Memo CP-M/9

18 June 1987

To: Distribution

From: H.D. Lemmel

Subject: Progress Report CDFE

With letter dated 87/5/31 we received from Dr. Varlamov, head of CDFE, a progress report for the forthcoming NRDC Meeting, Brookhaven, Oct. 1987. As it also includes proposals for the EXFOR Manual which are usually communicated by means of CP-Memos, I distribute herewith the progress report as Memo CP-M/9.

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CDFE FOR PHOTONUCLEAR RESEARCHES

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Reporting the works carried out the results obtained, and the problems faced with, at CDFE from mid-1985 to early in 1987 is expedient to begin by discussing the problems. The major present-day problem has arisen from actual absence of any international exchange by photonuclear data, first of all the data of machine-sensible form. True, within the said period, the CDFE received an excellent edition of Photonuclear Data-Abstract Sheets from Professor E. Fuller of USA NBS and, besides receives routinely the NSR file photonuclear data output samples from Professor S. Pearlstein and copies of the JAERI editions from Professor A. Hashizume. These materials make it easier, to some extent, for the CDFE and its cooperative institutions (including the specialized nuclear data centers (SCJAD) at several universities) to solve the problems of processing the distributing photonuclear data.

Regretfully, it has to be stated once again that, despite the respective actions of the 7th and 8th IAFA Consultant's Meetings the second version of B.L. Berman's compilation on the photonuclear reaction cross sections obtained using quasimonoenergetic photons. In this connection, CDFE is planning to extend the scope of its activities in compiling photonuclear works and to include the works of physicists from abroad, of course with an appropriate STATUS. In particular, this concern the EXFOR format records of the data published as plots in the Photoneutron Cross Section Atlas and obtained

using quasimonoenergetic photons (PREPRINT UCRL-78482, B.L. Berman, 1976) and also the data published in other similar editions and scientific periodicals.

The following works carried out during the above mentioned period in accordance with the main trends of the CDFE activities should be noted.

1. Computer processing of data in the EXFOR format

The next consecutive exchange magnetic tape CDFE TRANS M005 has been prepared for sending the IAEA NDS. The tape contains numerical data of 45 experimental works of Soviet physicists.

Exchange tape TRANS M006 is being completed.

All the data arrays on the photons and charged-particle induced reactions distributed through the channels of international exchange, namely the files with indices A, B, C, D, S, R, P, etc., have been obtained, adopted, and used actively.

2. Activities with bibliography

The series of the CDFE information bulletins "Photonuclear Data" has been continued with issues 8 and 9 containing systematized information about the experimental works on photonuclear reactions published in 1984 and 1985, respectively, in scientific periodicals both in the USSR and abroad.

The materials of CDFE information bulletins Nos.1-9 have baen used to publish and dissiminate Data Index "Photonuclear Data 1976-1985" where the photonuclear research results obtained during the decade are presented in an ordered form. The Data Index includes a table summarizing all the information about the features of the experiments carried out and about its main results and contains the complete list of references, the author index and the indices of the elements and reactions studied.

3. Preparation of reviews on given subjects

The results of studying the (γ , X γ') reactions on light and mediu nuclei obtained during the last two decades have been systematized and analized. The ENSDF file has been used to specify the spectroscopic information about low-lying levels of atomic nuclei from ^{7}Li to ^{52}Cr and to compile the partial cross sections of the processes of occupation individual states of final nuclei of the reactions with emissinn of neutron, protons, deuterons, tritons, and α -particles. The results of the analysis have been published in the review "Photonuclear Data (γ, X γ') Reactions".

The issue "Photodisintegration of Lithium Evaluated Cross Sections of Channels and Reactions" has been published in addition to the CDFE information Review" "Photodisintegration of Lithium. Atlas of Cross Sections" published and distributed earlier to carry out the program for preparing the evaluated photonuclear data. The issue includes a brief description of the approach used for the evaluation, the detailed information about the experimental works on photodisintegraion of Li isotopes, both included in the Atlas (1984) and published later, and the results of analyzing various partial cross sections of ^{6,7}Li photodisintegration. The evaluated cross sections of channels and photodisintegration reactions for the ^{6,7}Li isotopes are presented as plots and in numerical form. The numerical data are planned to include in a next CDFE exchange magnetic tape.

4. Evaluation of photonuclear data

The photonuclear research show quite a number of characteristic features which compicate the analysis and evaluation of the results obtained. The features include:

(1) the relatively small reaction yields, hence a low systematic

accuracy of measurements. The statistics has to be improved by making long-time experiments, thusby increasing the systematic errors due to drift of meters;

(ii) the continuous γ -quantum spectra used in most cases make it necessary to solve the inverse problem to obtain the cross section by means of unfolding of the reaction yield curve. The methods avoiding such problem (radioactive sources, radiative-capture reactions) deal primarily with low intensities of γ -quantum beams and, therefore, involve a poor statistics again;

(iii) the methods for solving the inverse problem appear to be diverse, thereby giving rise to definite systematic differences in the results.

Considering the circumstances outlined above the CDFE has designed a special approach to evaluate the photonuclear data, first of all the cross sections. The essence of the approach is to find the feasible contributions of disregarded systematic errors from analyzing and evaluating the generalized characteristics of initial cross sections, such as integral cross section and center of gravity. The systematic errors are allowed for using the procedures of an appropriate renormalization (scaling along the cross section axis) and a recalibration (scaling along the energy axis) of individual initial cross sections.

