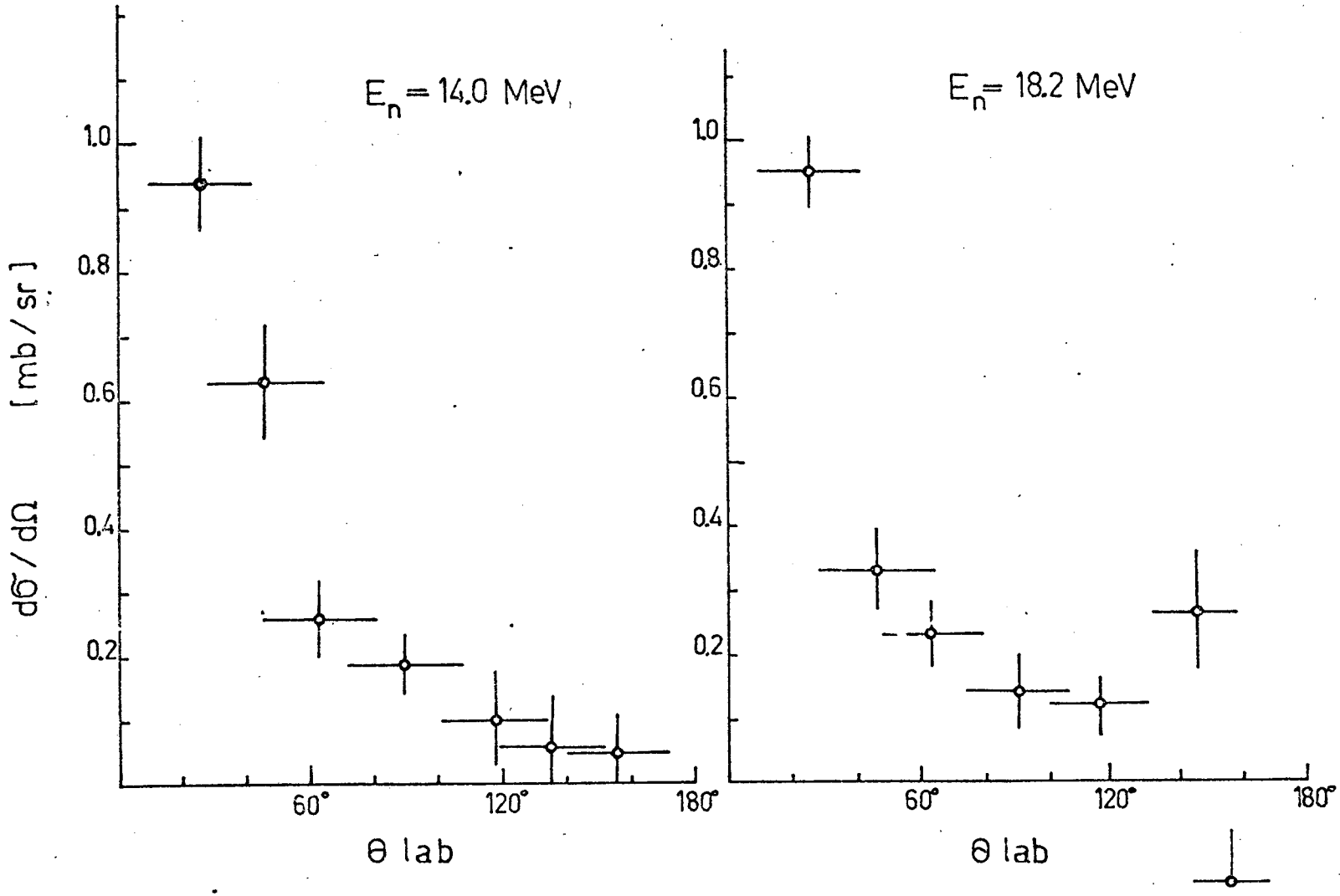


Fig.1. Angular distributions of alpha particles from the $^{149}Sm(n,\alpha)^{146}Nd$ reaction.

EXFOR 30515

EVALUATION OF THE $^{23}Na(n,2n)^{22}Na$ REACTION FOR THE IRDF*

L.Adamski, M.Herman and A.Marcinkowski
February 1979
Institute of Nuclear Research, Warsaw.

The evaluation is based on experimentally determined cross sections. The literature reviewed includes all papers referred in CINDA 76/77, its Supplement 5 and INIS Atomindex v.9. The available information is sparse. It consists of six cross section points measured at single neutron energies near 14 MeV [1-5] and three excitation curves measured by Liskien and Paulsen [6], Menlove et al. [7] and Picard and Williamson [8]. Despite of the fact that the three latter data sets have been obtained in careful experiments they are fairly spread out, one of them being higher by more than three standard deviations.

In this situation the cross sections of the $^{23}Na(n,2n)^{22}Na$ reaction have been remeasured by us specially for the purpose of this evaluation. The activation method has been applied for the cross section ratio measurement. The activities have been identified by the characteristic gamma-decay. The adopted decay data together with the resulting cross sections as well as with the reference reaction cross sections are presented in Table 1. This measurement confirms the data obtained earlier by Menlove et al. [7]. Bearing this in mind the excitation curve measured by Lisken and Paulsen turns out to be too high

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* International Reactor Dosimetry File

and after a discussion with the authors [9] we decided to renormalize it by a factor 0.493. In this way we have saved the shape of the curve which is felt to be an accurate one, for further evaluation (see Fig.1). The cross section value at 16.52 MeV measured by Menlove et al. has been disregarded because of the discrepancy between the tabulated values and the graphical presentation in Ref. [7]. Some of the data shown in Fig.1 have been readjusted to the recent standard cross sections and decay data [10-16].

