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COMITATO NAZIONALE ENERGIA NUCLEARE

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PROGRESS REPORT ON NUCLEAR DATA ACTIVITIES
IN ITALY
for the period from January to December 1977

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PROGRESS REPORT ON NUCLEAR DATA ACTIVITIES IN ITALY

for the period from January to December 1977

Compiled by
C. COCEVA
Comitato Nazionale Energia Nucleare
Bologna, Italy

1. C.N.E.N. - DIVISIONE DI FISICA - LABORATORIO DATI NUCLEARI - Via Mazzini, 2 - 40138 BOLOGNA (ITALY)

1.1 Penetrability of Multiple-Humped Fission Barriers

T. MARTINELLI, E. MENAPACE, A. VENTURA

Formulae have been deduced for the transmission coefficient (penetrability) of an unidimensional fission barrier with two or three humps, approximated by parabolic potentials. The corresponding Schrödinger equation has been solved exactly, in terms of parabolic cylinder functions. As a time saving alternative, an improved semiclassical (JWKB) formalism has been developed and its results for a three-humped barrier are compared in Fig. 1 with those of the exact calculation for neutron induced fission of ^{232}Th (barrier parameters taken from Caruana, Boldeman & Walsh - Nucl. Phys. A285 (1977) 205. Our JWKB formulae appeared in Nuovo Cimento Lett. 20(1977)267.

1.2 Proton and Neutron Single Particle Level Calculation in a Nilsson Potential

E. MENAPACE, A. VENTURA

Single particle levels in deformed nuclei are very important in calculations of: a) potential energy maps for theoretical fission path and barrier parameter determination; b) nuclear level densities; c) microscopic correction to the fragment masses at the scission point.
Levels of 10 proton shells and 11 neutron shells have been generated in a Nilsson potential with quadrupole ($0 \leq \varepsilon_2 \leq 1$) and hexadecapole ($0 \leq \varepsilon_4 \leq 0.16$) deformations, by modifying a program due to F. Fabbri and P.L. Ottaviani and using parameters given by Seeger and Howard (Nucl. Phys. A238 (1975) 491).

1.3 Strutinsky's Shell and Pairing Corrections to the Ground State (Liquid Drop) Mass of a Spherical or Deformed Nucleus

A. VENTURA

Shell and pairing corrections to the liquid drop formula of nuclear binding energy are calculated by means of the single particle levels

quoted in (B).
In shell corrections, Gaussian functions are utilized together with curvature corrections given by Hermite polynomials up to 6th order; in pairing corrections, use is made of BCS formalism with constant pairing strengths G , deduced from the average trend $\Delta = 10.5/\sqrt{A}$ MeV of the gap parameter Δ for both protons and neutrons.

1.4 BCS Level Density calculations for Spherical Nuclei

G. MAINO, E. MENAPACE, A. VENTURA

Nuclear level densities are calculated by the grand partition function method, starting from single particle levels (B) and a residual pairing n-n and p-p interaction treated in BCS approximation. The ground state gap parameter Δ , which is the same for protons and neutrons is assumed as an adjustable parameter. An unblocked solution is adopted for odd nucleon numbers. The theoretical results are compared with the experimental level spacing at the neutron binding energy for a number of spherical nuclei. Work is in progress for a more correct treatment of the blocking of unpaired particles, also in the case of deformed nuclei, treated as pure rotors with axial and reflection symmetry.

1.5 Semiempirical Calculation of Fission Probabilities

V. BENZI, G. MAINO, E. MENAPACE

Theoretical calculations of the ratio Γ_n/Γ_f due to Britt and collaborators (Phys. Rev.C7 (1973) 801) and to Metag et al. (Nucl. Phys. A213(1973)397), using microscopic shell model methods for nuclear level densities, show a bump-like structure with a maximum at about 4-5 MeV (incident neutron energy).
Previous semiempirical calculations in literature were in disagreement with this prediction; on the contrary, the bump-like structure is recovered in the present semiempirical approach, where compound nucleus reaction cross sections are obtained by subtracting from the corresponding experimental values contributions from inelastic collective effects (via coupled channel optical model calculations) and "knock-on"[1] contributions.

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(1) Code ADAPE (F. Fabbri, L. Zuffi) and PRODE (E. Menapace, M. Vaccari)

