

A New Database (Digital Chart) of Main GDR Parameters

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Abstract—A new digital chart of the main parameters of the giant dipole resonance (GDR) of atomic nuclei (energy, amplitude, width, and integrated cross section) is developed. For all nuclei investigated in photonuclear reactions, the data are presented on the corresponding resonances appearing in cross sections of the reactions of main nucleus GDR excitation and decay channels, i.e., the total photoabsorption (γ , *abc*), reactions with formation of neutron (γ , xn), (γ , n), and (γ , $2n$) and proton (γ , p), and others (with the formation of deuterons (γ , d), tritons (γ , t), and α particles (γ , α)). The chart has a useful and convenient scaling tool: a digital zoom that makes navigation around the chart much easier. Through the table of search request processing results, the chart is connected with several other databases containing information on reactions in the cross section of which a GDR is observed, the target and final nuclei of these reactions, and a corresponding international bibliography database.

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The Center for Photonuclear Experiments Data (CPED) has been operating for several years now at the Institute of Nuclear Physics of Moscow State University as part of the International Network of Nuclear Reaction Data Centers under the auspices of IAEA, along with three other Russian institutions (the Nuclear Data Center at the Institute of Physics and Power Engineering, the Center for Nuclear Physical Data in Sarov, and the Center for Atomic and Nuclear Data at the National Research Center Kurchatov Institute in Moscow) [1].

The term “photonuclear” in CPED corresponds to its specialization and main commitments in international cooperation, i.e. the processing, analysis, estimating, and spreading of data on reactions under the action of low- and moderate-energy incident photons. In view of this, CPED focuses upon not only supplying the International Nuclear Reaction DB (EXFOR) with photonuclear data, but also upon developing a dedicated DB on the main parameters of the GDR of atomic nuclei (energy, amplitude, width, and some other integral parameters that play an important role in different fundamental studies of electromagnetic interactions of nuclei, are of interest in the context of studying the structure and dynamics of atomic nuclei and mechanisms of nuclear reactions, and can be applied in practice).

In view of the great need for such data, the DB Giant Dipole Resonance Parameters. Photonuclear Reaction Cross Sections (<http://cdfc.sinp.msu.ru/services/gdrsearch.html>) was developed at the CPED [2, 3] and included a large volume of data on the main GDR parameters. The bank of corresponding data on the main GDR parameters of atomic nuclei is a true

pioneering work by CPED, as such data are found nowhere else. Different printed and electronic matter containing corresponding data served as information sources for the bank [4–7]. The DB search engine consisted of a user interface, implemented in request form, and a search scenario that processed input requests. Such a system allowed us to search reliably for records, answer user-specified criteria, and presented them in an appropriate form. A convenient connection was established between this search engine and those of other EXFOR nuclear reaction DBs also created at CPED, and the International NSR (Nuclear Science Reference) DB, implemented in the form of html links in the corresponding columns of the table with the results from processing user requests.

The use of the above DB over several years demonstrated its high efficiency and convenience for information support of photonuclear and related problems. The operating experience, however, allowed the formulation of some requirements for a considerable increase in its serviceability. In additions, new technologies appeared over time that allowed the search engine to be greatly improved through the implementation of graphical data representation. In view of this, work began several years ago on a new form of the DB with a search engine meeting the above requirements. Finally, a conceptually new DB [3] was developed on the basis of the previous one: the digital Chart of Giant Dipole Resonance Main Parameters, which combined the advantages of the old search engine with a tabular form of requests and the convenience of a new chart form.

The old version of the DB used a set of previously prepared graphic files corresponding to the DB state at the point of their creation. The new version uses a