In the next step separate polynomials P_1, P_2, P_3, P_4 have been fitted to the renormalized data of Liskien and Paulsen [6], Menlove et al. [7], Picard and Williamson [8], and all remaining ones /including ours/, respectively, by means of a least squares code. These polynomials have been next matched by a polynomial $P/E/ = \sum_{i=0}^{5} a_i E^i$, which provides the recommended excitation curve. The polynomial coefficients are listed in Table 2.

In the error analysis first the one-sigma confidence level has been established for all data or data sets. Subsequently the excitation curve has been divided into 1 MeV/energy bins starting with 13 MeV. Cross sections values obtained in the same experiment, which fell into one energy bin have been reduced to a single data point. In each energy bin the weighted mean square deviation (from $P/E/$) has been calculated, using the relative errors of the individual cross sections for determining the weighting factors.

The squares of the mean square deviations in the individual bins have been complemented by successive adding of the squares of the mean square deviations calculated over broader energy ranges (shown in Fig.2) in order to form the diagonal elements of the covariance matrix. The off-diagonal matrix elements have been constructed of those squares taken over the broader energy ranges as shown in

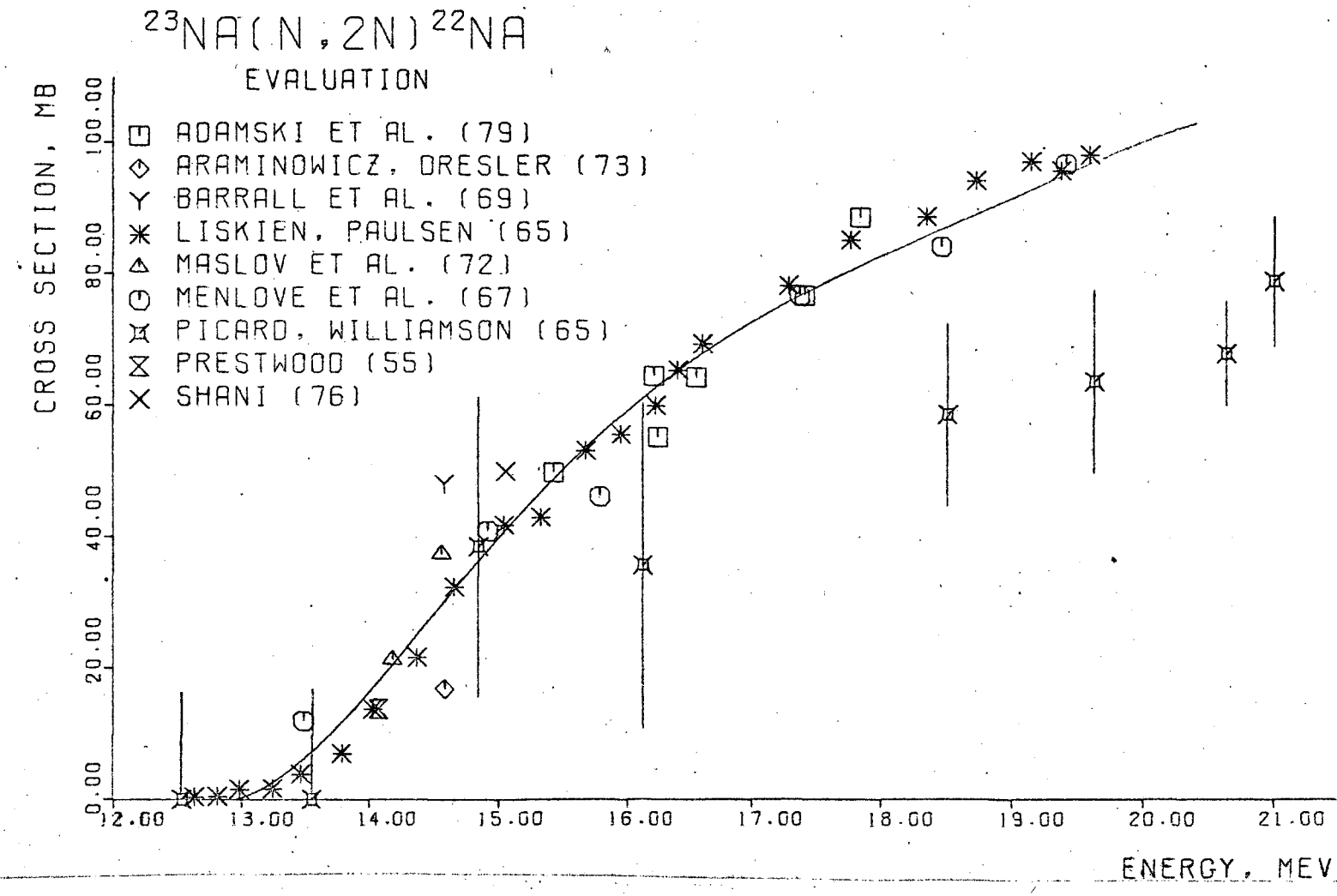
23NA(N,2N)22NA
EVALUATION
ADAMSKI ET AL. (79)
ARAMINOWICZ, DRESLER (73)
BARRALL ET AL. (69)
LISKIEN, PAULSEN (65)
MASLOV ET AL. (72)
MENLOVE ET AL. (67)
PICARD, WILLIAMSON (65)
PRESTWOOD (55)
SHANI (76)
CROSS SECTION, MB
0.00
20.00
40.00
60.00
80.00
100.00
12.00
13.00
14.00
15.00
16.00
17.00
18.00
19.00
20.00
21.00
ENERGY, MEV

Fig. 1.