Fig.1

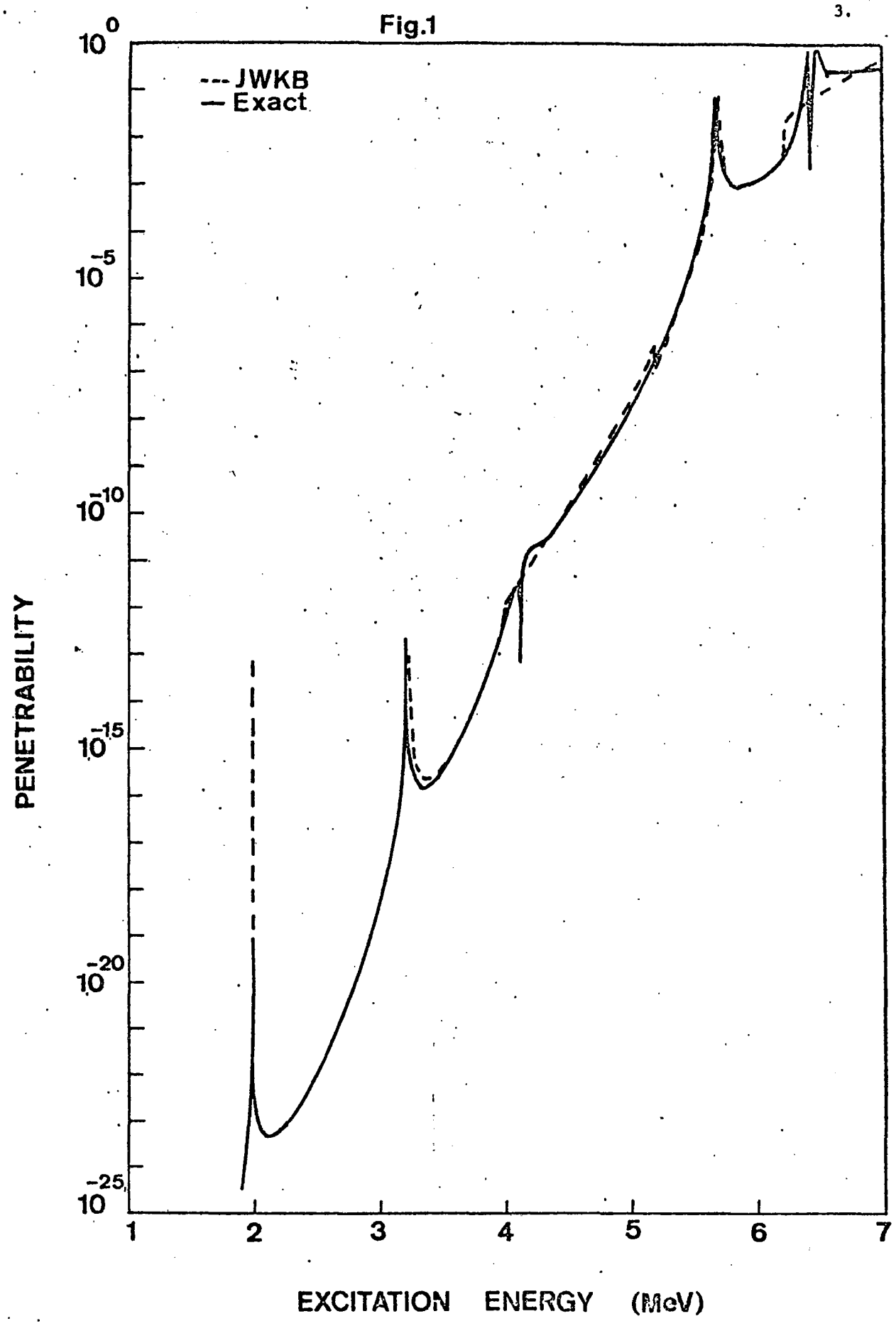
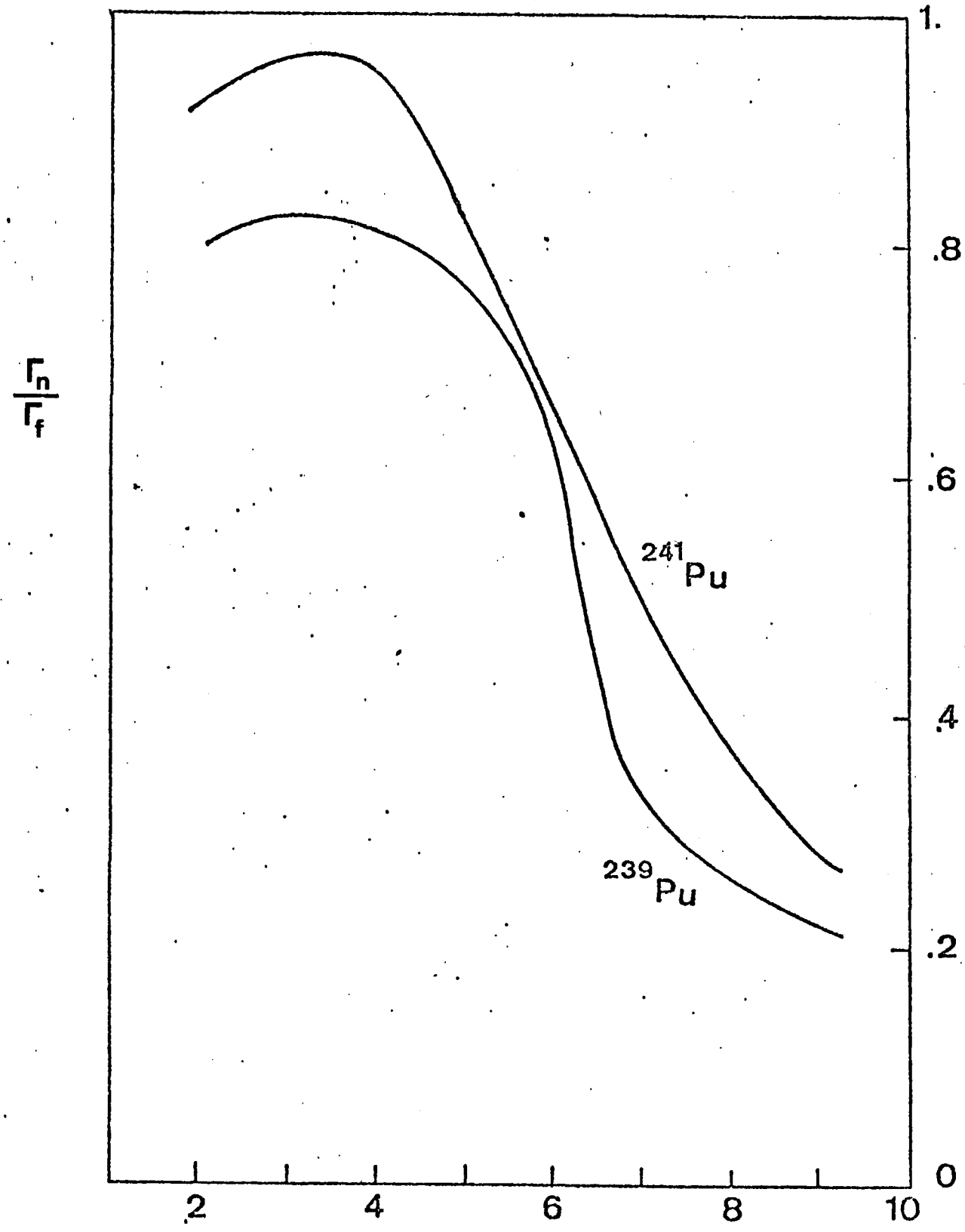