The method designed was used to evaluate a great number of the ^{6,7}Li photodisintegration reaction and channel cross sections. The results of the evaluation were published in the review mentioned above.

Sticking to the photonuclear data evaluation program, the CDFE has evaluated the U isotope photodisintegration cross sections. The results obtained will be published as an appropriate review.

The numerical data on the cross sections estimated will be presented on one of the CDFE exchange magnetic tapes.

5. Activities on the Actions of the IAEA NDS

In conformity with the CDFE proposals (MEMO CP/M-6,7) and with the IAEA NDS Actions , the next LEXFOR entries describing the use of the BIB keywords MOM-SEC and EMS-SEC and of the quantity-parameters ECO, MCO, EMS has been prepared (see Apprendix).

6. Activities in processing requests

Within the reviewed period the CDFE received and processed more than 500 requests concerning bibliography and some 300 requests concerning numerical information about the properties of atomic nuclei and the characteristics of the low- and medium-energy nuclear reactions.

7. Center Personnel

All the papers and materials concerning the international nuclear data exchange are to be forwarded to V.V. Varlamov, Head of the CDFE of the Institute of Nuclear Physics of Moscow State University.

8. Specification of address

CDFE, Institute of Nuclear Physics, Moscow State University,
Moscow 119899, USSR.

APPENDIX

Several novel codes had to be included in the EXFOR Dictionary to compile some works when preparing the CDFE TRANS M003 exchange magnetic tape. The appropriate proposals were set forth in MEMO CP/M-6,7. This appendix gives the texts of the respective EXFOR-MANUAL and LEXFOR.

1. Definitions of the keywords MOM-SEC and EMS-SEC

The keywords are used to give information (the linear momentum and the squared effective mass, respectively) about the secondaries of the reactions, just as the keyword EN-SEC defines the energy of a secondary.

The keyword MOM-SEC

(i) The keyword is used to give information about the secondary linear momentum and to define the secondary momentum fields given in Data Table (the COMMON and DATA Sections).

(ii) This keyword is optimal, but it obligatory when the Data-heading keywords M1, M2, etc. are used in the DATA Section. Either free text or coded information (not) accompanied by free text may be presented.

(iii) The format of coded information is:

(heading, particle).

Heading field. The field contains the heading or its definitions. i.e.- MIN,- MAX,-APRX.

Particle field. This field contains the code of a particle or a of a nuclide to which the data heading keyword refers. The code is: either a particle code from Dictionary I3.

or a nuclide coded in the standard format.

(IV) If more than one keyword are used, each of them is coded separately, starting from Column 12.

Example: MOM-SEC (M,1N)
(M2,P)
(M3,D).

The LEXFOR Secondary Momentum Section

The information on the detected particle momentum is introduced as follows:

(i) numerical values are included in the COMMON or DATA Sections under appropriate headings (the keywords from Dictionary 24).

If the writing under the keyword REACTION does not make it clear what is the particle to which the momentum value pertains, the particle may be specialized under the keyword MOM-SEC;

(ii) the keyword MOM-SEC may be used:

(1) to specify to which the reaction product the secondary moment given in COMMON or DATA Section refers.

(2) to give free text information about the secondary momentum.

The keyword must always be used when the data headings M1, M2, etc. are in COMMON or DATA Sections.

The keyword EMS-SEC

(i) The keyword is used to give information about the secondary squared effective mass for particle or particle system and to define secondary mass fields given in the DATA Table (the COMMON and DATA Sections).

(ii) this keyword is optimal, but is abligatory when the DATA headings EMS1, EMS2, etc. are used in the DATA Section. Either free text or coded information (not) accompanied by free text may be presented.

(iii) The format of coded information is:

(heading, particle)

Heading field. This field contains the data heading or its

definitions - MIN.-MAX.-APRX.

Particle field. This field contains the code of a particle or of a nuclide to which the data heading keyword refers. The code is:

either a particle code from Dictionary 13 or

or a nuclide code in the standard format.

(IV) If more than one key-word are used, each of them is coded separately, starting from Column 12.

Example: EMS-SEC (EMS1,N)
(EMS2,P+D).

The LEXFOR keyword secondary mass

The information about the masses of detected particles (or of their systems) is introduced as follows:

(i) numerical values are entered in the COMMON and DATA Sections under the appropriate DATA headings keywords (the keywords from Dictionary 24).

If the writing under the keyword REACTION does not make it clear what is the particle to which a given value of squared effective mass pertains, the particle may be specified under the keyword EMS-SEC;

(ii) the keyword EMS-SEC may be used:

(1) to specify the which reaction product the secondary mass given in the COMMON or DATA Section refers;

(2) to give free text information about secondary mass.

The keyword must always be coded when the DATA headings EMS1, EMS2,etc. are in the DATA or COMMON Sections.

2. Definition of the parameters ECO, MCO, and EMC

The parameters describe the specific information (correlations in energy ,momentum, and mass, respectively) for the reaction secondaries, just as the angular correlation parameter COR does.

Parameter ECO (MCO, EMC)

The values defining the energy (momentum ,mass) correlations between two more emitted particles are coded with the code ECO (MCO, EMC) in the field SF6 of the REACTION keyword. The momenta (energies, masses) given are defined by the particles specified in the REACTION code).

Example: Neutron-proton energy correlations in the (G, N+P) reactio

(...(G, N+P), ... , ECO).

Exact definition of the data given should be entered free text.