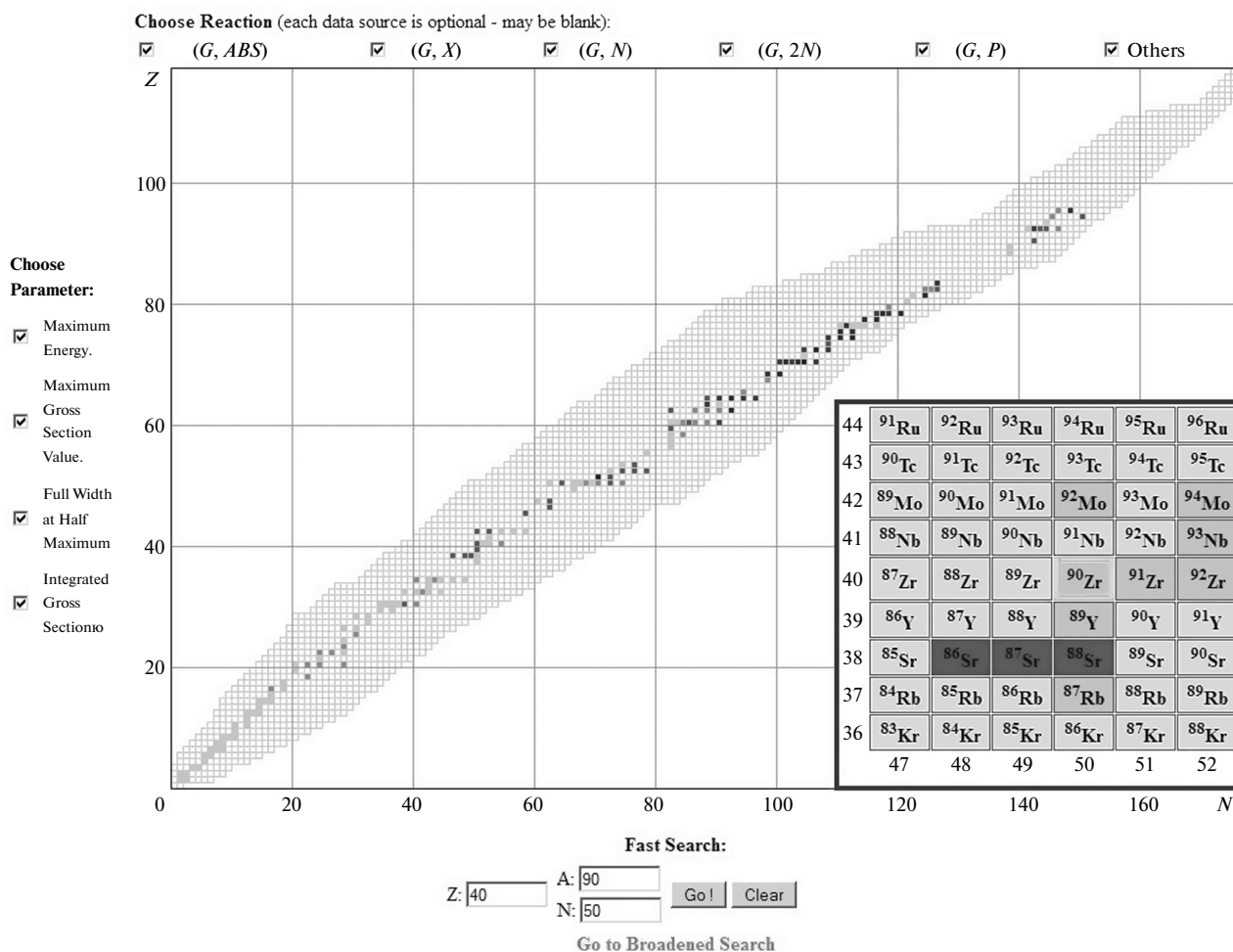


Fig. 1. Interface of the digital chart of main GDR parameters with a digital zoom and a quick search window.

chart produced at the point of user request and, hence, corresponds to the current collection of data on main GDR parameters.

In the new digital chart (Fig. 1), the data blocks describing the properties of the GDR of certain nuclei are presented in coordinates of the number of protons Z and the number of neutrons N . The convenience of the new graphic system of data representation in the digital chart includes the following:

—Data are sorted by main nuclear reactions—total photoabsorption (γ, abs) and reactions with the formation of neutrons (γ, xn), (γ, n), and ($\gamma, 2n$) and protons (γ, p), and a number of others—allowing a user to orient himself easily in the divisions of data collection.

—Ranges of the quantitative values of GDR parameters are marked with different tints, allowing us to combine data selection with certain assessments from the very beginning of data scanning in the digital chart.

—All of the available data are output by default, but a particular channel or any combination of channels can be selected.

—The the new chart is scaled using a unique navigation tool: a digital zoom that shows the vicinity of a selected nucleus in a secondary window (Fig. 1). The content of the digital zoom window (54 cells of 6×9 , presented in the (N, Z) coordinates and corresponding to certain isotopes colored in the style of the chart) produces the effect of a magnifying glass.

The advantages of the old search engine with tabular request have been improved and developed. When selecting a nucleus in the chart of main GDR parameters, the parameters Z , N , and A of a selected nucleus are recorded automatically in the fields of the Fast Search bar (Fig. 1) at the same time the digital zoom window opens.