--- JWKB
— Exact
PENETRABILITY
10^{0}
10^{-5}
10^{-10}
10^{-15}
10^{-20}
10^{-25}
1
2
3
4
5
6
7
EXCITATION ENERGY (MeV)

Fig.2



Distinct contributions from first and second chance fission are deduced from the total fission cross section, by means of the compound nucleus cross sections $\sigma(n,n')$ and $\sigma(n,2n)$ referring to the particular target nucleus and the ratio $\sigma_{tot.}(,f)/\sigma_{react.}$ referring to the nucleus obtained from the former by emission of neutron.
Calculations performed for the nuclei ^{233}U, ^{235}U, ^{239}Pu, ^{241}Pu (see fig. 2) agree with theoretical results within the estimated uncertainties of our method. Theoretical and semiempirical approaches may be utilized in the future for reciprocal check, in absence of experimental values of Γ_n/Γ_f .
A paper of this subject has been accepted for publication on Lettere al Nuovo Cimento.

1.6 Nuclear Data for Fission Products

F. FABBRI, E. MENAPACE, T. MARTINELLI, A. MONTAGUTI, M. MOTTA, G.C. PANINI, G. REFFO, A. VENTURA, M. VACCARI.

In the frame of the program for fast power reactors, the evaluation activity has mainly been applied to the nuclear data of fission product (FP).
The need of a good evaluation of such isotopes was pointed out since the first IAEA Panel, held in Bologna in 1973.
On the basis of a CNEN-CEA agreement for a common contribution to the neutronic project of the fast power reactor Superphenix, neutron cross sections and related data for 63 FP isotopes were completely evaluated. Table 1 contains the list of the isotopes with the estimated percent of the total contribution to the neutron absorption.
This work began in the past years and has been completed in 1977 with the evaluation and file creation for the series of isotopes n. 2, 3 of table 1. The following actions were required for the evaluation.

TABLE 1

List of the Isotopes with the Estimated Percent of the Contribution to the Neutron Absorption

Series 1		Series 2		Series 3	
Isotope	%	Isotope	%	Isotope	%
Ru 101	20.659	Zr 93	0.877	Ce 141	0.228
Rh 103	6.960	Nd 148	0.856	Zr 95	0.225
Tc 99	6.960	Sm 152	0.849	Ru 100	0.179
Pd 105	4.969	Eu 155	0.848	Sm 154	0.176
Pd 107	4.339	La 139	0.701	Rb 850	0.168
Ru 102	4.349	Nd 146	0.552	Cd 111	0.164
Sm 149	4.062	Pd 108	0.524	Sm 150	0.157
Pm 147	3.675	Ru 106	0.500	Gd 157	0.150
Nd 143	3.498	Sm 147	0.488	Pd 104	0.137
Sm 151	3.089	Ce 142	0.452	Tb 159	0.129
Mo 97	3.050	Zr 96	0.447	Gd 156	0.125
Ag 109	2.488	Ce 144	0.403	Nd 147	0.118
Eu 153	2.382	Eu 154	0.381	Zr 94	0.109
Nd 145	2.241	Zr 91	0.363	Ba 140	0.099
Mo 98	1.972	Pd 106	0.354	Ba 138	0.087
Ru 104	1.886	Nd 144	0.342	Zr 92	0.085
Mo 95	1.707	Nd 150	0.261	In 115	0.083
Mo 100	1.490	Pr 143	0.240	Y 91	0.078
Ru 103	1.262	Nb 95	0.252	Te 128	0.077
Pr 141	1.317	Ce 140	0.230	Pd 110	0.073
$Cs^{+}135$	1.902	$Cs^{+}137$	0.262		
$Cs^{+}133$	1.489				
Total	82.355	Total	9.920	Total	2.647
$Total^{+}$	85.746	$Total^{+}$	95.928	$Total^{+}$	98.575

1) Collection and critical comparison of experimental data (cross sections, resonance parameters in the energy range 0-15 MeV). For the isotopes with no resonance data, random generations were adopted, having the constraints to reproduce the thermal cross section and the resonance integral.

