# The CDFE Progress Report on the photonuclear data compilation and evaluation activity for 2018/2019.

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Progress report to the Technical Meeting on the International Network of Nuclear Reaction Data Centres at the IAEA Headquarters in Vienna, Austria, from 9 to 12 April 2019.

The report contains review of the Russia Lomonosov Moscow State University Skobeltsyn Institute of Nuclear Physics Centre for Photonuclear Experiments Data (Centr Dannykh Fotoyadernykh Eksperimentov - CDFE) main results for the period of time from the Technical Meeting of the International Network of Nuclear Reaction Data Centres at the Global Centre for Nuclear Energy Partnership (GCNEP), Bahadurgarh, Haryana, India from 1 to 4 May 2018 concern new photonuclear data compilations and old data corrections, analysis and evaluation of photonuclear data obtained in various experiments and nuclear data service in the whole.

## General

The main CDFE responsibility in the NRDC Network is compilation and processing of photonuclear data. The main CDFE scientific activity is joint evaluating of photonuclear reaction cross sections obtained in various experiments.

The CDFE total permanent stuff includes now three professional, two general service officers and two students of the MSU Physics Faculty.

The CDFE maintains several nuclear databases available through the CDFE Web-site – http://cdfe.sinp.msu.ru for solving the main task - dissemination of international nuclear data for providing Lomonosov Moscow State University (Skobeltsyn Institute of Nuclear Physics, primarily) and scientific and educational institutes and organizations of Russian Academy of Science for basic research, education and various applications.

## EXFOR Compilation

5 new CDFE EXFOR **trans.m095 – 099** TRANSes have been produced and transmitted to the IAEA NDS.

All TRANSes contain both **24** new ENTRYs and ***65*** *old ENTRYs* corrected with in accordance with the new EXFOR format rules and the comments and recommendations of the NRDC experts, first of all Naohiko Otsuka, Michael Fleming and Shin Okumura. The contents of all transmitted to the IAEA NDS TRANSes prepared in the CDFE are presented in Table.

Table

**New and old TRANSes contents**

| TRANS | *Old* | **New** | Total |
|---|---|---|---|
| **m095** | *48* | **5** | 53 |
| **m096** | *9* | **3** | 12 |
| **m097** | *1* | **2** | 3 |
| **m098** | *2* | **11** | 13 |
| **m099** | *5* | **3** | 8 |
| **All** | *65* | **24** | 89 |

## NRDC meetings Actions

In accordance with the Action A49 (Check if the volume number is absent for VMU (Vestnik Moskovskogo Universiteta - Seriya III, Fizika i Astronomiya) published in 1969 and before) from the NRDC2018 meeting the complete information table was presented for the IAEA NDS. It was concluded that the VMU volume number is absent for the issues published in 1948 to 1969 and 1996 to the present.

## Participation in the IAEA CRP

The Research Contract N 20501 “Evaluation of Partial and Total Photoneutron Reactions Cross Sections Using New Objective Physical Data Reliability Criteria” in the frame of the Coordinated Research Project N F41032 “Updating the Photonuclear Data Library and generating a reference database for Photon Strength Functions”.

## Nuclear Database Service

On the Web-site (http://cdfe.sinp.msu.ru) the CDFE maintains several nuclear databases produced using data funds of Nuclear Reaction Data Centres Network, USA NNDC and NSDD and those of CDFE:

- “Nuclear Reaction Database (EXFOR)”;
- “Complete Nuclear Spectroscopy Database "Relational ENSDF";
- “Nuclear Physics Publications ("NSR" Database)”;
- “Nucleus Ground and Isomeric State Parameters”;
- “Photonuclear Data Index since 1955”;
- “Chart of Giant Dipole Resonance Main Parameters”;
- “Chart of Nucleus Shape and Size Parameters”;
- “Chart of Atomic Nuclei”;

- "Calculator and Graph Engine for Atomic nuclei Parameters and Nuclear reactions and Radioactive Decays Features".

## Photonuclear Data Evaluation

In addition to activity in photonuclear data compilation and the CDFE continued the program of investigation of reliability partial photoneutron reaction cross sections obtained in various experiments using specially proposed objective physical criteria of data reliability. In addition to many nuclei investigated before (for example, $^{59}$Co, $^{63,65}$Cu, $^{78,80,82}$Se, $^{89}$Y, $^{91,94}$Zr, $^{115}$In, $^{116}$Sn, $^{133}$Cs, $^{138}$Ba, $^{140,142}$Ce, $^{141}$Pr, $^{159}$Tb, $^{181}$Ta, $^{186}$W, $^{208}$Pb, $^{209}$B) in the frame of the IAEA Coordinated Research Project N F41032 "Updating the Photonuclear Data Library and generating a reference database for Photon Strength Functions" (Research Contract N 20501 "Evaluation of Partial and Total Photoneutron Reactions Cross Sections Using New Objective Physical Data Reliability Criteria") 8 new nuclei were investigated ($^{75}$As, $^{76}$Se, $^{90,92}$Zr, $^{98}$Mo, $^{103}$Rh, $^{153}$Eu, $^{165}$Ho). For all 8 nuclei using experimental-theoretical method for evaluation of reliable partial ((γ, 1n), (γ, 2n), (γ, 3n)) and total photoneutron reaction (γ, tot) = (γ, 1n) + (γ, 2n) + (γ, 3n) reactions cross sections were obtained.