The html link to an advanced request form (Go to Broadened Search) is located below the Fast Search bar; it connects the chart of main GDR parameters with the new advanced request form.

The Fast Search bar is found in the request form of three elements: the parameters of the required nucleus, Z , N , and A . The fields N and A are alternatives: if a user fills in one of them, he must not fill in

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ONLINE SERVICES. SEARCH ENGINE FOR CHART OF GIANT DIPOLE RESONANCE MAIN PARAMETERS.

Each field in this form is optional - may be blank. [\[Click here for help...\]](#)

Advanced Search:		Examples
Exfor number :		m0001027 I0044005
Z :		12 10;20 7-82
A :		16 13;24;98 4-65
Reaction :		G.ABS G.N.G.P G.N.G.T
Maximum Energy (MeV) :		12.54 15-24.78
Maximum Cross Section Value (mb) :		10 4.90-9
Full Wight at Half Maximum (MeV) :		3.1 5-10.09
Integration Energy Limit (MeV) :		2.2 4-11.46
Integrated cross section (MeV * mb) :		4.3 3.21-6.29
First Momentum of Integrated Cross Section (mb) :		8.4 6.11-9.37
Reference/Year :		PHYS.REV.,C4,149 NUCL.PHYS 1971
NSR Keyno :		1985AH06 1995VA21
First Author :		FULLER
Number of founded results on the page :	50 v	

[Click here to submit query! See another window for results!](#)

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Fig. 2. Form for expanded search request.

another one; this allows incorrect requests, in which $Z + N \neq A$, to be avoided. The search by all data types available in the DB is implemented using the new request form for the search engine of main GDR parameters (Fig. 2):

- the number of the corresponding division (EXFOR number) of the international database on nuclear reactions;
- the nuclear charge Z ;
- the nuclear mass number A ;

CDFE search engine. Giant Dipole Resonance Parameters Data Base.

The 29 following data sets matched to your request...

[Click here for help](#)

