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May 1981

INSTITUT OF EXPERIMENTAL PHYSICS
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Application of Solid-State Nuclear Track detectors for the measurements of fission-cross section ratios

M. Várnagy

Fission cross-section ratios of $^{238}U/^{235}U$, $^{238}U/^{237}Np$, $^{235}U/^{237}Np$ and $^{239}Pu/^{235}U$ were determined in the range of 13.5-14.8 MeV neutron energy. Neutrons were preduced by a 180 kV Cockcroft-Walton generator using the $T(d,n)^4He$ reaction. The neutron energies were changed by the emission angle to the beam. The fission events from samples were detected with Makrofol KG SSNTD. Etching of the detector foils was carried out in 28 % KOH solution et a temperature of 60 ^oC. The etched foils were evaluated by a Jumping Spark Counter. Relative fission cross-sections were determined at in x angles /0^o, 30^o, 60^o, 90^o, 120^o and 150^o/. Results obtained in this experiments are presented in Table I. The trends of the relative cross sections within the limits of errors are in good agreement with those given by other authors. The results prove the possible use of SSNTD-s in combination with the ISC for the fission cross section measurements.

Table I.

E_n MeV	$nf(^{238}U/^{235}U)$	$nf(^{235}U/^{237}Nu)$	$nf(^{238}U/^{237}Np)$	$nf(^{239}Pu/^{235}U)$
13,52	0.5276 ± 0,0306	0.8815 ± 0.0451	0.4690 ± 0.0204	1.1456 ± 0.0699
13.75	0.5410 ± 0,0313	0.8947 ± 0.0458	0.4810 ± 0.0210	1.1382 ± 0.0694
14.12	0,5515 ± 0.0319	0.9006 ± 0.0461	0,4862 ± 0.0212	1,1302 ± 0,0689
14.45	0,5544 ± 0,0321	0.8893 ± 0.0455	0.4894 ± 0.0213	1.1260 ± 0,0687
14.70	0,5751 ± 0.0333	-	0.4965 ± 0.0216	1,1240 ± 0.0686
14.80	0.5726 ± 0,0332	0.8832 ± 0.0452	0.4965 ± 0,0216	1.1200 ± 0,0683

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1 M. Várnagy, S. Juhász, J. Csikai, Measurements of fission cross sections around 14 MeV, V. Vsesoyuznoi Konferentsii po Neitronnoi Fizike /Kiev, 15-19 September, 1980/.

2 M. Várnagy, S. Juhász, J. Csikai, M.A.B. Siddique and P. Raics, Measurements of fission cross-section ratios using track-etched detectors. X. International Symposium on Selected Topics of the Interaction of Fast Neutrons and Heavy Ions with Atomic Nuclei /Gaussig/Dresden, 17-21. november, 1980/

High intensity neutron generator

J.Csikai, T.Sztaricskai, I.Berkes, S.Szegedi

A low voltage, high intensity accelerator /neutron generator/ is under construction /200 kV, 30 mA/. The duoplasmatron ion source with 50 kV extraction voltage and an einzel lens are mounted on the vacuum system of the accelerator. Beam form investigations are in developement by using a Z80 based microcomputer. The single gap accelerating tube adn a post acceleration ion species selector /Wien-filter/ are under manufacturing. The water cooled rotating tritium target for 6-8 kW/cm^2 target load is under development.

Nanosecond pulsed neutron generator

T.Sztaricskai, G.Pető, L.Vasváry

A 300 kV nanosecond pulsed neutron generator was constructed for investigating prompt secondary radiations from construction materials. The generator delivers 3 nsec width, 2 Mcps repetition rate 14 MeV neutron pulses. The pulsation system is a Florov bunching one with 20 Mcp bunching frequency. A true coaxial Ge/Li/ detector is used for the prompt gamma ray investigations and a stilben /NE213/ scintillation detector is used for the neutron energy distribution measurements. Associated measuring system for correlated prompt neutron-gamma measurement is under development.

