2008/2009 progress report of the MSU SINP Centre for Photonuclear Experiments Data (CDFE)

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Progress Report to
the IAEA Technical Meeting of Nuclear Reaction Data Centers (NRDC),
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The presented report contains the short review of the main items of 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 2008 Technical Meeting of the International Network of Nuclear Reaction Data Centers (22 – 25 September, Obninsk, Russia) till the spring of 2009 and main results obtained.

EXFOR Compilations

Three new CDFE EXFOR **TRANSes TRANS.M047, TRANS.M048 and PRELIM.M049** have been produced and transmitted to the IAEA NDS.

In accordance with recommendations of the previous Technical Meeting (Obninsk) many of old ENTRYs were corrected following the comments of N.Otsuka, S.Dunaeva, V.Zerkin and N.Soppera. Therefore the first mentioned TRANS.M047 was devoted completely to those corrections.

On the whole three CDFE 2008/2009 TRANSes contain (**Annex 1**) 21 retransmitted and 12 new ENTRYs with 147 new data SUBENTs.

Photonuclear Data Evaluations

The CDFE program of consistent analysis and evaluation of total ((γ,xn) and (γ,sn)) and partial ((γ,n) and (γ,2n)) photonuclear reactions cross sections was continued. For 9 tin isotopes ^{112,114,116,117,118,119,120,122,124}Sn the combined analysis was carried out previously [1] for experimental data for cross sections of both total and partial photoneutron reactions obtained at MSU SINP using bremsstrahlung and at Livermore (USA) and Saclay (France) using quasimonoenergetic photons obtained at annihilation of relativistic positrons. The systematic disagreements between the various experiments data were analyzed and the method for their taking into account was carried out.

Now the modern model of photonuclear reaction based on the Fermi gas densities

equations [2] was used for evaluation [3] for 9 Sn isotopes of partial photoneutron reaction cross sections $\sigma(\gamma,n)$ and $\sigma(\gamma,2n)$ from the experimental data for cross section of total photoneutron reaction $\sigma(\gamma,xn) = \sigma(\gamma,n) + 2\sigma(\gamma,2n)$. Theoretically calculated function $F(E) = \sigma_{(\gamma,2n)}(E)/\sigma_{(\gamma,xn)}(E)$ was used for evaluation of partial reaction cross sections $\sigma^{eval}_{(\gamma,2n)}(E_\gamma) = F(E_\gamma)\cdot\sigma^{exp}_{(\gamma,xn)}(E_\gamma)$ and $\sigma^{eval.}_{(\gamma,n)}(E_\gamma) = \sigma^{exp}_{(\gamma,xn)}(E_\gamma) - 2\sigma^{eval}_{(\gamma,2n)}(E_\gamma) = \sigma^{exp}_{(\gamma,xn)}(E_\gamma) - 2F(E_\gamma)\cdot\sigma^{exp}_{(\gamma,xn)}(E_\gamma) = = (1 - 2F(E_\gamma))\cdot\sigma^{exp}_{(\gamma,xn)}(E_\gamma)$.

With those the total photoneutron reaction cross sections $\sigma(\gamma,sn)$ were evaluated for all 9 Sn isotopes under discussion, the regularities of the giant dipole resonance main parameters were analyzed in dependence of their mass number A. Data are published as the MSU SINP Preprint [2] and included into the CDFE trans PRELIM.M049 (ENTRY M0768).

In addition the same approach was used for partial photoneutron reaction cross sections $\sigma(\gamma,n)$ and $\sigma(\gamma,2n)$ evaluation for ^{63}Cu, ^{115}In, ^{169}Tm, ^{197}Au, ^{209}Bi and some other medium and heavy weight nuclei.