EXFOR SUBENT Number	Target Z-Symbol	Target A	Reaction	Final Z-Symbol	Final A	Maximum Energy (MeV)	Maximum Cross Section Value (mb)	Full Width at Half Maximum (MeV)	Integration Energy Limit (MeV)	Integrated Cross Section (MeV ⁻¹ mb)	First Momentum of Integrated Cross Section (mb)	Reference	NSR keyno	First Author
m0556013	40-Zr	90	G.ABS			16.7	259	5	23.7	1367.7	75	J.IZV.67.656.2003		V.V.VARLAMOV+
m0556013	40-Zr	90	G.ABS			19.28	181.88	5	23.7	1367.7	75	J.IZV.67.656.2003		V.V.VARLAMOV+
	40-Zr	90	G.XN			16	200	3.7	26	950	0	YAD.FIZ.14.27(1971)	1971IS08	B.S.ISHKHANOV+
I0027011	40-Zr	90	G.XN			16.659	215	4.5	25.9	1309	72.8	NUCL.PHYS.A175.609(1971)	1971LE28	A.LEPRETRE+
	40-Zr	90	G.XN			16.5	175	4	22.5	1270	0	IZVAN.SSSR.33.700(1969)	1969AN30	G.P.ANTROPOV+
I0011005	40-Zr	90	G.XN			16.724	180	4.5	27.6	1158	63	PHYS.REV.162.1098(1967)	1967BE63	B.L.BERMAN+
	40-Zr	90	G.XN			15.8	199	4.5	23	980	0	PHYS.REV.104.1334(1956)		P.F.YERGIN+
m0558004	40-Zr	90	G.X			16.7	29.65	7.9	23.9	190.5	10	J.NP/A.239.397.1975	1975SH04	K.SHODA+
m0558004	40-Zr	90	G.X			19.3	37.15	7.9	23.9	190.5	10	J.NP/A.239.397.1975	1975SH04	K.SHODA+
m0558004	40-Zr	90	G.X			21.3	35.45	7.9	23.9	190.5	10	J.NP/A.239.397.1975	1975SH04	K.SHODA+
m0558004	40-Zr	90	G.X			23.1	14.5	7.9	23.9	190.5	10	J.NP/A.239.397.1975	1975SH04	K.SHODA+
m0360003	40-Zr	90	G.X			16.3	204.17	4.3	27.4	1113.3	62.5	C.72SENDAI.359.72		H.J.ASKIN+
m0535005	40-Zr	90	G.X			16.67	219.1	5.3	25.67	1373.3	77.1	J.YK.1-2.46.2003		V.V.VARLAMOV+
m0558002	40-Zr	90	G.X			15.75	201.82	3.3	27.9	1070.5	59.6	J.YK.14.27.1971		B.S.ISHKHANOV+
	40-Zr	90	G.SN			16	200	3.7	28	930	0	YAD.FIZ.14.27(1971)	1971IS08	B.S.ISHKHANOV+
	40-Zr	90	G.SN			16.67	215	4.5	25.9	1260	70.8	NUCL.PHYS.A175.609(1971)	1971LE28	A.LEPRETRE+
I0011018	40-Zr	90	G.SN			16.724	180	4.5	27.6	1060	59.1	PHYS.REV.162.1098(1967)	1967BE63	B.L.BERMAN+
I0027012	40-Zr	90	G.N	40-Zr	89	16.689	215	4.5	25.9	1211	68.7	NUCL.PHYS.A175.609(1971)	1971LE28	A.LEPRETRE+
I0011006	40-Zr	90	G.N	40-Zr	89	16.724	180	4.5	27.6	962	55.2	PHYS.REV.162.1098(1967)	1967BE63	B.L.BERMAN+
m0535003	40-Zr	90	G.N	40-Zr	89	16.8	218.2	5.2	27.6	1211.6	70.3	J.YK.1-2.46.2003		V.V.VARLAMOV+
I0027013	40-Zr	90	G.2N	40-Zr	88	24.588	19	8	25.9	49	2.03	NUCL.PHYS.A175.609(1971)	1971LE28	A.LEPRETRE+
I0027013	40-Zr	90	G.2N	40-Zr	88	23.751	18	8	25.9	49	2.03	NUCL.PHYS.A175.609(1971)	1971LE28	A.LEPRETRE+
I0011007	40-Zr	90	G.2N	40-Zr	88	25.124	22.6	8	27.6	98	3.93	PHYS.REV.162.1098(1967)	1967BE63	B.L.BERMAN+
m0558004	40-Zr	90	G.P	39-Y	89	19.3	74.3	6	23.9	381	20	NUCL.PHYS.A239.397(1975)	1975SH04	K.SHODA+
m0558004	40-Zr	90	G.P	39-Y	89	16.5	59.3	6	23.9	381	20	NUCL.PHYS.A239.397(1975)	1975SH04	K.SHODA+
m0558004	40-Zr	90	G.P	39-Y	89	21.3	70.9	6	23.9	381	20	NUCL.PHYS.A239.397(1975)	1975SH04	K.SHODA+
m0558004	40-Zr	90	G.P	39-Y	89	23.1	29	6	23.9	381	20	NUCL.PHYS.A239.397(1975)	1975SH04	K.SHODA+
m0125002	40-Zr	90	G.P	39-Y	89	21.5	30	6	30.5	159.1	7.2	PHYS.LETT.10.310(1964)		I.I.DUSHKOV+
m0165002	40-Zr	90	G.P	39-Y	89	21.5	300	4.7	30.5	1591.2	71.7	J.IZV.29.213.65		I.I.DUSHKOV+

Fig. 3. Output table of search request results.

- the reaction (Reaction);
- the maximum energy of resonance (Maximum Energy);
- the full width and half maximum of resonance (Full Width and Half Maximum);
- the integrated cross section (Integrated Cross Section);
- the initial momentum of an integrated cross section (Initial Momentum of Integrated Cross Section);
- the reference/year of a publication (Reference/Year);
- the reference code of the international reference DB (NSR Keyno);
- the name of the first author of a publication (First Author).

The advanced request form has been improved in the following ways:

- searching by all the DB parameters and by an arbitrary set of individual parameter values and their ranges;
- instead of searching by an individual parameter value or a single range of values, a search by parameters of arbitrary length and order of combination is possible;
- input parameters are checked for inadmissible characters; when there is such a character, a warning with an indication of the admissible characters appears;

- there are prompts near each entry field explaining the meaning of the parameters corresponding to a given field.

The above considerably lowers the restrictions on request compilation and thus opens up new possibilities for a user and enhances the system capabilities.