New reliable evaluated data were prepared for including into the EXFOR database, maintained both in the Web-sites of:

- IAEA NDS (https://www-nds.iaea.org/exfor/exfor.htm);
- USA NNDC (http://www.nndc.bnl.gov/exfor/exfor.htm);
- MSU SINP CDFE (http://cdfe.sinp.msu.ru/exfor/index.php).

In accordance with previous meeting Actions many EXFOR area M subentries included photoneutron reaction cross sections evaluated without new objective physical criteria of data reliability during the IAEA 1996 – 1999 CRP included into the ENTRY M0635 were superseded by newly data evaluated using those criteria. The complete list of 54 superseded EXFOR SUBENTs was presented for the IAEA NDS.

## Publications

Correspondent articles were submitted to the International Conference on Nuclear Data for Science and Technology "ND-2019", Beijing, China, 19-24 May, 2019 and 69th Meeting on Nuclear Spectroscopy and Atomic Nucleus Structure (Nucleus 2019), July 01-05, 2019, Dubna, Russia. New obtained data were presented as talks at the 68th Meeting on Nuclear Spectroscopy and Atomic Nucleus Structure, «Nucleus 2018», 1 – 6 July 2018, Voronezh,

Russia and published in the journals Physical Review C, Physics of Atomic Nuclei, Bulletin of the Russian Academy of Sciences, Moscow University Physics Bulletin, Memoirs of the Faculty of Physics of Lomonosov Moscow State University:

1. V.V.Varlamov, A.I.Davydov, B.S.Ishkhanov, V.N.Orlin. The reliability of photoneutron cross sections for $^{90,91,92,94}$Zr. Eur. Phys. J. A 54 (2018) 74.
2. V.V.Varlamov, V.D.Kaidarova. Evaluation of Reliable Cross Sections of Partial and Total Photoneutron Reactions for the $^{139}$La Nucleus. Bull. Rus. Acad. Sci. Phys., 82, №6 (2018) 614.
3. V.V.Varlamov, V.D.Kaidarova, M.E.Stepanov. The Reliability of Cross Sections of Partial Photoneutron Reactions for $^{98}$Mo. Moscow University Physics Bulletin, 2018, V. 73, N. 1, 68.
4. V.V.Varlamov, V.D.Kaidarova. Reliability of the partial photoneutron reaction cross sections for $^{139}$La and $^{145,148}$Nd. Memoirs of the Faculty of Physics of the Lomonosov Moscow State University, N4, 2018, 1840201.
5. Varlamov V.V., Davydov A.I. New photoneutron reaction cross section data for $^{153}$Eu and $^{165}$Ho. LXVIII International Conference «Nucleus-2018». Fundamental Problems of Nuclear Physics, Atomic Power Engineering and Nuclear Technologies (LXVIII Meeting on Nuclear Spectroscopy and Nuclear Structure), July 2 – 6, 2018, Voronezh, Russia. Book of Abstracts. Saint Petersburg, Publishing VVM, 2018, p. 97.
6. Varlamov V.V., Kaydarova V.D. Evaluation of reliable partial and total photoneutron reaction cross sections for $^{145,148}$Nd. LXVIII International Conference «Nucleus-2018». Fundamental Problems of Nuclear Physics, Atomic Power Engineering and Nuclear Technologies (LXVIII Meeting on Nuclear Spectroscopy and Nuclear Structure), July 2 – 6, 2018, Voronezh, Russia. Book of Abstracts. Saint Petersburg, Publishing VVM, 2018, p. 98.
7. V.V.Varlamov, V.D.Kaidarova, V.N.Orlin. New reliable data on the photodisintegration of $^{160}$Gd. Memoirs of the Faculty of Physics of the Lomonosov Moscow State University, N1, 2019, 1910202.
8. V.V.Varlamov, A.I.Davydov, B.S.Ishkhanov. New data on photoneutron reaction cross sections for $^{76,78,80,82}$Se nuclei. Physics of Atomic Nuclei, 82, N1 (2019) 13.
9. V.Varlamov, A.Davydov, V.Kaidarova. Evaluation of reliable cross sections of photoneutron reactions on $^{103}$Rh и $^{165}$Ho. Yadernaya Fizika, 82, N3 (2019) 1 (Phys. Atom. Nucl. 2019, submitted).
10. V.Varlamov, A.Davydov, V.Kaidarova, V.Orlin. Photoneutron reaction cross-section data for $^{75}$As: experiments and evaluation. Phys. Rev. C 99, N 2 (2019) 024608.

## Short-term (2019/2020) Program

The main items of CDFE (2019/2020) program, main priorities and most important tasks are traditional and the following:

- continuation of new photonuclear data compilation using EXFOR format, new TRANSes (M100, M101, etc.) production;
- correction of old ENTRYs in accordance with new EXFOR coding rule changes and the NRDC Network experts comments and recommendations;

- continuation of analysis and evaluation using objective physical criteria of total and partial photonuclear reaction cross sections obtained in various experiments;
- upgrading of all databases put upon the CDFE Web-site (http://cdfe.sinp.msu.ru).