2) Average parameter determination for cross section calculation in the unresolved region. Calculations were performed based on the strength functions and optical model, the last one being applied to the "continuum" region.

Try and test calculations for both steps where performed with the CRESO code.

The parameters obtained for each isotope are the following:

<D> average spacing for s-wave resonances

$\langle \Gamma_\gamma \rangle_{J,\pi}$ average radiative width for each J,π

$S_\emptyset$, S1, S2 strength functions. For $\ell=\emptyset,1$ obtained from resonances; for $\ell=2$ from systematics and fitting the experimental cross section data by means of the statistical model.

The <D> determination is one of the most important and critical problems of the work. In fact, in the statistical model the cross section values are inversely proportional to this parameter.
Thus, for a good determination, a large application of statistical methods was required.
When no resonance parameters were found in literature, the local and overall systematics of the density parameter "a" were used.
Special codes were developed for statistical analysis of resonances and orbital momentum assignment (SCEGLIE, MLE, FRANCE codes).
In the energy region of the continuum, where optical model is adopted, some other codes (CERBERO, ERINNI, CRAPONE) were used which were set up during a study of many years.
The chief criterion of all the evaluation was to achieve a systematic consistency: self consistency in evaluated data and integral data; global consistency between evaluated and integral data. This target was achieved for the majority of the most important isotopes.
The data have been written in files according to the ENDF/B format rules, by means of a series of codes (FAMOLTO, SYSMF, etc...). Each material has a structure based upon pointwise data plus a smooth background to which two ranges of resonance data (resolved and unresolved) are to be added.

A successive step was the creation of a multigroup library. Cross sections have been averaged following the 25 group CARNAVAL scheme by the FOURACES code. Groupwise graphs were produced in order to perform additional checks and to compare this evaluation with other equivalent sources (ENDF/B-IV, JENDL-1, RCN-2). Papers on methods and results were presented at the Kiev Conference, 18-22 April 1977 and to the International Conference on Neutron Physics and Nuclear Data for Reactors and Other Applied Purposes, Harwell, 25-29 Sept. 1978.

1.7 Extension of the Width Fluctuation Correction to Reactions Involving Continuum Level Excitations

F. FABBRI, G. REFFO

The concepts of decay-width-pooled distributions and of effective number of degrees of freedom have proven helpful in the calculation of inelastic scattering cross sections and emitted particle spectra, where channels leading to the excitation of bands of levels in the continuum are open at energies low enough for the width fluctuation effects to remain sizeable.

F. Fabbri, G. Reffo: Nucl. Sc. Eng. 66, 251(1978)

1.8 Parameter systematics for statistical theory calculations

G. REFFO

In order to provide the formalism used in the evaluation work with the necessary parameters (where experimental information is missing), the systematic behaviour of most important parameter has been investigated starting with the trends predicted by nuclear

theories.

G. Reffo: Cont. Paper to 2nd Panel on Fission Products Nuclear Data, Petten 5-9 Sept. 1977.

1.9 Actinide Nuclear Data

E. MENAPACE, G. OLIVA, L. TONDINELLI

In the frame of IAEA research agreement n. 1874/CF, thermal cross sections and resonance integrals of $^{243,244}Pu$, ^{242}Am, $^{246,248}Cm$, ^{249}Bk have been evaluated, in order to complete the available library.

Sensitivity analyses have been performed with time dependent perturbation methods and the results have been presented at the "1st Meeting on Nuclear Transmutation of Actinides" (NEA-EURATOM), Ispra, 16-18 March 1977" (°). Such analyses indicated as first priority data to be included in the evaluation program for 1978 the ones referring to $^{241,242}Pu$, $^{241,243}Am$, ^{242}Cm.

(°) E. Menapace, G. Oliva, L. Tondinelli: "Preliminary Sensitivity Studies for Transcurium Isotope Building in Thermal Reactors", First Tech. Meeting on the Nuclear Transmutation of Actinides, Ispra, 16-18 March 1977.

1.10 Total Neutron Cross Section Measurement in ^{91}Zr and ^{96}Zr

C. COCEVA, P. GIACOBBE, M. MAGNANI

The analysis of the neutron transmission experiment on ZrO_2 samples 89% enriched in the isotope ^{91}Zr has been completed up to 15 keV, allowing the determination of the resonance parameters $2g\Gamma_n$, J , ℓ. Results were obtained for 68 resonances. For some details on the experiment, performed at the Geel Linac, see Progress Report on Nuclear Data Activities in Italy 1976 - NEANDC (E) 182 "U", vol. 7.

An additional high-precision transmission measurement using metallic natural samples has been performed below 1 keV with a double aim: a) to obtain further high-quality information about some controversial spin or parity assignments in this region, and on the difference between the potential scattering of the isotope and the average potential scattering of Zr ; b) to have some information about the Doppler broadening in the ZrO_2 crystals of the sample. A contribution concerning the results along with those obtained in capture experiments by a BCMN - Geel group will be submitted to the International Conference on Neutron Physics and Nuclear Data for Reactors and other Applied Purposes, Harwell, September 1978.

The analysis of the transmission experiment on ^{96}Zr-enriched samples is in progress.