Fig.2. These ranges reflect similarities in the experiments, which allow of correlations. Subsequently the relative covariance matrix has been formed according to the prescription of the ENDF/B-V data covariance files format [17], LB=5

$$COV(X_i, Y_j) = \sum_{K,K'} P_{j;k'}^{i;k} F_{xy;\,kk'} X_i Y_j$$

with X_i and Y_j being the P/E/ values corresponding to the centres of the two bins in question.

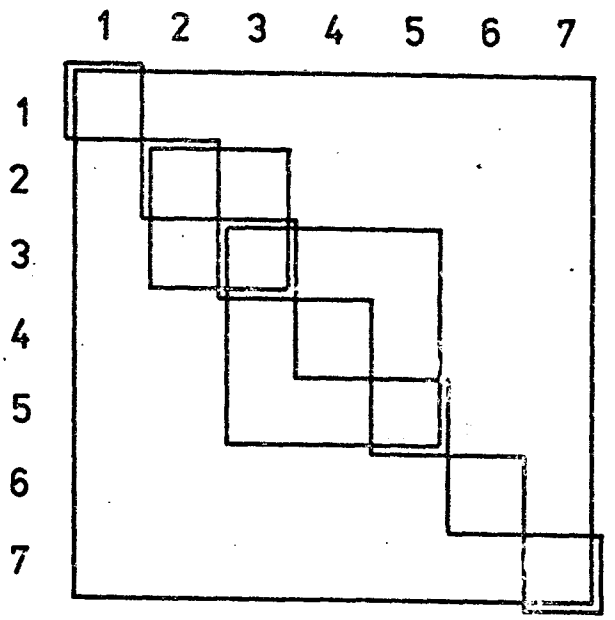

Fig.2. Correlation scheme for the covariance matrix.

TABLE 1

Cross Sections for the $^{23}Na(n,2n)^{22}Na$ Reaction

	$^{23}Na(n,2n)^{22}Na$	$^{27}Al(n,\alpha)^{24}Na$
γ - ray branching	1275 keV - 0.9994	1369 keV - 1.0
conversion coeff.	6.7E-6	0.0
$T_{1/2}$	2.602 y	15.02 h

$E_n \pm \Delta E$ MeV	$\sigma \pm \Delta\sigma$ mb	σ_{ref} mb
15.5 ± 0.5	49.8 ± 4.0	105.5
16.2 ± 0.8	64.6 ± 4.9	92.5
16.3 ± 0.3	55.3 ± 4.3	92.0
16.6 ± 0.1	64.4 ± 4.2	86.5
17.4 ± 0.4	76.8 ± 5.9	72.8
17.8 ± 0.1	88.6 ± 6.6	66.0

TABLE 2

Polynomial Coefficients for the Recommended Cross Sections of the $^{23}Na(n,2n)^{22}Na$ Reaction in the Neutron Energy Range from 13 to 20 MeV

a_o	a_1	a_2	a_3	a_4	a_5
3.622E+4	-1.080E+4	1.273E+3	-7.416E+1	2.142E+0	-2.458E-2

the coefficients are given in mb · MeV^{-i}

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SODIUM-23 DIRECT(N,2N) ENDF/B MATERIAL NO. 0
NEUTRON CROSS SECTION

REACTION Q VALUE -.12410E+08 EV

INTERPOLATION LAW BETWEEN ENERGIES
RANGE DESCRIPTION
1 TO 39 Y LINEAR IN X

NEUTRON CROSS SECTIONS

INDEX.	ENERGY EV	CROSS SECTION BARNS	ENERGY EV	CROSS SECTION BARNS	ENERGY EV	CROSS SECTION BARNS	ENERGY EV	CROSS SECTION BARNS	ENERGY EV	CROSS SECTION BARNS
1	.12960E+08	.0	.13000E+08	.20000E-03	.13200E+08	.21000E-02	.13400E+08	.47000E-02	.13600E+08	.81000E-02
6	.13800E+08	.11900E-01	.14000E+08	.16100E-01	.14200E+08	.20600E-01	.14400E+08	.25200E-01	.14600E+08	.29800E-01
11	.14800E+08	.34400E-01	.15000E+08	.38900E-01	.15200E+08	.43300E-01	.15400E+08	.47500E-01	.15600E+08	.51400E-01
16	.15800E+08	.55200E-01	.16000E+08	.58700E-01	.16200E+08	.62000E-01	.16400E+08	.65000E-01	.16600E+08	.67800E-01
21	.16800E+08	.70400E-01	.17000E+08	.72800E-01	.17200E+08	.75100E-01	.17400E+08	.77100E-01	.17600E+08	.79100E-01
26	.17800E+08	.81000E-01	.18000E+08	.82800E-01	.18200E+08	.84600E-01	.18400E+08	.86300E-01	.18600E+08	.88000E-01
31	.18800E+08	.89800E-01	.19000E+08	.91500E-01	.19200E+08	.93200E-01	.19400E+08	.95000E-01	.19600E+08	.96700E-01
36	.19800E+08	.98400E-01	.20000E+08	.10000E+00	.20200E+08	.10150E+00	.20400E+08	.10290E+00		

