CDFE 2024/2025 status report on photonuclear data processing activity.

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Status report for the Technical Meeting of the International Network of Nuclear Reaction Data Centres, 17 - 20 June 2025 (Madrid, Spain).

The report shortly describes the main activity of the Centre for Photonuclear Experiments Data (Centr Dannykh Fotoyadernykh Eksperimentov - CDFE) of the Russia Lomonosov Moscow State University Skobeltsyn Institute of Nuclear Physics in photonuclear data processing, compilation and evaluation for the period of time after the previous Technical Meeting of the International Network of Nuclear Reaction Data Centres, 14 - 17 May 2024 (the IAEA's Headquarters, Vienna, Austria).

EXFOR Compilation

8 CDFE EXFOR final TRANSes **trans.m130–trans.m137** and 1 preliminary ***prelim.m138*** have been produced and transmitted to the IAEA Nuclear Data Section.

CDFE TRANSes contain **79** ENTRYs (total SUBENT number is 551) – **10** new ones compiled in accordance with the contents of the NRDC Network Memos, the NDS database "Articles for compilation" (https://www-nds.iaea.org/nrdc/alloc/ and ***69 old ones*** corrected in accordance with the new EXFOR format rules and the comments and recommendations of the NRDC experts, first of all, Naohiko Otsuka and Svetlana Dunaeva.

Contents of **new** and *old* trans.m* and ***prelim.m**** TRANSes

TRANS	Numbers of ENTRYs		
	Old	**New**	Total (SUBENTs)
m130	*11*	**0**	11 (68)
m131	*12*	**0**	12 (64)
m132	*4*	3	7 (79)
m133	*3*	1	4 (55)
m134	*5*	0	5 (55)
m135	*12*	**1**	13 (48)
m136	*2*	**4**	6 (33)
m137	*14*	**0**	14 (75)
prelim.m138	*6*	***1***	*7 (74)*
Common	*69*	**10**	79 (551)

New data obtaining

The CDFE research of reliability of photonuclear reaction cross sections obtained in various experiments was continued. Using the experimental-theoretical method for evaluation of cross sections of partial photoneutron reactions (γ, 1n) and (γ, 2n), based on objective physical criteria before it was found that for more than 50 nuclei from ^{51}V to ^{209}Bi the relevant experimental data obtained using beams of quasi-monoenergetic annihilation photons not

meet physical criteria because of significant systematic uncertainties of the method for photoneutron multiplicity sorting basing on the measured neutron energies. In this type experiments cross sections of partial reactions (γ, 1n) and (γ, 2n), as well as (γ, 3n), were determined at first and were used for determination total photoneutron reaction cross-section $\sigma(\gamma, tot) = \sigma(\gamma, 1n) + \sigma(\gamma, 2n) + \sigma(\gamma, 3n)$ and that neutron yield one $\sigma(\gamma, sn) = \sigma(\gamma, 1n) + 2\sigma(\gamma, 2n) + 3\sigma(\gamma, 3n)$.

Because of that, investigations of reliability of cross sections determined using quite different method, may-called inverse, on the beams of bremsstrahlung were started. The neutron yield cross sections σ(γ, sn) were obtained at first. The special statistical theory corrections for neutron multiplicity to σ(γ, sn) gave to one possibility to exclude the contribution of (γ, 2n) reaction cross-section and to obtain σ(γ, tot) and after natural different subtraction/summation procedures – (γ, 1n) reaction cross sections.

Up to now the new unpublished before data were obtained for several nuclei:

- ^{51}V, ^{52}Cr, ^{59}Co, ^{58,60}Ni: $\sigma(\gamma, 2n) = \sigma^{publ}(\gamma, tot) - \sigma^{publ}(\gamma, 1n)$;
  $\sigma(\gamma, sn) = \sigma^{publ}(\gamma, tot) + \sigma(\gamma, 2n)$;

- ^{90}Zr, ^{115}In: $\sigma(\gamma, 2n) = \sigma^{publ}(\gamma, sn) - \sigma^{publ}(\gamma, tot)$;
  $\sigma(\gamma, 1n) = \sigma^{publ}(\gamma, tot) - \sigma(\gamma, 2n)$;

- ^{127}I: $\sigma(\gamma, 1n) = \sigma^{publ}(\gamma, tot) - \sigma^{publ}(\gamma, 2n)$;
  $\sigma(\gamma, sn) = \sigma^{publ}(\gamma, tot) + \sigma(\gamma, 2n)$;

- ^{165}Ho: $\sigma(\gamma, tot) = \sigma^{publ}(\gamma, sn) - \sigma^{publ}(\gamma, 2n)$;
  $\sigma(\gamma, 1n) = \sigma^{publ}(\gamma, sn) - 2\sigma^{publ}(\gamma, 2n)$.

Unpublished data for ^{52}Cr, cross sections of reactions ^{52}Cr(γ, 2n)^{50}Cr and ^{52}Cr(γ, sn) are really new because those were not obtained in experiments with annihilation photons.