1.11 Experimental Aspects of the Statistical Theory of Nuclear Spectra Fluctuations

C. COCEVA, M. STEFANON

The analysis of neutron transmission and capture in ^{156}Gd has been completed. Energy and $g\Gamma_n$ of 87 resonances were determined and their values were used for testing the statistical model of random hamiltonians, including also experimental effects. The experimental results for ^{156}Gd were found to be in agreement with the predictions of the theory based on the Gaussian Orthogonal Ensemble. The importance of measuring also the neutron widths for testing the statistical properties of resonance energies was established, in connection with the experimental uncertainties in the definition of a pure sequence. Estimates were obtained of the average level spacing of ^{156}Gd, $D=35.5\pm2$ eV and of the s and p wave neutron strength functions, $10^4 s_o=1.8\pm0.3$, $10^4 s_1=2.1\pm0.5$.

1.12 Low-Energy Gamma Spectra from Resonance Neutron Capture in ^{191}Ir

C. COCEVA, P. GIACOBBE

The measurement of low-energy gamma-spectra between 118 and 618 keV from neutron capture in 20 resonances of ^{191}Ir below 90 eV has been performed on the 13m flight-path of the Geel linac.
The aims of the measurement were: a) to try the spin assignment of some resonances with the low-energy population method; b) to give a contribution to the ^{192}Ir spectroscopy, using the gamma-population method of the compound nucleus levels to get information about their spin; groups from Fribourg, Riga, Brookhaven, Argonne, Livermore and Munich are currently interested in the spectroscopy of this nucleus on complementary lines of research.
The difficulties of the analysis lie in the very high level density of the odd-odd compound nucleus, whose structure can hardly be resolved by a Ge(Li) detector, and in the complete lack of spectroscopic information about ^{192}Ir . Beacuse of such difficulties, the spin could be assigned to 10 resonances only. Information about the spin of the parent states of 21 low-energy gamma lines were obtained. Such information will be both tested and exploited when the joint efforts of all the mentioned laboratories will allow to connect the observed gamma lines in a level scheme.
The results will be reported in a contribution submitted to the Third International Symposium on Neutron Capture Gamma-Ray Spectroscopy, Brookhaven, September 1978.

2. ISTITUTO NAZIONALE DI FISICA NUCLEARE - SEZIONE DI CATANIA - CENTRO SICILIANO DI FISICA NUCLEARE E STRUTTURA DELLA MATERIA - Corso Italia, 57 - 95129 Catania (Italy)

2.1 Fission Cross Section of Re, W and Ta by a Coherent Photon Beam from 1000 MeV Electrons

V. BELLINI, V. EMMA, A.S. FIGUERA, S. LO NIGRO, C. MILONE and G.S. PAPPALARDO

Istituto di Fisica Generale dell'Università - Catania
Istituto Nazionale di Fisica Nucleare - Sezione di Catania

G. BOLOGNA

Laboratori Nazionali dell'INFN - Frascati

The photofission yields of Re, W and Ta induced by a coherent bremsstrahlung beam from 1000 MeV electrons striking a diamond single crystal have been measured.
The experiment has been performed at eighteen different energies of the main peak of the photon spectrum, in the energy range between 220 MeV and 550 MeV, by detecting the fission fragments with glass sandwiches.
The behaviour of the photofission cross section has been deduced from the experimental yields by using an appropriate unfolding method. The obtained curves clearly show a first resonance centred at photon energy $k \simeq 350$ MeV with a FWHM $\simeq 145$ MeV, while there is a hint of a second resonance at $k \simeq 750$ MeV.
Information on the energy dependence of the nuclear fissility from 100 MeV to 1000 MeV has been deduced from the comparison of the estimated photofission cross-section with the total photon interaction cross section.
It has been found that the photomesonic model of the fission process permits to explain the energy dependence of our photofission cross section if a nuclear fissility increasing with photon energy is assumed.

2.2 A Statistical Analysis of the Neutron-Induced Fission and Total Cross-Section of ^{235}U up to 36 keV

G. LANZANO', E. MIGNECO

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Istituto Nazionale di Fisica Nucleare - Sezione di Catania
Centro Siciliano di Fisica Nucleare e di Struttura della Materia - Catania.

The relative fission cross section of ^{235}U has been measured up to 200 keV with a nominal resolution of 1.0 ns/m.
The data have been analysed in order to detect nonstatistical effects due to intermediate structure. The statistical tests which have been applied to this fission and similar total-cross-section data include calculation of the correlation serial coefficients, variance and Wald-Wolfwitz tests. The comparison of the results indicates the presence of intermediate-structure effects in fission cross section which may be interpreted on the basis of the double-humped deformation potential. Under the assumption that the first not fully open channel is the $K^{\pi}=2^{-}$, the energies of the outer barrier and of the shape isomer of this transition state are obtained.

2.3 Fission Isomer of $^{237}Np^{m}$

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R. DE LEO, A. PANTALEO

Istituto di Fisica dell'Università di Bari - Istituto Nazionale di Fisica Nucleare, Sezione di Bari

The excitation function and lifetime $T_i = (45\pm5)$ns of a ^{237}Np fission isomer were measured using the $^{238}U(p,2n)$ reaction and the fission-in-flight method. The analysis of the delayed-to-prompt fission ratio provided an excitation energy of (2.85 ± 0.4)MeV for the isomeric state and a branching ratio of $1.9.10^{-3}$ between γ and fission decays.