Energy Dependence of the Mass Distribution for the $^{238}U(n,f)$ Process in the 1.5-15 MeV Region

S. Nagy, S. Daróczy, P. Raics, I. Boda, I. Matajsz*

The recent increased interest in fast breeder reactors has stimulated systematical studies of the fission product yields as a function of neutron energy. One of the authors participated in the detailed measurement of mass distributions in monoenergetic neutron induced fission of ^{238}U in the 1,5-8 MeV energy range [1] performed at the Chemistry Division of Argonne National Laboratory.

In the present work all the cumulative yields for the monoenergetic neutron induced fission of ^{238}U, published before 1980, has been collected and updated. In the 14-15 MeV range recommended mass yields were given [2] by essentially the same way as in our former compilation [3].

The mass distributions at 10 neutron energies /1.5, 2.0, 3.0, 3.9, 5.5, 6.9, 7.7, 9.0 and 14.7 MeV/ have been fitted by the superposition of 5 Gauss-curves. The energy dependence of the parameters of Gauss-curves were also fitted /Table 1, as proposed by Cook et al. [4]. Our results are presented in Fig.1, together with the results of Cook et al, which were based on the mass

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distributions at 2 neutron energies only. The energy dependence of the gross and fine structures of the mass distributions were discussed [5].

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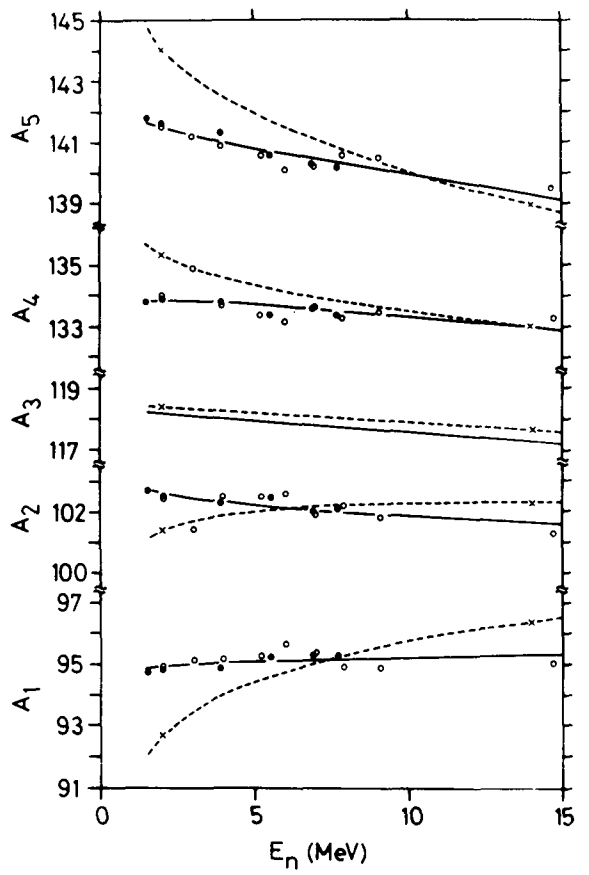

