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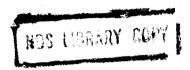
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Progress Report to the IAEA - NDS

on Current Nuclear Data Activities

A. Marcinkowski
Institute of Nuclear Research, Warsaw, Poland

March 1983

IAEA NUCLEAR DATA SECTION, WAGRAMERSTRASSE 5, A-1400 VIENNA

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1. <u>Evaluation of the Excitation Curves for the</u> ^{28}Si/n,p/^{28}Al

   <u>and</u> ^{181}Ta/n,2n/^{181m}Ta <u>Reactions</u> [+]

   L. Adamski, M. Herman and A. Marcinkowski

   The excitation curves for the ^{28}Si/n,p/^{28}Al and the
   ^{181}Ta/n,2n/^{181m}Ta reactions have been evaluated in the neu-
   tron energy range from threshold up to 24 MeV. The experi-
   mental data cover the energy ranges up to 9 MeV and above
   12 MeV. In order to fill the gap between 9 and 12 MeV one
   has to resort to statistical model calculations. Such calcu-
   lations including the preequilibrium emission have been
   performed with aid of the EMPIRE [1]/ code. The results of
   calculations agree very well with the evaluated experimental
   data above 12 MeV of neutron energy and provide the recom-
   mended shape of the excitation curve down to 9 MeV. Below
   9 MeV the fine resolution experiments provide a structure-like
   curve.

   [1]/ M. Herman, A. Marcinkowski and K. Stankiewicz, to be pub-
   lished and contribution to the present report

   _____

2. <u>Calculations of Neutron and Photon Production Cross Sections</u>

   <u>on Mo Isotopes</u> [+]

   M. Herman and A. Marcinkowski

   The calculations of inclusive neutron and photon spectra
   following the neutron induced reactions, at 14 MeV bombarding
   energy, on Mo isotopes are in progress. The calculations

include the evaporational and preequilibrium components
described in an angular momentum dependent formalism. All
calculations are conducted with use of the EMPIRE code [1].
The parameterization of the model calculations follows the
method reported by Reffo [2]. The extension of the calculations
to other projectile energies and target nuclides is taken
into consideration.

[1] M. Herman, A. Marcinkowski and K. Stankiewicz, to be pub-
lished and contribution to the present report

[2] G. Reffo, CNEN Report RT/FI/78/11, Bologna

[+] Part of an Interregional Project on Measurements and Analy-
sis of 14 MeV Neutron Nuclear Data Needed for Fission and
Fusion Reactor Technology, coordinated by the International
Atomic Energy Agency - Nuclear Data Section under the
Research contract No. 3241/RB

3. Calculation of the Cross Sections of the $^{107}Ag/n,2n/^{106g}Ag$
and $^{109}Ag/n,2n/^{108g}Ag$ Reactions in the Threshold Region

M. Herman and A. Marcinkowski

This work is aimed at completion of the recent evaluation
of the excitation curves for the $^{107}Ag/n,2n/^{106g}Ag$ and
$^{109}Ag/n,2n/^{108g}Ag$ reactions performed under an IAEA research
contract [1]. No experimental data exist close to the threshold
energies for both reactions. Therefore the cross sections
up to 11.5 MeV of neutron energy have been calculated with
aid of the EMPIRE code, according to the statistical model

of nuclear reactions including the compound nucleus as well as the preequilibrium components. The parameterization of the model calculation follows the systematics given in ref. [2]/ The results complete the recommended data sets reported in ref. [1]/,

Cross Sections in mb		
E_n /MeV/	$^{107}Ag/n,2n/^{106g}Ag$ [†]	$^{109}Ag/n,2n/^{108g}Ag$ [††]
9.50	0	10
9.75	0	86
10.00	28	204
10.50	184	435
11.00	341	609
11.50	480	-

[†] threshold energy 9.72 MeV

[††] threshold energy 9.32 MeV

[1]/ L. Adamski, M. Herman, A. Marcinkowski and An Jong Do, Final report on the International Atomic Energy Agency Research contract No. 2741/RB; also INR report No. 1931/I/IXA/PL/A

[2]/ G. Reffo, CNEN Report RT/FI/78/11, Bologna

4. <u>A Program for Calculation of Spectra and Cross Sections within the Combined Preequilibrium and Compound Nucleus Model of Nuclear Reactions</u>

M. Herman, A. Marcinkowski and K. Stankiewicz

The EMPIRE program calculates spectra and cross sections

for capture and/or multistep nuclear reactions in the frame of a combined preequilibrium and compound nucleus model. The angular momentum conservation is observed throughout the whole calculations. To this end angular momentum considerations have been incorporated into the geometry dependent hybrid model of preequilibrium emission. The decay of the compound nucleus is treated either in terms of the HRTW theory [1] or in terms of the standard Hauser-Feshbach theory. The program is flexible enough to treat capture cross sections at very low energies as well as multiparticle emission at energies of several tens of MeV. It is particularly well suited for calculations of isomeric cross sections and cross sections for production of gamma rays, accompanying the decay of low excited levels.

Very recently the code has been included into the International Nuclear Model Code Intercomparison Spherical Optical and Statistical Model Study, carried out by the NEA Data Bank, under the auspices of the IAEA.

[1] H.M. Hofmann, T. Mertelmeier, M. Herman and J.W. Tepel, Z. Phys. A297 /1980/ 153

5. Parity and Exciton Number Distributions of Excited Particle-Hole States

W. Augustyniak

The randomly chosen configurations of excited particle-hole states have been simulated by the Monte Carlo method. The probabilities of excitation of any configuration have been expressed in terms of the Fermi distribution. It is

assumed that the parity of a configuration is defined as a product of the parities of states populated by particles due to broken pairs. The number of configurations of the same parity and exciton number are counted. For the odd nuclei the level blocking method has been applied.