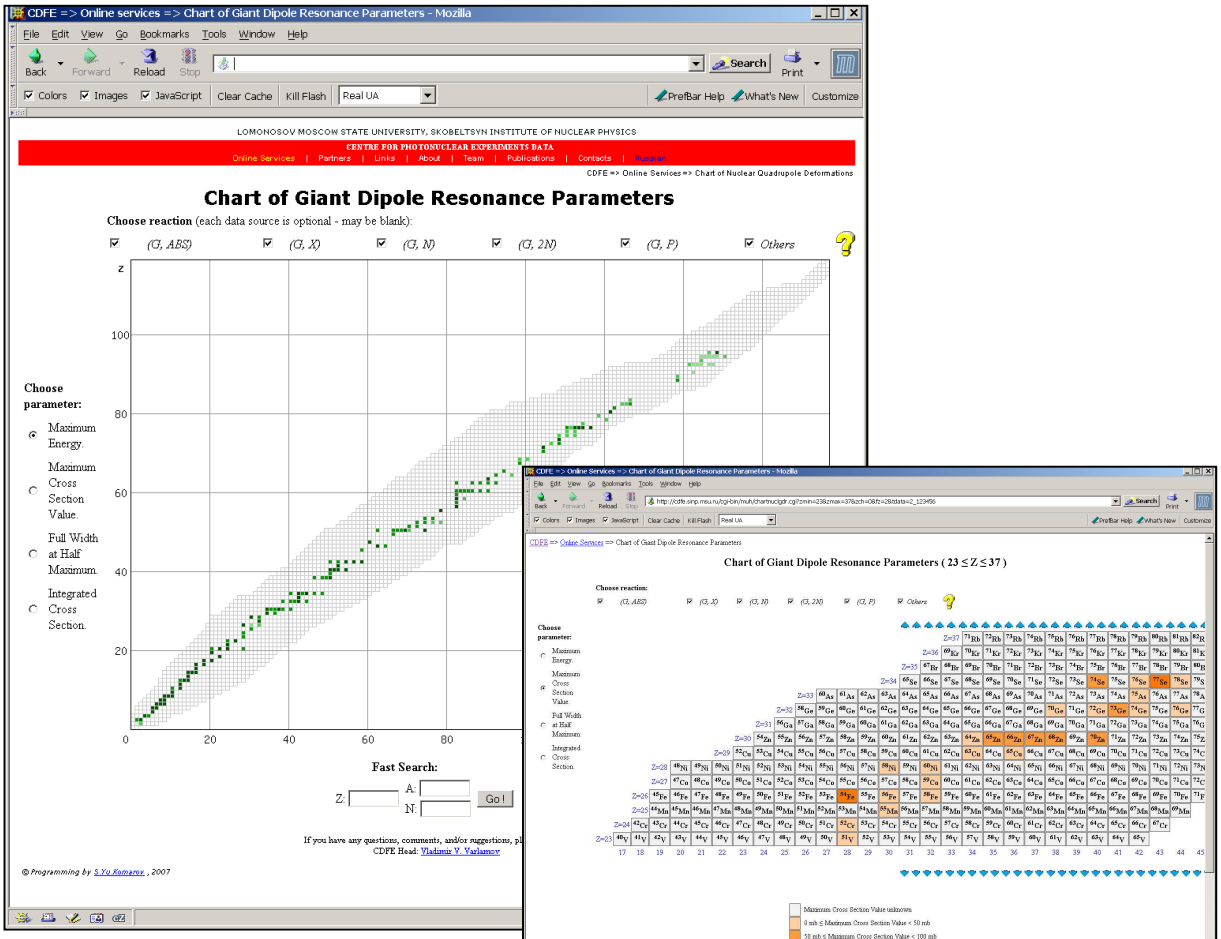
Upgrading of Databases

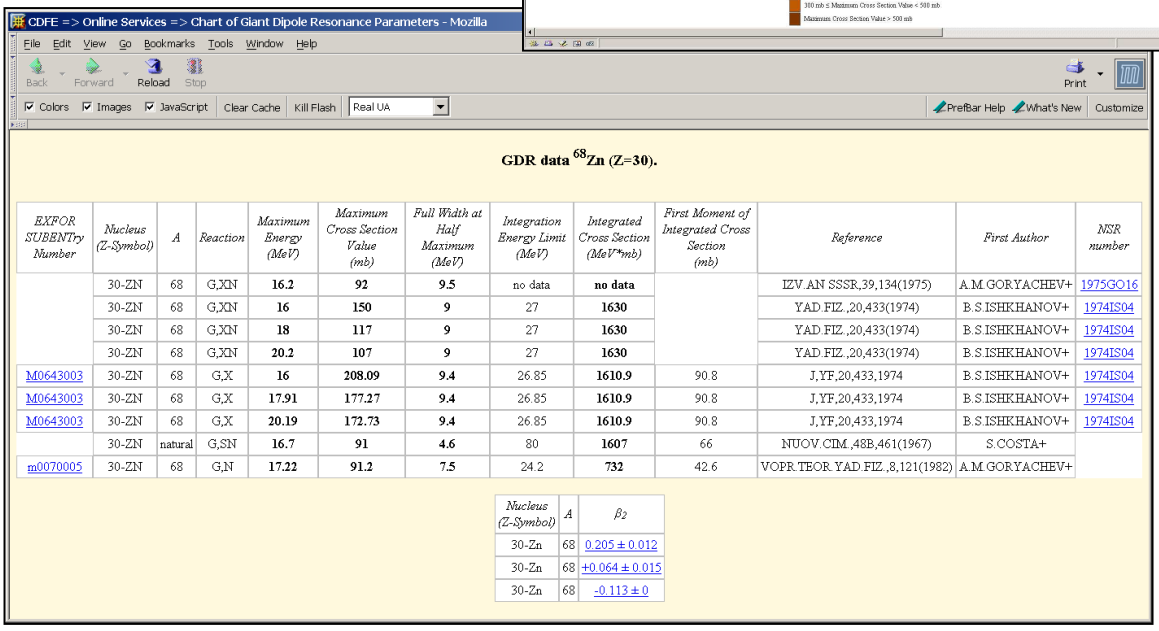
The main CDFE relational nuclear data databases put upon the CDFE Web-site (http://cdfe.sinp.msu.ru) have been upgraded significantly – needed corrections, many additions.