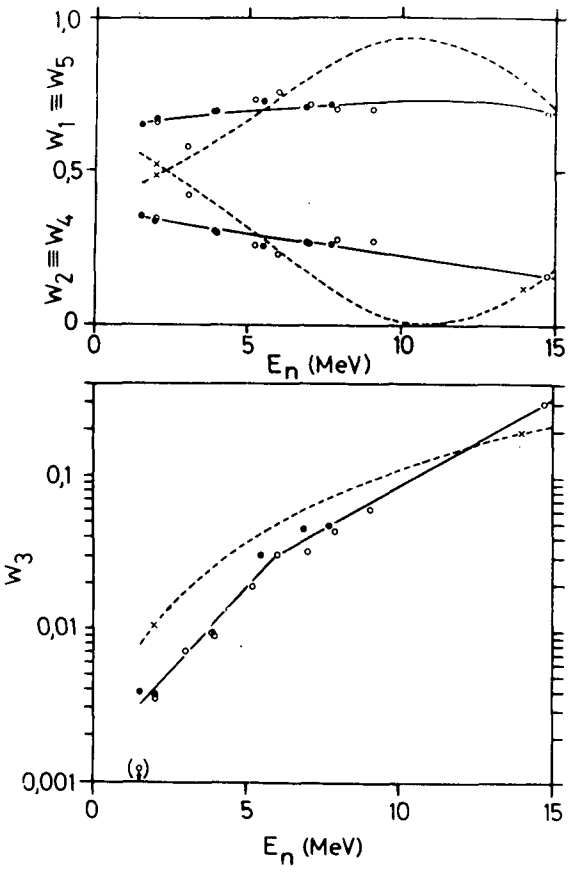

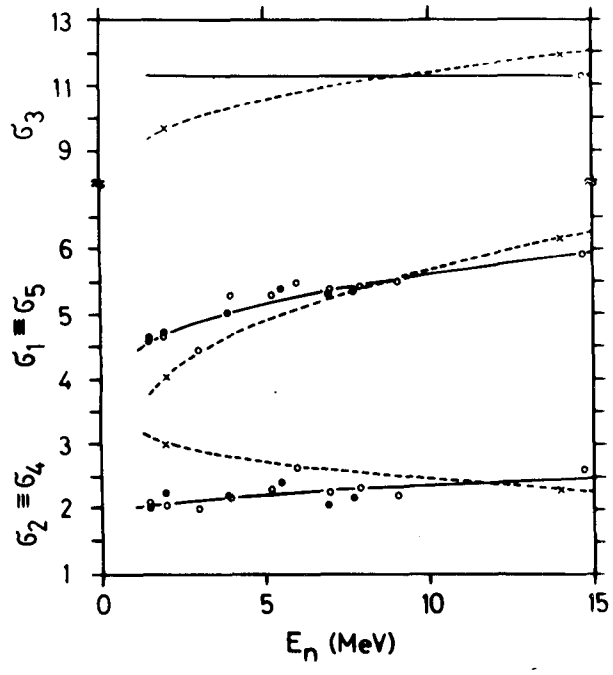

Fig.1. Energy dependence of the fitted Gauss-curve parameters, based on the data from Ref [1] (•) and on all the data (o); the solid curves represent the functions and parameters from Table 1. The dashed curves and x points represent the fits of Cook et al. [Ref 4].

Table 1.

Energy dependence of the parameters of Gauss-curves fitted to the mass distributions

parameter	the function	a or Γ	b or E_o	energy range (MeV)
A_1	$A_{1,2}=a+b\sqrt{E-E_f}$	94,84	0.136	
A_2		102,84	-0,337	
A_3	$A_3=[239-\bar{\nu}(E_n)]/2$	2.230	0.1596	$1.0\leq E_n\leq 5.0$
		2,226	0.1642	$5.0\leq E_n\leq 7.0$
	$\bar{\nu}(E_n)=a+bE_n$	2.306	0.1505	$7.0\leq E_n\leq 12.0$
		2.458	0.1385	$12.0\leq E_n\leq 15.0$
A_4	$A_{4,5}=2A_3-A_{2,1}$			
A_5				
σ_1	$\sigma_{1,2}=a+b\sqrt{E-E_f}$	4.393	0.4129	
σ_2		1.998	0.1259	
σ_3	$\sigma_3=11,3$			
σ_4	$\sigma_4=\sigma_2$			
σ_5	$\sigma_5=\sigma_1$			
W_3	$W_3=a.\exp(bE_n)$	0.0014	0,5174	$E_n<6.0$
		0,0063	0,2606	$6.0\leq E_n<15.0$
W_1	$W_1=(1-W_3/2)\cos^2\theta$			
W_2	$W_2=(1-W_3/2)\sin^2\theta$			
	$tg\theta=\sqrt{W_2/W_1}=2/(E_n-E_o)\Gamma$	-106.58	0.007011	
W_4	$W_4=W_2$			
W_5	$W_5=W_1$			
	$E=E_n+4,8$MeV			
	$E_f=6.12$ MeV			

A, σ and W are the position, width and weight parameters of Gauss-curves, respectively.