2.4 Study of Some ^{16}O States at High Excitation Energy

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Centro Siciliano di Fisica Nucleare e di Struttura della Materia -
- Catania - Istituto di Fisica dell'Università

N. SAUNIER, E.F. da SILVEIRA

Département de Physique Nucléaire - CEN Saclay, B.P.2 91190,
Gif-sur-Yvette, France

The particle-particle angular-correlation method is applied to the reaction $^{12}C(^{6}Li,d)^{16}O \rightarrow + {}^{12}C$. Deuterons were detected at $\theta_1=0^{o}$. Spin and parity of some highly excited ^{16}O states are deduced. Analysis of the correlation patterns indicates that a direct transfer is a dominant mechanism.
The angular correlation corresponding to the $^{16}O_{21.8} \rightarrow \alpha + {}^{12}C_{4.43}$ is specially analysed and interference effects due to the different l values involved in the decay are discussed.

3. UNIVERSITA' DI FIRENZE - ISTITUTO DI FISICA "A. GARBASSO" - LARGO ENRICO FERMI, 2 - ARCETRI - FIRENZE

3.1 In Beam γ-Ray Spectroscopy of ^{44}K and ^{48}Ca

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Istituto di Fisica dell'Università and INFN - Firenze

G. LO BIANCO, N. MOLHO
Istituto di Fisica dell'Università and INFN - Milano

This work has been performed using the proton beam from the A.V.F. Cyclotron in Milan, at energies ranging from 18 to 35 MeV.
The target was $CaCO_3$ powder (97.2% enriched in ^{48}Ca), sandwiched between two Mylar foils.
From single and γ-γ coincidence spectra we could identify many new levels and transitions in ^{44}K, as shown in the figure, where heavier lines are used for them. From time-delay spectra of γ's with respect to the beam bunches, an upper limit has been established for the lifetime of the levels at 383, 520 and 1368 keV (1 ns).
These results have been presented at the topical conference on medium-light nuclei, Florence 1977.
In the course of the same experiment, levels in ^{48}Ca have been populated via the $^{48}Ca(p,p'\gamma)^{48}Ca$ reaction.
Besides confirming by γ-γ coincidences the existence of a doublet at 4504-4507 keV, we could show that the lifetime of 2.2 ns, previously[1] attributed to the 5147 keV level, actually belongs to the lower level at 4504 keV, to which the former decays, while the 5147 keV level is "prompt" within the experimental resolution ($\tau_m < 1$ ns).
On the basis of these results, it seems appropriate to assign $J^\pi = 4^+$ to the 4504 keV level; while the proposed[2] value ($5^{\pm}$) for the 5147 keV level is consistent with our results.
These results have been published on Phys. Rev. C, Vol. 15, n. 6 2245 (1977).

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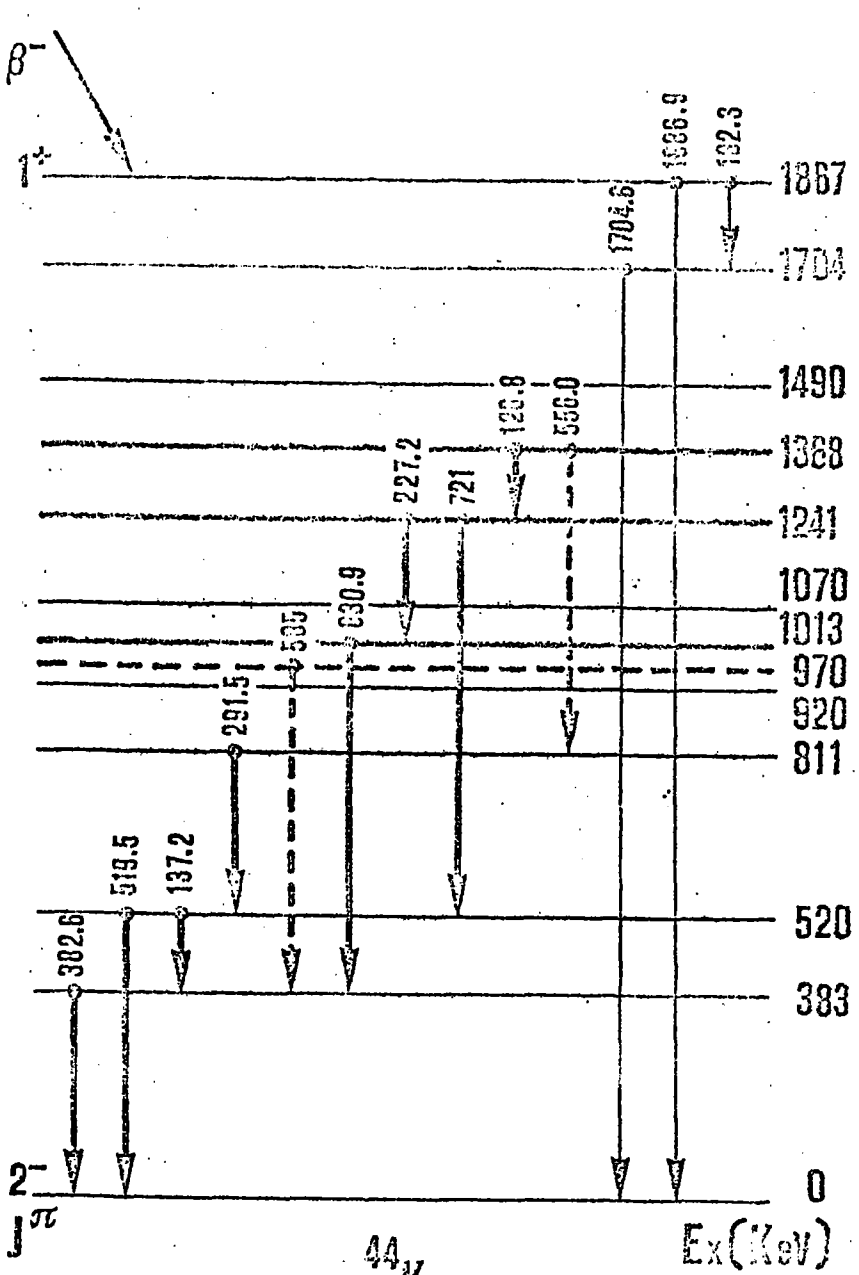
(2) A. Tellez, R. Ballini, J. Delaunay and J.P. Fouan, Nucl. Phys. A127, 438 (1969).


