MSU SINP CDFE 2005 – 2006 Progress Report



I.N.Boboshin, V.V.Varlamov, S.Yu.Komarov, N.N.Peskov, M.E.Stepanov, V.V.Chesnokov

Progress Report to the IAEA Technical Co-ordination Meeting of the Network of Nuclear Reaction Data Centres (25 – 28 September 2006, IAEA NDS, Vienna, Austria).

The folowing report contains the short review of the works carried out by the Lomonosov Moscow State University Skobeltsyn Institute of Nuclear Physics Centre for Photonuclear Experiments Data (Centr Dannykh Fotoyadernykh Eksperimentov – CDFE) concern the IAEA Nuclear Reaction Data Centres Network activities for the period of time from the Technical Meeting on Coordination of the Network of Nuclear Reaction Data Centres (12 - 14 October 2005, IAEA NDS, Vienna, Austria) till the fall of 2006 and main results obtained.

EXFOR Compilations

Two new CDFE EXFOR **TRANSes** M039 and M040 have been produced and transmitted to the IAEA NDS. Many old data have been corrected in accordance with comments of O.Schwerer, D.Rochman, and N.Otsuka. On the whole the CDFE TRANSes mentioned contain (**Annex 1**) 16 retransmitted and 11 new ENTRYs with 34 new data SUBENTs.

Upgrading of Databases

The CDFE relational nuclear data databases (<u>http://cdfe.sinp.msu.ru</u>) have been upgraded significantly:

- the "2005" part (the "2006" is in processing) has been added to the CDFE "Photonuclear Data Index"; as whole the "Photonuclear Data Index 1955 -2005" database has been added by a significant amount of entries from /1/; for articles included into international EXFOR nuclear reaction data fund all data sets are available in forms of table and graphs;
- the database "Giant Dipole Resonance Parameters" has been upgraded significantly: many new data sets have been added.

The New Database – Chart of Nuclear Quadrupole Deformations

New Chart (relational database, really) of Nuclear Quadrupole Deformations (http://cdfe.sinp.msu.ru/services/nsr/defchart/defmain.html) has been developed using various sources of related information (quadrupole moments and parameters of quadrupole deformation β_2) /2, 3/ - more than 1300 of electric quadrupole moment values for more than 440 nuclides and 1765 B(E2)↑ values for about 200 nuclides. Database is realized as information system analogue to well-known Chart of nuclides (nuclide properties sorted in N and Z coordinates). The colour and intensity solution of the Chart individual nuclide elements gives to one possibility for comfortable overview and search of nuclei of different (spherical, prolate and oblate) shapes in various N and Z regions.

Photonuclear Data Evaluations

As an continuation of CDFE program of consistent analysis and evaluation of total and partial photonuclear reactions cross sections joint combined evaluation of total (γ ,xn) and (γ ,sn) and partial (γ ,n), (γ ,2n) and (γ ,3n) photoneutron reactions cross sections was carried out /4/ for ¹²⁷I because many applied research needs. Those were based on the results of investigation of various photonuclear reactions in experiments used the bremsstrahlung and quasimonoenergetic annihilation photon beams. The reasons of data disagreements were analyzed, the values of renormalization factors for putting all data in consistency to each other were obtained. The evaluated cross sections energy dependencies were obtained, integrated cross section values have been calculated.

Evaluated data are in preparation for the new CDFE EXFOR TRANS M041.

Nuclear Structure Data

Using new CDFE Chart of nuclear quadrupole deformation parameters the systematical comparative analysis of that from various sources was carried out for many even-even nuclei. The clear systematical disagreements of those parameters obtained from nuclear quadrupole moments data (Q-type) and from reduced transition probability $B(E2)\uparrow$ data (B-type) were revealed. It was found out that all nuclides (with only few exceptions) can be clearly separated into 2 groups: 1) for isotopes of Ti, Cr, Zr, Nd, Sm, Gd, Dy, Er, W, Os, Ra good agreement is observed for data of both types; 2) for isotopes of C, Si, Ar, Ca, Fe, Ni, Zn, Ge, Se, Kr, Sr, Mo, Ru, Pd, Cd, Sn, Te, Ba, Yb, Hf, Pt, Pb B-type deformation parameters are systematically (and in many cases – significantly) larger than G-type ones (in cases of only few exceptions mentioned above (Mg, Xe, U) both types of disagreement are combined). It

was shown that two types data difference could be explained in the frame of assumption about the not-negligible role of dynamical vibrations of nucleus surface.