Recommendation for the excitation function of the $^{238}U(n,2n)$ reaction from threshold to 19 MeV

N.V. Kornilov, V.N. Vinogradov, N.S. Rabotnov, O.A. Sal'nikov /FEI, Obninsk, USSR/;
P. Raics, S. Daróczy, S. Nagy, J. Csikai /IEP, Kossuth University, Debrecen, Hungary/

Measured cross section data for the $^{238}U(n,2n)$ reaction from threshold to 19 MeV have been collected from the available literature. A brief description was given to each work and the necessary renormalisations were performed. Pade's approximation was applied at the fitting of the data to recommend the excitation function.

Reference:

N.V. Kornilov, V.N. Vinogradov, N.S. Rabotnov, O.A. Sal'nikov, P. Raics, S. Daróczy, S. Nagy, J. Csikai, Otsenka secheniya reaktsii $^{238}U(n,2n)$ ot paroga do 19 MeV, to be published in "Voprosy atomnoi nauki i tekhniki", 1981.

Experimental comparison of cross sections of the $^{27}Al(n,\alpha)$, $^{56}Fe(n,p)$ and $^{238}U(n,f)$ reactions for neutrons of 6.5-10.5 MeV

P. Raics, S. Daróczy, S. Nagy /IEP, Kossuth University, Debrecen, Hungary/;
N.V. Kornilov, B.V. Zhuravlev, O.A. Sal'nikov /FEI, Obninsk, USSR/

Cross sections of the $^{27}Al(n,\alpha)$ and $^{56}Fe(n,p)$ reactions were measured relative to the $^{238}U(n,f)$ process in the 6.5-10.5 MeV region. The activation technique was applied together with a fission chamber. The results were compared to different data sets from the literature. It seems ENDF/B-IV. to be the most acceptable and consistent data set for these three reactions.

Reference:

P. Raics, S. Daróczy, S. Nagy, N.V. Kornilov, B.V. Zhuravlev, O.A. Sal'nikov, Experimental comparison of cross sections of the $^{27}Al(n,\alpha)$, $^{56}Fe(n,p)$, $^{238}U(n,2n)$ and $^{238}U(n,f)$ reactions for neutrons of 6.5-10.5 MeV, to be published in the Proc. of the 5th All-Union Conference on Neutron Physics, Kiev, 15-19 Sept. 1980.

/n,2n/ excitation functions for evaluation work described by an appropriately simplified solution of the Griffin exciton model

Z.T. Bődy

Continuing the search for simple formulae describing /n,2n/ excitation function which can be used in evaluation work /1/ we tried an analytical solution of the problem in the Griffin exciton model formalism with suitable simplifications. The result is /2/

$$\sigma_{n,2n} = \sigma_o \left[1 - \frac{B/y/}{B/1/} \right], \text{ where } y = \frac{Q}{E} \text{ and}$$

$$B/y/ = \sum_{r=o}^{n} \sum_{k=o}^{n-r} \sum_{j=o}^{r} R_r/s/ \binom{n-r}{k} \binom{r}{j} /-1/^j \frac{y^{2k+2j+2}}{2k+2j+2} \left[\frac{y}{2k+2j+3} + 1 - y \right]$$

and

$$R_r/s/ = \binom{n}{r} \frac{n/1-\delta_{rn}/ + 2r+s+2}{/2r+s/\ /2r+s+2/\ /2r+s+4/} .$$

Here E is the neutron energy in the c.m. system, Q is the reaction energy /"Q-value"/, δ_{rn} is the Kronecker symbol and s is a parameter characterising the pre-equilibrium contribution. /In the equilibrium limit - when s=o - an equivalent of the Weisskopf formula results./

The other parameter σ_o should also be chosen appropriately, while n can be given as the nearest integer to $\sqrt{2gE}$ expressed by the single particle level density g.