6. <u>Cross Section Measurements for the /n,2n/ Reactions on</u> ^{134}Ba, ^{142}Nd, ^{150}Nd and ^{144}Sm

An Jong Do [§], J. Dresler [+], U. Garuska [+], M. Herman and A. Marcinkowski

The cross sections for the ^{134}Ba/n,2n/^{133m}Ba, ^{142}Nd/n,2n/^{141g}Nd, ^{142}Nd/n,2n/^{141m}Nd, ^{150}Nd/n,2n/^{149}Nd, ^{144}Sm/n,2n/^{143g}Sm and ^{144}Sm/n,2n/^{143m}Sm reactions have been measured, by the activation method, in the neutron energy range from 13.0 to 17.9 MeV. The absolute cross sections have been obtained by referring the measured gamma ray yields to the yield of the ^{56}Fe/n,p/^{56}Mn reaction. Comparison with theoretical calculations taking into account the nucleon evaporation and preequilibrium emission provided good agreement between theory and experiment.

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7. Measurements of the Cross Sections for the ^{181}Ta/n,2n/^{180m}Ta Reaction [§]

L. Adamski, J. Dresler[+], U. Garuska[+], M. Herman and
A. Marcinkowski

Because of the large scatter of available experimental data the cross sections of the ^{181}Ta/n,2n/^{180m}Ta reaction have been remeasured by the activation method in the neutron energy range from 13.4 to 15.4 MeV. The gamma rays of energies 93 keV and 103 keV following the 8.1 h decay of the ^{180m}Ta isomeric state were measured and referred to the yield of the ^{56}Fe/n,p/^{56}Mn reaction.

8. Measurements of the Differential Cross Sections of the ^{58}Ni/n,p/^{58}Co Reaction at 18.5 MeV Neutron Energy

J. Rondio, A. Korman and B. Mariański

Proton energy spectra are currently measured from the ^{58}Ni/n,p/^{58}Co reaction with use of a new multi-telescope system. Eight telescopes, each one consisting of transmissive proportional counters and a thick lithium drifted silicon detector, allow to measure the angular distribution in the range 10° to 160°, with step 10°, at two different positions of the scattering chamber [1]. Enriched target containing 99.7% of ^{58}Ni was used. The results of measurements demonstrate the presence of transitions to analog states of the E1 and M1

giant resonances.

[1]/ B. Mariański, J. Rondio and A. Korman, Nucl. Instr. Meth.

in press

9. Angular Distributions of Alpha Particles from the /n,α/
Reaction on ^{143}Nd and ^{149}Sm

W. Augustyniak, L. Głowacka, M. Jaskóła, Le Van Khoi [+],

J. Turkiewicz and L. Zemło

Angular distributions of alpha particles from the /n,α/
reaction were measured, by direct registration of alphas, using
a n-type surface barrier silicon detector, as described in [1]/.
The neutrons were obtained from the ^{3}H/d,n/^{4}He reaction with
deuterons accelerated in a 3 MV Van de Graaff accelerator.
The neutron flux was monitored by counting the protons recoiled
from a polyethylene foil. The absolute cross sections were
obtained by referring the measured yields to the activity
induced in the ^{56}Fe/n,p/^{56}Mn reaction. The neutron bombarding
energy was 12.3 MeV.

Angular Distributions of Alpha Particles		
Theta /deg/	^{143}Nd/n,α/^{140}Ce	^{149}Sm/n,α/^{146}Nd
26 ± 17	0.81 ± 0.04	0.85 ± 0.09
46 ± 17	0.40 ± 0.06	0.41 ± 0.09
63 ± 17	0.20 ± 0.06	0.32 ± 0.09
90 ± 17	0.11 ± 0.06	0.24 ± 0.09
118 ± 18	0.01 ± 0.06	0.15 ± 0.12
135 ± 17	0.04 ± 0.07	0.01 ± 0.14
156 ± 15	0.07 ± 0.05	0.17 ± 0.15

The angular distributions correspond to alpha particles populating levels at excitation energies lower than 5 MeV.

[1]/ M. Jaskóła, J. Turkiewicz, L. Zemło and W. Osakiewicz,

   Acta Phys. Pol. B2 /1971/ 521

[+] Present address: Institute of Physics, University of Hanoi, Vietnam

10. Differential Cross Sections for the /n,α/ Reactions on ^{143}Nd, ^{147}Sm and ^{156}Gd Nuclei

W. Augustyniak, J. Dalmas [+], L. Głowacka, M. Jaskóła and J. Turkiewicz

   The alpha particle spectra from interaction of fast neutrons with heavy deformed nuclei have been measured, by direct detection of alphas with use of a silicon surface barrier detector, at an emission angle 25 $\pm$ 15 degrees. The cross section integrated over the spectral energy range from 15.0 to 22.5 MeV, for the ^{143}Nd/n,α/^{140}Ce reaction at 12.3 MeV neutron energy, equals 1.3 $\pm$ 0.2 mb/sr, and for the ^{147}Sm/n,α/^{144}Nd reaction at 19.5 MeV, integrated from 20.1 to 29.6 MeV, is equal to 2.9 $\pm$ 0.4 mb/sr.

   The measurements are continued for the ^{143}Nd/n,α/^{140}Ce reaction at 20.5 MeV, and for the ^{156}Gd/n,α/^{153}Sm reaction at 18.0 MeV bombarding energy.

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