23NA(N,2N) COVARIANCE MATRIX ELEMENTS IN ENDF/B-V FORMAT

RELATIVE VALUES, MAGNITUDE = (DELTA SIGMA/SIGMA)**2

ENERGY (EV)	.10000E-04	.13000E+08	.14000E+08	.15000E+08	.16000E+08	.17000E+08	.18000E+08	.19000E+08
.10000E-04	0.	0.	0.	0.	0.	0.	0.	0.
.13000E+08		.19100E+00	.81800E-02	.45500E-02	.33800E-02	.28700E-02	.25600E-02	.23500E-02
.14000E+08			.15800E-01	.35600E-02	.78700E-03	.66900E-03	.60100E-03	.54700E-03
.15000E+08				.79600E-02	.12000E-02	.10200E-02	.33400E-03	.30400E-03
.16000E+08					.25300E-02	.75700E-03	.24800E-03	.22600E-03
.17000E+08						.13800E-02	.21100E-03	.19200E-03
.18000E+08							.59600E-02	.17200E-03
.19000E+08								.62100E-02

ON THE USE OF THE ENDF/B-IV LIBRARY FOR CALCULATION OF GROUP CONSTANTS WITHIN THE FEDGROUP SYSTEM OF NUMERICAL CODES

K. Stankiewicz

Institute of Nuclear Research, Nuclear Data Group, Świerk

The FEDGROUP system of numerical codes [1] has been created in the Central Research Institute for Physics in Budapest, in cooperation with the Kurchatov Institute in Moscow, the Central Institute for Nuclear Research in Rossendorf and the Institute of Nuclear Research in Świerk. It has been aimed to allow the use of different libraries of differential evaluated data. Initially the system was suited to work with the KEDAK and UKNDL library formats. This paper reports the completion of the system, which allows to work with the ENDF/B-IV input file also when containing resonance parameters in the resolved and/or unresolved resonance regions.

1 The presentation of the resonances in ENDF/B-IV

Two options of the ENDF/B-IV file formats [2] are acceptable:

a/ No resonance parameters are given. The point-values of the total cross section σ_t, elastic cross section σ_{el}, capture cross section σ_γ, fission cross section σ_f, and so on, are given at some energies in the range from 0.00001 eV up to 20 MeV.

b/ Resonance parameters are given for the resolved and unresolved resonance regions, as well as the energies defining the boundaries of applicability of the parameters. The presentation of the total, elastic,

capture and fission cross sections depend on the energy region. For energies surpassing 0.00001 eV but lower than the low energy limit for the use of the resolved resonance parameters the file contains point-values of σ_t, σ_{el}, σ_γ, and σ_f. In the region of applicability of resonance parameters the file contains point-values σ_t^o, σ_{el}^o, σ_γ^o, σ_f^o, which have to be added to appropriate cross section calculated from a definite prescription e.g. the single-level Breit-Wigner formula. The cross sections are

$$\sigma_x = \sigma_x^{S.L.B.W.} + \sigma_x^o \quad / x = t, el, \gamma, f /,$$

where negative σ_x^o are accepted.

For energies surpassing the high energy limit for the use of the unresolved resonance parameters the file contains again the energy-point-values of σ_t, σ_{el}, σ_γ, and σ_f. If the parameters describing unresolved resonances are energy dependent a discontinuity may appear at some energies. At these energies two different parameter sets are given in the library.

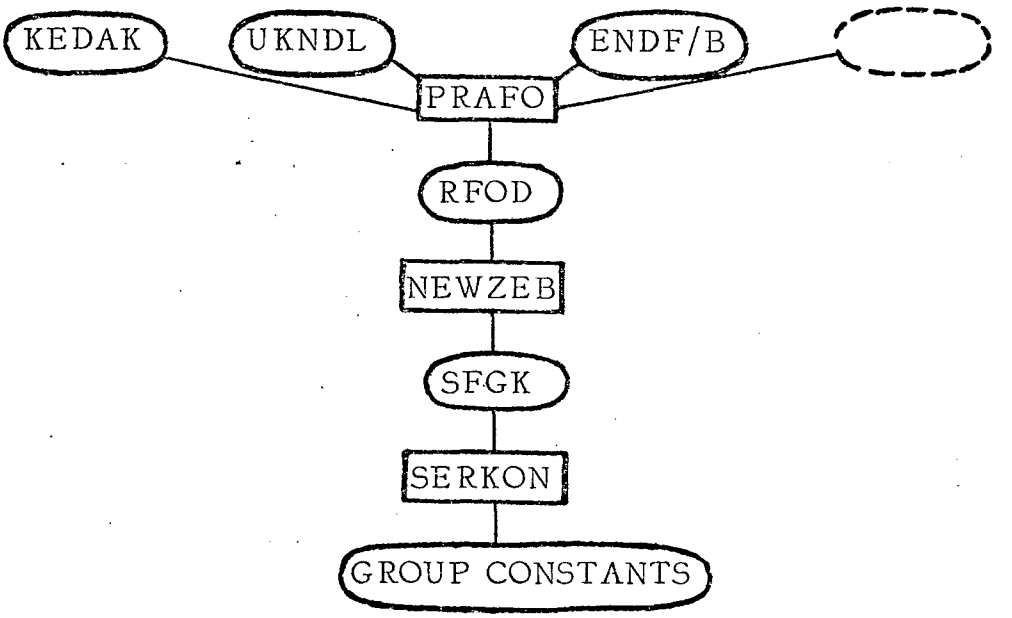
It's worth to mention that the effective scattering length $\hat{a}$, given for each isotope, is used for calculation of the phase shift $\Phi_o = k\hat{a}$, whereas the channel radius a expressed as a function of mass number A

$$a = (1.23A^{1/3} + 0.8) \cdot 10^{-1}$$

is used for calculation of the penetration factor $P_o = ka$.