The new chart of GDR parameters is connected with other CPED DBs, allowing a user to gain a complete picture of the experimental data on a nucleus of interest. The connections are made using a table of the search request results (Fig. 3):

- A link in the EXFOR SUBENT number division directs the user to the corresponding division of the nuclear reaction DB [8] (<http://cdfe.sinp.msu.ru/exfor/index.php>). By following this link, he can get a brief bibliographical description of a work, a graphic presentation (a *.bmp file) of the corresponding reaction cross section, and a table of the numerical values of the cross section used for the graphic presentation.

- Links in the division with the target (Target) and final (Final) nuclei (Z-Symbol or A) direct the user to the corresponding DB divisions with the parameters of the ground and isomer states of atomic nuclei ([http://cdfe.sinp.msu.ru/cgi-bin/_gsearch.cgi?z="Z-Symbol" or "A"](http://cdfe.sinp.msu.ru/cgi-bin/_gsearch.cgi?z=)). By following these links, he can find different data characterizing a stable target nucleus (e.g., stable isotope abundance, unstable nucleus life-time, spin-parity, mass, excess mass, binding energy, quadrupole momentum, quadrupole deformation

parameter, charge radius, energy of nucleon separation, decay mode) and a final nucleus.

—A link in the Reaction division is used to create a corresponding direct request to a Calculator and Graphic System for Atomic Nuclei Parameters and Parameters of Nuclear Reactions and Radioactive Decays (http://cdfc.sinp.msu.ru/services/calc_thr/calc_thr_ru.html), allowing calculation of the thresholds and energies of certain reactions.

—A link in the Reference division directs the user to the corresponding division of the NSR DB (http://cdfc.sinp.msu.ru/services/nsr/Search_form.shtml) and provides detailed bibliographical information about a work, including a detailed abstract in keywords and special descriptions.

A system for indicating an intermediate GDR structure that can appear against the main resonance is provided in the table of search results. If there are well pronounced resonances of intermediate structure in the reaction cross section, their main parameters are given in additional lines that all have the same reference link (the Reference division).

It should be especially noted that special software has been developed for the digital chart to load data from the body of numerical data of the EXFOR International Nuclear Reaction DB, supported by the IAEA Network of Nuclear Data Centers [8].

The digital chart contains about 60000 records in total (~130 MB) from around 20000 publications.

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REFERENCES

1. Otsuka, N. and Dunaeva, S., *International Nuclear Data Committee (IAEA Nuclear Data Section)—0401*, Vienna International Centre, 2010.
2. Boboshin, I.N., Varlamov, A.V., Varlamov, V.V., et al., *Vserossiiskaya ob"edinennaya konferentsiya "Tekhnologii informatsionnogo obshchestva — Internet i sovremennoe obshchestvo" Sankt-Peterburg, 20–24 noyabrya 2000* (Proc. Joint All-Russian Conf. "Technologies of Information Society — Internet and Modern Society". St. Petersburg, Nov. 20–24, 2000), St. Petersburg: Izd. SPbGU, 2000, p. 102.
3. Varlamov, V.V., Vyazovskii, V.V., Ekhlakov, I.A., et al., *XI Vserossiiskaya nauchnaya konferentsiya RCDL'2009 "Elektronnye biblioteki: perspektivnye metody i tekhnologii, elektronnye kollektsii"* (Proc. 11th All-Russian Sci. Conf. RCDL'2009 "Electronic Libraries: Progressive Methods and Technologies, Electronic Collections"), Petrozavodsk: Izd. Karel'skogo nauchn. tsentra RAN, Sept. 17–21, 2009, p. 386.
4. Fuller, E.G. and Gerstenberg, H., *Photonuclear Data — Abstracts Sheets 1955–1982*, USA Nation Bureau of Standards, 1986.
5. Asami, T. and Nakagawa, T., *Bibliographic Index to Photonuclear Reaction Data (1955–1992) JAERIM-93–195, INDC(JPN)—167L, JAERI*, Japan, 1993.
6. Varlamov, V.V., Sapunenko, V.V., and Stepanov, M.E., *Photonuclear Data Index 1976 — 1995*, Moscow: Izd. Mosk. Univ., 1996.
7. Varlamov, A.V., Varlamov, V.V., Rudenko, D.S., et al., *Atlas of Giant Dipole Resonances. Parameters and Graphs of Photonuclear Reaction Cross Sections. IAEA NDS, INDC(NDS)—394*, Vienna, 1999.
8. Complete Data Base on Nuclear Reactions (EXFOR). <http://cdfc.sinp.msu.ru/exfor/index.php>

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