New double magic nucleus ⁹⁶Zr has been found out on the base of systematical joint analysis of nucleon single-particle subshells energy positions and occupation probabilities and "magicy parameters" - energy $E(2^{+1})$ of the first 2⁺ state, ratio $E(4^{+1})/E(2^{+1})$ and nucleus quadrupole deformation parameter β_2 . It was pointed out that in ⁹⁶Zr there are two closed subshells with the large identical moment j = 5/2 (i.e. $\pi 1 f_{5/2}$ and $\nu 2 d_{5/2}$) near to Fermi and in addition above one of them, $\pi 1 f_{5/2}$, the closed subshell with j = 1/2, $\pi 2 p_{1/2}$, occurs. Several other new magic were revealed by application of ⁹⁶Zr subshell structure features scheme (an empirical rule) to other nuclei subshells: 1) with j = 3/2 (i.e. $\pi 1 d_{3/2}$ and $\nu 2 p_{3/2}$) together with j = 1/2, $\nu 2 p_{1/2}$ closed subshell above leads to magic nucleus ⁵⁴Ca, discussed in; 2) with j = 5/2 (i.e. $\pi 1 d_{5/2}$ and $\nu 1 d_{5/2}$) together with j = 1/2, $\pi / \nu 2 s_{1/2}$ closed subshells above leads to magic numbers N = 16 for Z = 14 (³⁰Si) and vise versa – N = 14 for Z = 16 (³⁰S); 3) with j = 3/2 (i.e. $\pi 1 p_{3/2}$ and $\nu 1 p_{3/2}$) together with j = 1/2, $\pi / \nu 1 p_{1/2}$ closed subshells above leads to magic numbers N = 8 for Z = 6 (¹⁴C) and vise versa – N = 6 for Z = 8 (¹⁴O). The empirical rule under discussion can be attributed to additional specific attractive proton-neutron interaction.

New evaluated nuclear structure data on new non-traditional magic nuclei and nuclear static and dynamic deformations are submitted for reports to the International Conference on Nuclear Data for Science and Technology at Nice, France (ND-2007).

CDFE Short-term Programmes

The main items of CDFE future short-term programmes, priorities and new tasks in fields both photonuclear and nuclear structure data are listed in the **Annex 2**.

References

- E.G.Fuller, H.Gerstenberg. Photonuclear Data Abstracts Sheets 1955 1982. NBSIR 83-2742. U.S.A. National Bureau of Standards, 1986.
- 2. N.J.Stone. Table of Nuclear Magnetic Dipole and Electric Quadrupole Moments. Preprint Oxford Physics, Clarendon Laboratory OXFORD OX1 3PU U.K., 2001.
- P.Raghavan, Table of Nuclear Moments. Atomic and Nuclear Data Tables, 42 (1989) 189.
- V.V.Varlamov, B.S.Ishkhanov, I.V.Makarenko, V.N.Orlin, N.N.Peskov. Evaluation of ¹²⁷I Photonuclesr Reaction Cross Sections. Preprint MSU SINP - 2006 - 9/808 (in Russian - http://dbserv.sinp.msu.ru:8080/sinp/files/pp-808.pdf).

TRANS M039		TRANS M040	
ENTRY N	Amount of SUBENTs	ENTRY N	Amount of SUBENTs
M0385	3	M0680	7
<i>M0419</i>	1	M0681	10
M0507	3	M0686	6
M0510	5	M0687	2
M0537	7	M0688	4
M0538	4	M0689	1
M0543	3	M0690	1
M0600	2	M0691	1
M0629	5	M0692	1
M0631	2		
M0633	6		
M0637	1		
M0669	2		
M0679	11		
M0680	7		
M0683	4		
M0684	3		
M0685	4		
Total new: 4	Total new: 18	Total new: 7	Total new: 16
Sum of new ENTRYs: 11 *)			
Sum of new SUBENTs: 34 *)			

Annex 1. The CDFE new EXFOR TRANSes M039, M040, and M041 (PRELIM) contents (*old corrected* and **new** ENTRYs)

*) For crazy coincidence of financial, technical, manpower, health, scientific business etc. reasons the sums of new ENTRYs and SUBENTRYs are not enough large unfortunately.

Annex 2. The main items of the CDFE future short-term programmes.

1. Continuation of photonuclear data compilation using EXFOR format, new TRANSes (M041, M042, etc.) production.

2. Upgrading and addition of all CDFE databases.

3. Continuation of joint analysis and evaluation of photonuclear reaction cross sections obtained using various methods, first of all in experiments with bremsstrahlung and quasimonoenergetic annihilation photons, with the aim of definition and excluding of systematical discrepancies.

4. Investigation of possibility of development of Giant Dipole Resonance Chart using the experience of previous production of the Chart of Nuclear Quadrupole Deformations.

5. Investigations of new non-traditional magic nuclei properties and existence conditions using the search possibilities of the CDFE database "Relational ENSDF".