2 The structure of the FEDGROUP system

The structure of the FEDGROUP system of codes is displayed below.



here squares denote programmes and rounded areas denote data sets.

The input set of evaluated data is transformed into a binary code library RFOD by the programme PRAFO. Different input data libraries need special versions of the PRAFO code. The unique RFOD set is used as input for the main NEWZEB code, which calculates the library of group constants SFGK in a binary code and a definite format. The code SERKON transferes the SFGK library set into a format suitable for use in a definite reactor project. The version of the SERKON code depends on the required format of the group constants needed.

3 The additions to the FEDGROUP set

The PRAFO code has been completed by adding subroutines, which transform the ENDF/B-IV data into the binary RFOD set. Among those subroutines the one called ENDF steers the data flow. The resonance parameters are transformed and subdivided into the resolved and unresolved resonance parameters of the RFOD set. The point-values of σ_t,

$\sigma_{el}, \sigma_{\gamma}, \sigma_{f}$ of the ENDF/B-IV set are rewritten in RFOD. The differentiation between sets containing σ_{t}^{o}, σ_{el}^{o}, σ_{γ}^{o}, σ_{f}^{o} and those, which don't contain these parameters are realized in NEWZEB only. This has required following changes in NEWZEB: sixth block, which serves for calculating the screened cross sections /or screened resonance integrals/ in the resolved resonance region, has been modified; seventh block, which calculates the screened cross sections /or screened resonance integrals/ in the unresolved resonance region, has been modified. The main subroutines, steering the calculations in block six and seven called initially BLO6 and BLO7 have been exchanged by new procedures BLO6E and BLO7E. The changes pertain introducing the σ_{x}^{o} into the two blocks in question. Appropriate modification of the RESEC subroutine is followed by adding σ_{x}^{o} to the cross section calculated on the basis of the resonance parameters. Changes have been introduced into the subroutines REQT, GROP, RESCAL, ROMRES, RESINF, TOTRES and RESTAT. New subroutines WCT and PINT have been also added. WCT reads σ_{x}^{o} from RFOD, whereas PINT interpolates between σ_{x}^{o} values.

The differentiation between $\hat{a}$ and a has been followed. For resolved resonances the total width is calculated accordingly

$$\Gamma_t /E/ = \Gamma_n /E_r / \sqrt{\frac{E}{E_r}} + \Gamma_{\gamma} ,$$

instead of using $\Gamma_t/E/$ from the library. This implies modification of RESEC, RESKO and XSEC in NEWZEB.

The bound levels are accepted at an energy $E^{+} = |E_r|$, which implicates further modification of RESKO. The discontinuities of unresolved resonance parameters have been eliminated in the PRAFO code. The above modifications don't affect the input and output formats of the FEDGROUP system.

4 CROSS-1, CROSS-2, CROSS-3 and NEWZEB subroutines

The elastic scattering matrix can be obtained from the ninth block of the NEWZEB programme, which requires the point-values of elastic cross section in the whole energy region as input. In case of the ENDF/B-IV input it may happen that the data set RFOD contains in some energy regions σ^{o}_{x} instead of σ_{x}. In order to overcome this difficulty new programmes have been added, which create a new RFOD library, containing in addition to the resonance parameters also the σ_{t}, σ_{el}, σ_{γ}, σ_{f} values in the whole energy range. The new programmes are partly based on some of the subroutines of NEWZEB, they act as follows:

CROSS-1, rewrites the σ^{o}_{x} values from RFOD /in a choosen energy region/ into a new auxiliary set,

CROSS-2, calculates the cross sections according to the single-level Breit-Wigner formula, adds the σ^{o}_{x} point-values, and writes in addition the result to the output of CROSS-1 in the auxiliary set,

CROSS-3, calculates cross sections in the unresolved resonance region, adds the σ^{o}_{x} point-values, and writes in addition the result to the summed outputs of CROSS-1 and CROSS-2,

NEWRF, exchanges the partial data sets in RFOD into the results of calculations with use of CROSS-1, CROSS-2 and CROSS-3.

The input data of the CROSS-type subroutines have similar structure like those of the NEWZEB programme, with the exception that the group boundaries are replaced by the limits of validity of the resonance parameters.

In Table 1 and 2 the group constants for ^{151}Eu, calculated from the ENDF/B-IV Fission Product Library, are presented.