β⁻
1⁺
2⁻
Jπ
44K
Ex(Kev)
1867
1704
1490
1388
1241
1070
1013
970
920
811
520
383
0
1586.9
1704.6
132.3
227.2
721
120.8
556.0
630.9
535
291.5
519.5
137.2
382.6

3.2 The B(E2) Value of the Transition Between the Ground State and the First Excited State in ^{49}Ti"

P.A. MANDO', P. SONA, N. TACCETTI, G. LIBERATI

Istituto di Fisica dell'Università di Firenze - I.N.F.N. - Sezione di Firenze.

The B(E2) value of the 1381 keV transition connecting the $7/2^-$ ground state to the $3/2^-$ first excited level in ^{49}Ti has been determined by means of Coulomb excitation measurements using the alpha particle beam from the CN Van der Graaff accelerator of Laboratori Nazionali di Legnaro (PADOVA). Measurements were taken at four different energies of the beam ranging from 5.25 up to 5.8 MeV. The target consisted of an 1 mg/cm^2 self supporting titanium foil containing 81.8% ^{49}Ti and 14.1% ^{48}Ti. Gamma rays were detected in singles by means of two coaxial Ge(Li) detectors (having 10% efficiency and 3 keV in beam resolution for 1300 keV gammas) placed, on opposite sides, at 90° to the beam direction with the front face 2 cm distant from the beam spot. The B(E2) value was determined relative to that of the $0^+ 2_1^+$ 983 keV transition in ^{48}Ti. The weighted average of the results obtained at different energies gives for the ratio $B(E2)\downarrow (3/2^- \rightarrow 7/2^-, {}^{49}Ti)/ B(E2)\downarrow (2^+ \rightarrow 0^+, {}^{48}Ti)$ the value $(0.24 \pm .03)$. Assuming for the $B(E2)\downarrow (2^+ \rightarrow 0^+, {}^{48}Ti)$ the most precise value reported in the literature [1], namely

$$B\downarrow (E2\ 2^+ \rightarrow 0^{+48}, Ti) = (138 \pm 12) e^2 fm^4 \ .$$

we get as final result

$$B\ (E2)\downarrow (3/2^- \rightarrow 7/2^-, {}^{49}Ti) = (33^{+}{}_{-5}) e^2 fm^4$$

This result is consistent with the lower and upper limit reported in the literature for the same transition

$B(E2)\downarrow > 32\ e^2 fm^4$ ref.2)
$B(E2)\downarrow < 60\ e^2 fm^4$ ref.3)

References

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2) D.C.S. White, W.J. McDonald, D.A. Hutcheon and G.C. Neilson: Nucl.Phys. A260, 189(1976)
3) O.F. Afonin, A.P. Grinberg, I.K. Lemberg and I.N. Chugunov: Sov.J.Nucl. Phys. 6, 160(1961).

3.3 Search for $1/2^-$ level at 1.292 MeV in ^{55}Mn

T. FAZZINI, A. GIANNATIEMPO, P.R. MAURENZIG

Istituto di Fisica dell'Università di Firenze - INFN Sezione di Firenze

A search has been made by means of an $(\alpha,\alpha'\gamma)$ reaction for a $1/2^-$ level at 1292 keV in ^{55}Mn. According to Peterson et al. [1] this level has been identified by means of two-nucleon transfer reactions. We have tried to populate this level via Coulomb excitation from the $5/2^-$ ground state using an alpha particle beam at energies ranging from 4.5 to 7 MeV, from the CN Van der Graaff accelerator of Laboratori Nazionali di Legnaro. No evidence has been found for the existence of such a level since the relevant $B(E2)_{\uparrow}$ value comes out to be $(.3\pm.5)\ e^2fm^4$. This is in strong disagreement with the result recently reported in the literature [2] ($B(E2)_{\uparrow} = 48\pm 4\ e^2fm^4$) which has been obtained by Coulomb excitation.