New Databases Development

Using the CDFE experience of previously producing of relational database "Giant Dipole Resonance Parameters, Photonuclear Reaction Cross Sections" (http://cdfe.sinp.msu.ru/services/gdrsearch.html) and electronic Chart ("Chart of Nucleus Shape and Size Parameters" - (http://cdfe.sinp.msu.ru/services/radchart/radmain.html)) new electronic Chart ((http://cdfe.sinp.msu.ru/services/gdrchart/gdrmain.html)) of main parameters of Giant Dipole Resonance was developed and now is available as testing version.

New electronic Chart contains data on several main GDR parameters - energy, amplitude, width and integrated cross section. Data were obtained from cross sections of many total ((γ,abs), (γ,xn) and (γ,sn)) and partial ((γ,n), (γ,2n), (γ,3n), (γ,p), (γ,d), (γ,t), (γ,α)) reactions using both many available original and comprehensible [4] publications and EXFOR database.





EXFOR SUBENTry Number	Nucleus (Z-Symbol)	A	Reaction	Maximum Energy (MeV)	Maximum Cross Section Value (mb)	Full Width at Half Maximum (MeV)	Integration Energy Limit (MeV)	Integrated Cross Section (MeV*mb)	First Moment of Integrated Cross Section (mb)	Reference	First Author	NSR number
	30-ZN	68	G,XN	**16.2**	**92**	**9.5**	no data	**no data**		IZV.AN SSSR,39,134(1975)	A.M.GORYACHEV+	1975GO16
	30-ZN	68	G,XN	**16**	**150**	**9**	27	**1630**		YAD.FIZ.,20,433(1974)	B.S.ISHKHANOV+	1974IS04
	30-ZN	68	G,XN	**18**	**117**	**9**	27	**1630**		YAD.FIZ.,20,433(1974)	B.S.ISHKHANOV+	1974IS04
	30-ZN	68	G,XN	**20.2**	**107**	**9**	27	**1630**		YAD.FIZ.,20,433(1974)	B.S.ISHKHANOV+	1974IS04
M0643003	30-ZN	68	G,X	**16**	**208.09**	**9.4**	26.85	**1610.9**	90.8	J,YF,20,433,1974	B.S.ISHKHANOV+	1974IS04
M0643003	30-ZN	68	G,X	**17.91**	**177.27**	**9.4**	26.85	**1610.9**	90.8	J,YF,20,433,1974	B.S.ISHKHANOV+	1974IS04
M0643003	30-ZN	68	G,X	**20.19**	**172.73**	**9.4**	26.85	**1610.9**	90.8	J,YF,20,433,1974	B.S.ISHKHANOV+	1974IS04
	30-ZN	natural	G,SN	**16.7**	**91**	**4.6**	80	**1607**	66	NUOV.CIM.,48B,461(1967)	S.COSTA+	
m0070005	30-ZN	68	G,N	**17.22**	**91.2**	**7.5**	24.2	**732**	42.6	VOPR.TEOR.YAD.FIZ.,8,121(1982)	A.M.GORYACHEV+	

Nucleus (Z-Symbol)	A	β_2
30-Zn	68	0.205 ± 0.012
30-Zn	68	+0.064 ± 0.015
30-Zn	68	-0.113 ± 0