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TABLE 1

Effective Resonance Integrals for Eu-151 $RI(\sigma_0)/\tau$
$(\tau = \int_{\Delta E} \frac{1}{E} dE)$

Group number	Energy range eV	σ_0 = 100 barns	σ_0 = 1000 barns	σ_0 = 10^6 barns
15	9118.0 - 5530.0	8.928	10.117	10.328
16	5530.0 - 3519.1	11.768	13.853	14.243
17	3519.1 - 2239.45	15.056	18.574	19.271
18	2239.45-1425.1	18.902	24.687	25.925
19	1425.1 - 906.898	23.258	32.472	34.648
20	906.898- 367.262	30.670	48.698	54.053
21	367.262-148.728	40.319	77.006	92.589
22	148.728-75.5014	45.398	106.752	142.628
23	75.5014-48.052	38.168	96.375	140.068
24	48.052 -27.7	48.534	135.610	213.082
25	27.7 - 15.968	43.533	123.461	199.194
26	15.968 -9.877	54.104	169.141	270.645
27	9.877 -4.0	51.145	145.751	277.890

TABLE 2

Elastic Scattering Matrix $W_{el}^{i \to j}$ for Eu-151, (in barns)

Group number	15	16	17	18	19	20	21
15	18.32	0.282					
16		19.807	0.461				
17			21.267	0.581			
18				22.729	0.679		
19					24.172	0.755	
20						26.681	0.417

THEORETICAL DESCRIPTION OF THE ^{128}Xe NUCLEUS

J.Srebrny, Ch.Droste, L.Goettig, T.Morek
Institute of Experimental Physics, Warsaw University

Properties of the excited states of the ^{128}Xe nucleus deduced from the available experimental data [1,2,3,4,5] have been compared with predictions of the collective models [6,7].

The experimental data used for this analysis were taken mainly from our previous investigations, thus including the information about low-spin excited states of the ^{128}Xe nucleus populated in the β^+ decay of ^{128}Cs [1], and the information about higher-spin states, up to spin value 8, populated in the ^{126}Te $(\alpha, 2n)$ ^{128}Xe reaction [2].

To describe the structure of the ^{128}Xe nucleus the collective quadrupole model of Dobaczewski et al. [6] has been applied. In this approach the Hamiltonian of the quadrupole motion consists of the kinetic energy with the inertial functions dependent on γ (β, γ - are the Bohr's deformation parameters), and of the γ -independent potential of the form:

$$V(\beta) = 1/2\ C_2\beta^2 + G\left(\exp\left(-\beta^2/a^2\right) - 1\right),$$

where C_2, G and a are parameters which can be uniquely transformed into the more intuitive ones, namely: β_o - equilibrium deformation, $D=-V(\beta_o)$ and $C=d^2V/d\beta^2\big|_{\beta=\beta_o}$ - depth and stiffness of the potential V, respectively.

These assumptions (concerning γ -independence of the potential) are in close agreement with results of microscopic calculations which give for nuclei in this region $(52 < Z,N < 80)$ potentials practically flat in the γ parameter. On the other hand, the γ -dependence of the inertial functions, resulting from microscopic calculations as well, turns out to be very important [8].

To keep in accordance with microscopic calculations, microscopic values of β_0 and D were assumed, namely: $\beta_0 = 0.13$ and D=0.35 MeV [9]. The inertial functions were assumed as follows:

$$B_{\beta\beta}(\beta,\gamma) = \text{const}$$

$$B_{\beta\gamma}(\beta,\gamma) = 0$$

$$B_{\alpha}(\beta,\gamma) = B_{\alpha}(\tilde{\beta},\gamma) = f B_{\alpha}^{micr}(\tilde{\beta},\gamma) + b \,, \qquad \alpha = \gamma\gamma, x, y, z.$$

This means that the γ-dependence of the inertial functions B_α was also taken from microscopic calculation [10], but in order to get agreement with the experiment the microscopic functions had to be changed introducing parameters f and b. In the present calculation these parameters were assumed as being the same as for the ^{124}Xe and ^{126}Xe nuclei [11], namely: f=7.35 and b=124.5 MeV. Thus only two parameters, one from the potential (C) and one from the kinetic part of the Hamiltonian $(B_{\beta\beta})$, remained free and have been used to fit theoretical results to the experimental data. The resulting parameters are as follows: C=159 MeV and $B = 43\hbar^2 \text{MeV}^{-1}$.

The comparison of the experimental excitation energies of the ^{128}Xe nucleus with those resulting from the above calculation is presented in Figure 1.

The experimental data for ^{128}Xe were also compared with predictions of the rigid triaxial rotor model of Davydov and Filippov. The model is often used to describe the structure of transitional nuclei, although its basic assumptions are in contradiction to existing microscopic calculations. The results for $\gamma = 25^\circ$ and $E(2_1^+) = 366$ keV are shown on the right-hand side of Figure 1.

The comparison of the experimental values of reduced transition probabilities $(B(E2))$ or branching ratios with those predicted in the frame of the two collective models is shown in Table 1.

As it is seen from the presented comparisons, the experimental en-

ergies for ^{128}Xe cannot be described in terms of the rigid triaxial rotor model. Satisfactory agreement between the experimental and theoretical values (better in the case of energy and worse for branching ratios) has been obtained in the model of Dobaczewski et al. taking into account main results of microscopic calculations of the potential. It should be noted, that although the rather serious change of the microscopically calculated inertial functions is needed, values of the scaling parameters are identical for the three Xe isotopes.