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Investigation of Nuclear Reactions by 14 MeV Fast Neutrons

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a./ The experimental investigation of the energy- and angular-distributions of the emitted fast neutrons is in progress for reactions induced by 14 MeV fast neutrons. The neutron spectra are measured over ~300 keV threshold by the time-of-flight technique with ~1,3 nsec time resolution. Recently, experiments have been done for the Fe/n,n',E_n,ϑ_n/, Cu/n,n', E_n,ϑ_n/ and Bi/n,n',E_n,ϑ_n/ /natural targets/ reactions. The results are analized by statistical nuclear models.

b./ The activation method has been adopted and currently used for the measurement of excitation functions around 14 MeV neutron energy. Recently, measurements have been finished for ^{56}Fe/n,2n/, ^{56}Fe/n,p/, ^{58}Ni/n,2n/, ^{58}Ni/n,p/ ^{58}Co^{g+m} and ^{65}Cu/n,2n/, ^{65}Cu/n,p/ reactions in the energy range of 13,9-14,7 MeV. The analysis of the data is made by the Hauser-Feschbach method.

The Effect of Selenomethionin in Radiation Protection

Valeria Kovács
Roland Eötvös University /Budapest, Department of Atomic Physics

Research work has been done for the study of the metabolic pathway of selenomethionin using the methods of radiometry, radiochromatography, proton magnetic resonance, electron spin resonance and chemoluminescence in the case of white rats. The results show evidences that appropriate doses of selenomethionin can decrease of demages caused by free radicals induced either in ionizing irradations or in other pathological /e.g. cancer/ processes.

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TWO MODELS OF ANALYZING THE SHAPES OF DOPPLER BROADENED GAMMA LINES

M.M. Abdel-Hady, A.Kiss, E.Koltay, B.Nyakó, Gy.Szabó

Results of a line-shape program based on the Blaugrund formalism of Doppler-Shift Attenuation process have been compared with those given by the Currie's version of Monte Carlo code treating the slowing down process statistically. General conclusions have been drawn on the accuracies of the above mentioned methods. Test calculations are being performed on the special case of the reaction $^{13}C(p,\gamma)^{14}N$ investigated in our earlier experiments.

RESONANCE LEVELS OF ^{28}Si IN (α,α) AND (α,γ) REACTIONS

J.Cseh, E.Koltay, Z.Máthé, E.Somorjai, L.Zolnai

Resonance levels of ^{28}Si were examined in the $^{24}Mg(\alpha,\alpha)^{24}Mg$ and $^{24}Mg\ (\alpha,\gamma)^{28}Si$ reactions for $E_\alpha \leq 5140$ keV. A number of new J^π--values and other parameters of the resonances has been determined. The preliminary results of the R-matrix analysis of elastic scattering are as follows /$E_{\alpha,LAB}$ [keV], J^π, Γ_α/Γ, $\Gamma_{c.m.}$[keV]/:

3199, 2^+, 0.60, 0.45;
3304, 1^-, 1.0, 3.5;
3400, 2^+, 0.35, 1.3 ;
3487, 1^-, 0.74,1.3;
3490, 0^+, 0.86, 5.9 ;
3466, 0^+, 1.0, 3.4;
3792, 0^+, 1.0, 3.0 ;
3808, 3^-, 0.18,12.0;
4263, 2^+, 0.15, 4.5 ;
4309, 2^+, 0.53,1.9;
4472, 1^-, 0.21, 11.4;
4493, 3^-, 021, 0.9;
4541, 3^-, 0.29, 20.0;
4566, 1^-, 0.72,5.3;
4622, 2^+, 0.44, 6.5;
4656, 4^+, 0.58,1.3;
4661, 2^+, or 4669, 1^-, 0.3, 4.0;
4760, 2^+, 0.42, 5.9;
4789, 3^-, 10., 3.7;

From gamma-ray angular distribution a $J^\pi=2^+$ value was determined for the resonance at $E_\alpha=3790$ keV. The branching rations and strengths of the (α,γ) resonances were determined up to $E_\alpha=5015$ keV.

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