Nuclear Structure Data Evaluations

Investigations of traditional and new magic and near magic nuclei were continued using possibilities of the CDFE Complete Nuclear Spectroscopy Database "Relational ENSDF" and ("Chart of Nucleus Shape and Size Parameters" [5 - 7]. Single-particle both proton and neutron states energies and occupation probabilities were evaluated using joint analysis of data from nucleon stripping and pick-up reactions for many of nuclei from the middle of the 1f-2p shell (mainly for ^{56,58,60,62,64,66,68,70,72}Ni). Evaluated data were compared with calculations in the frame of dispersive optical model.

Short-term (2009/2010) Program

The main items of CDFE future short-term one-year program, main priorities and several most important new tasks in fields both photonuclear reaction and nuclear structure data are the following:

1. Continuation of photonuclear data compilation using EXFOR format, new TRANSes (M050, M051, etc.) production.
2. Continuation of joint analysis and evaluation of total and partial photonuclear reaction cross sections obtained using various methods, first of all in experiments with bremsstrahlung and quasimonoenergetic annihilation.
3. Upgrading (corrections and additions) of all databases put upon the CDFE Web-site (http://cdfe.sinp.msu.ru).
4. Continuation of efforts concern investigation of possibilities of production of new photonuclear databases, containing data for energies higher GDR, first of all for meson photoproduction reaction data.

References

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2. B.S.Ishkhanov, V.N.Orlin. Preequilibrium model of photonucleon reactions that is based on Fermi gas densities. Yadernata Fizika, 71 (2008) 517 (Physics of Atomic Nuclei 71, (2008) 493).
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4. E.G.Fuller, H.Gerstenberg. Photonuclear Data - Abstracts Sheets 1955 - 1982. NBSIR 83-2742. U.S.A. National Bureau of Standards, 1986.
5. I.N.Boboshin, V.V.Varlamov, B.S.Ishkhanov, S.Yu.Komarov, E.A.Romanovsky. Shell Structure of New Magic Nuclei: Systematics of Features. Bull.Rus.Acad.Sci.Phys. 72 (2008) 283.
6. O.V.Bespalova, I.N.Boboshin, V.V.Varlamov, T.A.Ermakova, B.S.Ishkhanov, S.Yu.Komarov, E.A.Romanovsky, T.I.Spasskaya, T.P.Timokhina,. Analysis of the New Data on Single-Particle Structure of Nuclei from the Middle of the 1f-2p Shell within the Dispersive Optical Model. Bull.Rus.Acad.Sci.Phys., 72 (2008) 847.
7. I.N.Boboshin, B.S.Ishkhanov, E.A.Romanovsky, V.V.Varlamov. New Magic Nuclei ^{96}Zr, ^{54}Ca, ^{30}S, ^{30}Si, ^{14}O, ^{14}C, and Other Existence Conditions. The 2-nd International Conference "Current Problems in Nuclear Physics and Atomic Energy (NPAE-Kyiv2008)", June 9 – 15, 2008. Book of Abstracts. Institute of Nuclear Research, 2008, p. 101.

Annex 1.

The contents of new 2008/2009 CDFE's EXFOR transes
(*old corrected* and **new** ENTRYs)

TRANS.M047		**TRANS.M048**		**PRELIM.M049**	
ENTRY N	Amount of SUBENTs	ENTRY N	Amount of SUBENTs	ENTRY N	Amount of SUBENTs
M0241	*3*	*M0179*	*2*	**M0761**	**3**
M0271	*3*	*M0184*	*5*	**M0762**	**10**
M0283	*22*	*M0191*	*2*	**M0763**	**9**
M0346	*10*	**M0765**	**2**	**M0764**	**13**
M0536	*4*	**M0766**	**23**	**M0768**	**46**
M0546	*1*	**M0767**	**3**	**M0771**	**18**
M0592	*2*	**M0769**	**14**		
M0673	*3*	**M0770**	**3**		
M0725	*2*				
M0733	*2*				
M0736	*2*				
M0738	*2*				
M0740	*5*				
M0744	*4*				
M0745	*3*				
M0746	*6*				
M0758	*5*				
M0759	*3*				
Total new: 0	**Total new: 0**	**Total new: 5**	**Total new: 45**	**Total new: 6**	**Total new: 99**
Sum of new ENTRYs: 11 **Sum of new SUBENTs: 144**					