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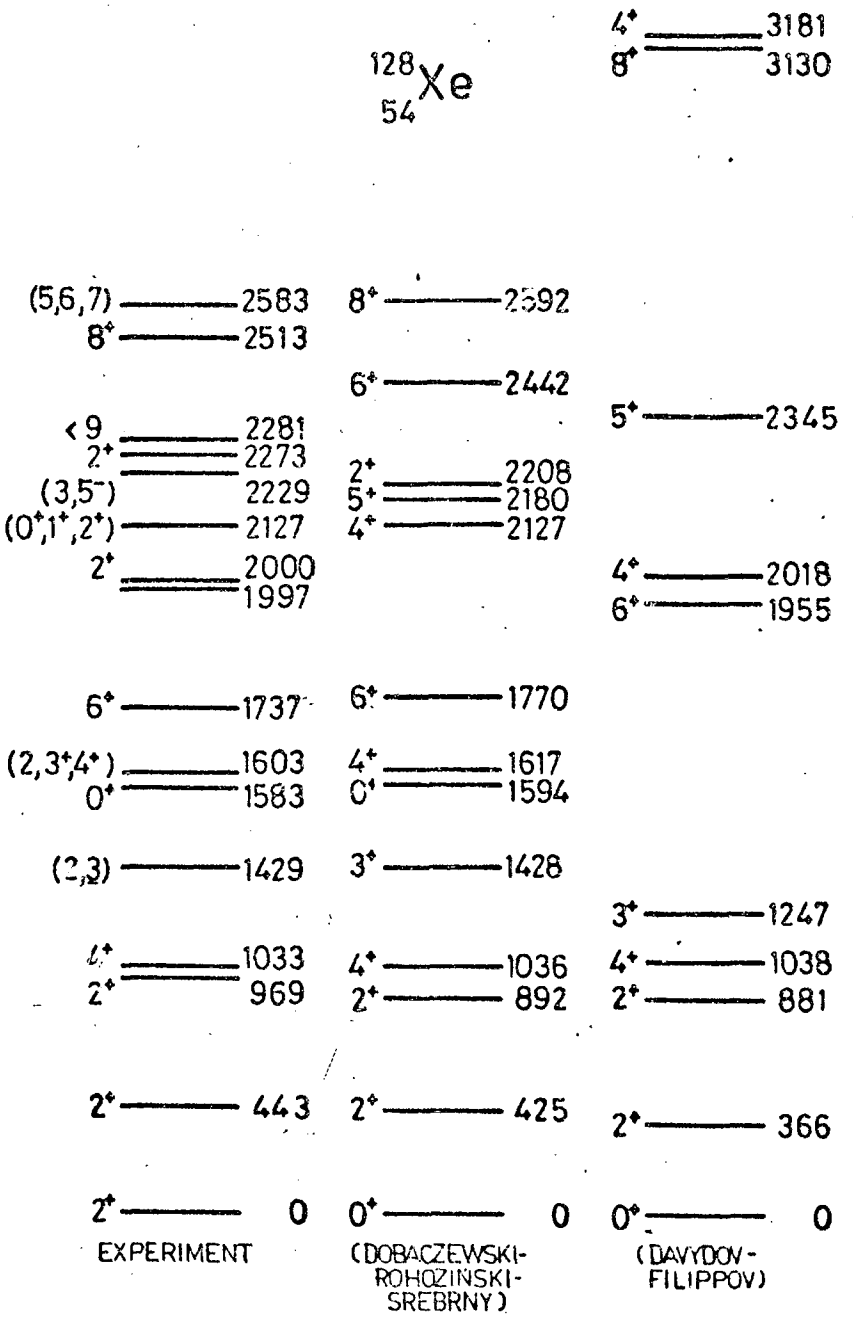

Fig.1. Comparison of the energy of excited states with predictions of the collective models.

TABLE 1.

Comparison of the experimental values of the reduced transition probabilities with predictions of the collective models.

	Experiment	Dobaczewski–Rohoziński–Srebrny	Davydov-Filippov
$B(E2;\ 2_1^+ \to 0_1^+)$	0.15 (1)	0.158	*)
$\frac{B(E2;\ 2_2^+ \to 0_1^+)}{B(E2;\ 2_2^+ \to 2_1^+)}$	0.0125(4)	0.0007	0.0490
$\frac{B(E2;\ 0_2^+ \to 2_1^+)}{B(E2;\ 0_2^+ \to 2_2^+)}$	0.145(5)	0.022	**)
$\frac{B(E2;\ 4_2^+ \to 2_2^+)}{B(E2;\ 4_2^+ \to 4_1^+)}$	$\geqslant$ 0.55	1.16	1.40
$\frac{B(E2;\ 3_1^+ \to 2_1^+)}{B(E2;\ 3_1^+ \to 2_2^+)}$	0.010(5) or 0.06(4)	0.0014	0.044

*) - not calculated in the model, used only to determine a value of the β parameter.

**) - cannot be calculated, there is no 0_2^+ state predicted by the model.

PARTICLE- CORE COUPLING IN ^{127}Cs AND THE PROBLEM OF γ - STIFFNESS

D.Chlebowska
Institute of Nuclear Research, Warsaw
J.Dobaczewski, Ch.Droste and J.Srebrny
Department of Physics, University of Warsaw
G.Leander
NORDITA, Copenhagen

The negative parity states of the ^{127}Cs nucleus observed in the ^{127}I/α,4n/^{127}Cs reaction [1] are described in term of the collective properties of the neighbouring even-even nucleus using the particle - core coupling model. In this model the particle - core interaction Hamiltonian is represented by the product of the nucleon quadrupole moment operator and the collective quadrupole moment operator of the core. The only information about the core which is needed are the values of the excitation energies and reduced matrix elements $\langle R \| E2 \| R' \rangle$ where $|R\rangle$ and $|R'\rangle$ denote the states of the core, in our case the ^{126}Xe nucleus. Two models for description of ^{126}Xe nucleus were used, namely the rigid triaxial rotor model [2] and γ-dynamical semimcroscopic model [3] . The calculations done using the γ -dynamical model suggest that the ^{126}Xe nucleus is γ-soft [4] , it means that the wave functions are spread and their dispersions in γ -deformation parameter are large. The aim of the present paper is to test these two very different descriptions of the ^{126}Xe nucleus by means of considering the properties of the ^{127}Cs nucleus.