Unpublished data for ^{68}Zn, cross sections of reactions ^{68}Zn(γ, 1n)^{67}Zn, ^{68}Zn(γ, 2n)^{66}Zn and ^{68}Zn(γ, tot), were obtained at first time using experimental-theoretical method because the only one $\sigma^{publ}(\gamma, sn)$ was obtained in experiment using bremsstrahlung and nothing was obtained for ^{68}Zn in experiments with annihilation photons.

Photonuclear Data Evaluation

For all of nuclei mentioned new evaluated cross sections meeting physical criteria were obtained using experimental-theoretical method. It was found that the situations with data reliability are different in cases of relatively heavy (^{90}Zr, ^{115}In, ^{127}I, and ^{165}Ho) and light (^{51}V, ^{52}Cr, ^{59}Co, ^{68}Zn, ^{58,60}Ni) nuclei. It was shown that in cases of relatively light nuclei experimental partial photoneutron reaction cross sections are not reliable because of some shortcomings of undirect (statistical theory corrections) method of determination: σ(γ, 1n) are unreliably underestimated, but σ(γ, 2n) vice versa overestimated. It was shown in particular that the main source of such method systematic uncertainties is that the contributions of (γ, 1n1p) reaction were not taken into account. In light nuclei this two-nucleon neutron-proton reaction has parameters close to those of reaction (γ, 2n) and reduces accuracy of statistical theory corrections.

Main publications

1. V.V.Varlamov, A.I.Davydov, I.A.Mostakov. Reliability of ^{51}V photoneutron reaction cross sections obtained using bremsstrahlung. Eur. Phys. J. A. 60, 44 (2024) 1–8.

2. S.S.Belyshev, V.V.Varlamov, L.Z.Dzhilavyan, A.A.Kuznetsov, A.M.Lapik, A.L.Polonski, A.V.Rusakov, V.I.Shvedunov. On activation studies of photonuclear reactions

on gamma-beams from backward Compton scattering at E gamma < 40 MeV. Moscow University Physics Bulletin. 79, N. 1 (2024) 7–13.

3. V.V.Varlamov, A.I.Davydov. Photonuclear experiments: from the bremsstrahlung to backward Compton scattering photons. Moscow University Physics Bulletin. 79, N 2 (2024) 178–185.

4. V.V.Varlamov, A.I.Davydov, I.A.Mostakov. Reliability of cross sections of the photoneutron reactions on ^{51}V and ^{59}Co nuclei in the bremsstrahlung beam experiments. Bull. Rus. Acad. Sci. Phys., 88, № 8 (2024) 1211–1217.

5. V.V.Varlamov, A.I.Davydov, I.A.Mostakov, V.N.Orlin. Photoneutron reaction cross sections for ^{90}Zr in different experiments. Phys. Atom. Nucl. 87, N5 (2024) 575–585.

6. V.V.Varlamov, A.I.Davydov, I.A.Mostakov, V.N.Orlin. ^{52}Cr photoneutron reactions in experiments with bremsstrahlung. Phys. Atom. Nucl., 87, N6 (2024) 669–677.

7. V.V.Varlamov, A.I.Davydov, I.A.Mostakov, V.N.Orlin. New data on photoneutron reaction cross sections for ^{68}Zn. Phys. Atom. Nucl., 87, N2 (2024) S264–S273.

8. V.V.Varlamov, A.I.Davydov, V.N.Orlin. Photonuclear partial reaction cross sections: systematic uncertainties and reliability. Atomic Data and Nuclear Data Tables, 161 101697 (2025) 1–14.

9. V.V. Varlamov and A.I. Davydov. Photodisintegration of ^{109}Ag: problems and new data. Eur. Phys. J, A 61, 107 (2025) 1–5.

10. V.V.Varlamov, A.I.Davydov, I.A.Mostakov, V.N.Orlin. Photoneutron reaction cross sections for light and medium-heavy nuclei in experiments on the beams of bremsstrahlung. Bull. Rus. Acad. Sci. Phys., 89, № 8 (2025), in print.

11. V.V.Varlamov, A.I.Davydov, I.A.Mostakov, V.N.Orlin. Photoneutron reaction cross sections for ^{115}In. Phys. Atom. Nucl., 88 (2025), in print.

Short-term 2025/2026 Program

The main items of CDFE 2025/2026 program, main priorities and most important tasks are traditional and the following:

- new photonuclear data compilations using EXFOR format, production of new CDFE TRANSes (trans.m139, trans.m140, etc.);
- corrections of old ENTRYs in accordance with new EXFOR coding rules and the NRDC Network expert's comments and recommendations;
- analysis of total and partial photonuclear reaction cross sections obtained in various experiments, carried out using different sources of photons (bremsstrahlung, quasi-monoenergetic annihilation photons, laser Compton backscattering photons) reliability using the objective physical criteria;
- evaluation of new cross sections meeting those criteria using the experimental-theoretical method.