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(1) R.J. PETERSON, S. PITTEL and H. RUDOLPH - Phys. Letters 37B(1971)278

(2) R.G. KULKARNI - Physics Scripta 13(1976)213

3.4 Lifetime Measurements in ^{98}Tc

M. BINI, A.M. BIZZETI-SONA, P.G. BIZZETI, P. BLASI, E. FOCARDI, N. TACCETTI

Istituto di Fisica dell'Università - Firenze - Italy
Istituto Nazionale di Fisica Nucleare - Sezione di Firenze - Italy

The reaction ^{98}Mo(p,n) ^{98}Tc has been used to investigate [1] the low lying levels of ^{98}Tc. Measurements have been performed at the 7.5 MV Van de Graaff of Laboratori Nazionali di Legnaro (Padova).
Gamma-gamma coincidence measurements have been made with two Ge counters (a coaxial one of $\sim$ 60 cm^3 and an intrinsic Ge counter of 1 cm^3).
Delayed γ-rays have been studied with the pulsed beam-delayed coincidence method.
A new isomeric state with a mean life $\tau_m = (11.6 \pm 0.3)$ ns has been observed at the excitation energy 138.6 keV. This level has been found to decay with γ-rays of 47.8 keV, 50.8 keV and 65.2 keV. The low lying level scheme obtained for the ^{98}Tc is shown in fig. 1. The 43.6 keV transition shows a prompt and a delayed component. The mean life of the latter results to be $\tau_m = (20.3 \pm 0.6)$ μs in agreement with the value reported by Wender and Martin [2].
The 20.3 μs isomeric state could be identified with one of the two new levels found at 73.4 keV and at 90.8 keV.

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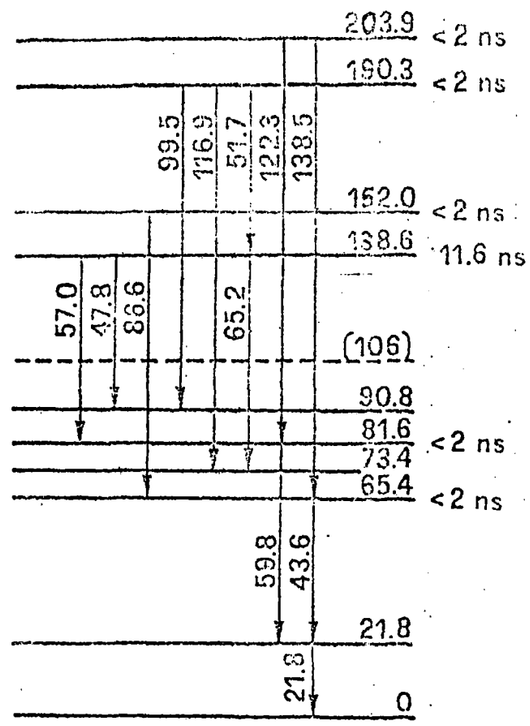
203.9
< 2 ns
190.3
< 2 ns
99.5
116.9
51.7
122.3
138.5
152.0
< 2 ns
138.6
11.6 ns
57.0
47.8
86.6
65.2
(106)
90.8
81.6
< 2 ns
73.4
65.4
< 2 ns
59.8
43.6
21.8
21.8
0

^{98}Tc

3.5 Isomeric Transitions in ^{100}Tc"

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The ^{100}Tc nucleus has been investigated with the reaction $^{100}Mo(p,n)^{100}Tc$ and a pulsed proton beam with energy ranging from 4 MeV to 5.2 MeV.
Prompt and delayed γ-rays have been observed with an 1 cm^3 intrinsic germanium detector. The time spectrum of the 172.2 keV γ-ray de--exciting the ^{100}Tc first excited state shows a prompt part and a delayed part. The measured mean life comes out to be $\tau_m = (11.9 \pm 0.3)$ μs. The proton beam was pulsed 20 μs on and 80 μs off, by means of an electrostatic chopper.
In order to identify the isomeric transition feeding the first excited state, conversion electron measurements have been performed with a small magnetic spectrometer (1). A delayed electron line of 25.7 ± 0.5 keV energy (corresponding to the transition 200 keV $\rightarrow$ 172 keV from the second to the first excited level) has been observed, and its mean life results to be consistent with the one of the delayed 172 keV γ-rays.

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4. ISTITUTO NAZIONALE FISICA NUCLEARE - SEZIONE DI TRIESTE - VIA ALFONSO VALERIO, 2 - TRIESTE (ITALY)

4.1 A Study of the $^{75}As(n,n'\gamma)$ ^{75}As Reaction

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The de-excitation gammas following the inelastic scattering of neutrons from ^{75}As have been studied for incident neutron energies from 1300 to 2800 keV by steps of 100 keV. The energy levels and the branching ratios of their decays have been deduced from excitation function measurements: 58 energy levels have been found in the excitation energy region below 2.8 MeV, 12 of which are reported for the first time in this work. The experimental excitation functions and angular distributions have been compared with the theoretical predictions based on the statistical theory of the compound nucleus. Spin and parity assignments for the levels and multipolarity determinations for the decays have been made for excitation energies of levels up to 2300 keV.

CINDA ENTRIES

Element S	Element A	Quantity	Energy Min	Energy Max	Source	Vol & Page	Date	Type	Laboratory		Comments
ZR	91	TOT		15+3	NEANDC(E)	192 7	078	M	BOL	COCEVA+ TRANS RESPARS	TBP NDG
ZR	96	TOT		15+3	NEANDC(E)	192 7	078	M	BOL	COCEVA+ TRANS RESPARS	IN PROGRESS
U	235	NF		36+3	NEANDC(E)	192 7	078	M	CAT	LANZANO+ NDG	
U	238	N2N			NEANDC(E)	192 7	078	E	CAT	MIGNECO+ NDG	
AS	75	SIN	13+5	28+5	NEANDC(E)	192 7	078	E	TRI	ABBONDANNO+ NDG G DEEXCT CØMPNUC LVL	