In our calculations the negative parity states in ^{127}Cs nucleus were

assumed to be formed by the odd proton in the $1h_{11/2}$ and $2f_{7/2}$ orbits coupled to the γ -soft or triaxial rigid core. The energy difference, $E(2f_{7/2}) - E(1h_{11/2})$ is assumed to be equal to 5 MeV according to the Nilsson scheme. The radial matrix elements $\langle nlj | r^2 \frac{m\omega}{\hbar^2} | n' l' j' \rangle$ are assumed to be constant and equal to 40 MeV [5], the strength of the particle - core interaction $\varkappa(\frac{\hbar}{m\omega})^2$ is assumed to be equal to $120\ A^{-5/3}$ MeV [6]. In the case when the rigid triaxial rotor model is used to describe the collective properties of ^{126}Xe the parameter β was determined from the experimental $B/E2; 2_1^+ \rightarrow 0_1^+$ / value, and the parameter γ_0 by taking the value $\gamma_0 = 23^\circ$ which gave the best description of the energy spectrum in ^{127}Cs. In the case of γ - dynamical model the same parameters as in [4] were used for the ^{126}Xe nuclei. The calculated energies of the selected levels of the ^{127}Cs nucleus assuming the γ - soft and γ - rigid core are compared with experiment in Fig.1. In presented results the reduced matrix elements $\langle R \| E2 \| R' \rangle$ of the core were taken from the model calculations and the excitation energies of ^{126}Xe, if known, were taken from the experiment.

We obtained satisfactory agreement between existing experimental data and calculated ones. The quality of the desciption of ^{127}Cs is similar irrespectively of whether the γ - soft or γ -rigid core are used. This fact does not allow to draw conclusion which core used for description of ^{127}Cs is better. More results about theoretical description of the ^{127}Cs nucleus and also the ^{129}Cs and ^{133}La nuclei will be published soon.

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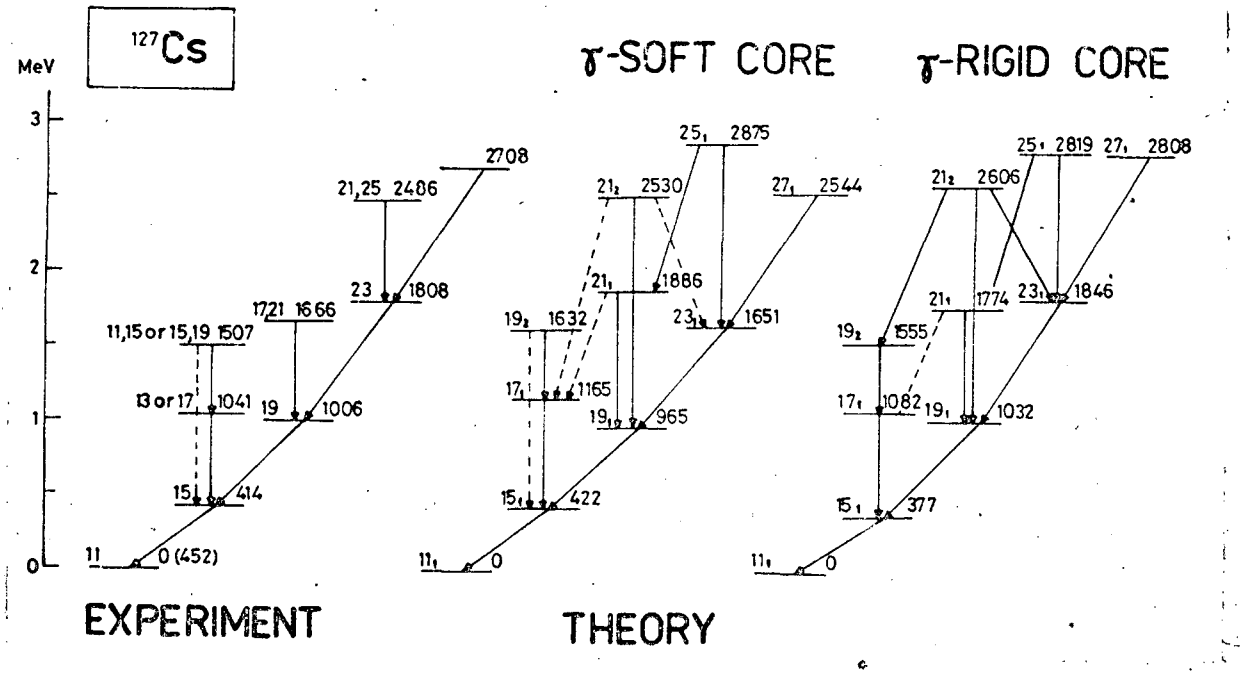

Fig.1. Negative parity states in ^{127}Cs. The core is assumed to be gamma-soft or gamma-rigid. The excitation energies are measured from the $11/2^-$ state. Gamma transitions with intensity between 20% and 60% of the strongest transition are represented by dashed line and the transitions with intensity 60% by solid line. The spin values are indicated.