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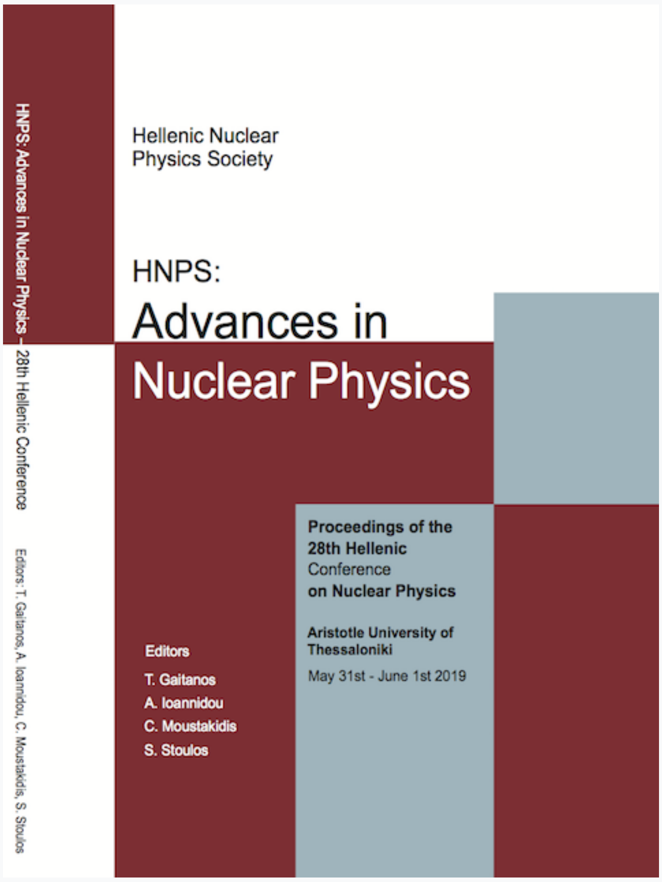

An upgrade of the UoA nuclear electromagnetic moments database

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An upgrade of the UoA nuclear electromagnetic moments database

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Abstract *A web–based database of nuclear electromagnetic moments data has been created and hosted online at the University of Athens since 2012 [1]. In this work, we report on an update which has focused on syncing spectroscopic information, electric quadrupole and magnetic dipole moments with the ENSDF database [2] and literature values. A new feature is the incorporation of nuclear charge radii values obtained after 2015. Additionally, instructions of how to use the database, alongside with annonations and abbreviations, are presented.*

Keywords *database, charge radii, electric quadrupole moment, magnetic dipole moment*

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INTRODUCTION

Nuclear moments play a vital role in our effort to better understand the nucleus. The Electric Quadrupole Moment (Q) is an observable that relates directly to the shape and size of the nucleus. On the other hand, the Magnetic Dipole Moment (μ) is a quantum operator that describes the nuclear magnetism in terms of the spin of the state in which the nucleus resides. Thus, measuring magnetic dipole moments can determine the wave function of a nuclear state in terms of the single-particle degrees of freedom. Despite the significance of the above values, the related experimental data are scattered throughout literature. As a result, the need to provide a user–friendly database that includes all the available experimental data is substantial.

THE DATABASE

The current version includes information for nearly every element (up to Z=118), with the most recent update having a cut–off date 2019-03-31. The main feature of the current effort is the addition of over 150 entries and 3 new experimental techniques of electric quadrupole and magnetic dipole moments. The update was based on searching published works found in the NSR database [3] and focused on pure experimental results. Data from the same database regarding rms charge radii ($\delta\langle r^2\rangle$) published after 2017 were also included in the database for the first time. Additionally, level energies, half-lives and spin/parity values were synced with the ENSDF database.

Overall, the database now includes over 6300 levels with nuclear electromagnetic moments and charge radii. Elementary particle data are also available, adopting them directly from the Particle Data Group Evaluations [4]. Each entry is accompanied by the experimental method used to deduce it. A key feature of our database is the incorporation of the NSR keyword and DOI (digital object identifier) next to each experimental entry. Thus, all the available values for every energy level are gathered in the same group, with direct hyperlinks to the original citations, see also Fig. 1.

Isotope	Mass Excess [keV]	Energy [keV]	$t_{1/2}$	Spin/Parity	μ [nm]	Q [b]	R [fm]	Ref. Std	Method	NSR keyword	doi	Comment
^{19}Ne	1752.05 ± 0.16	0.	17.22 s	$1/2^+$	-1.8846(8)			[^{21}Ne]	CFBLS	2005GE06	10.1103/PhysRevC.71.064319	

Figure 1. *A typical example of information regarding a random isotope*

DATABASE ARCHITECTURE

The main user interface of the database comprises of a search form (Fig. 2):

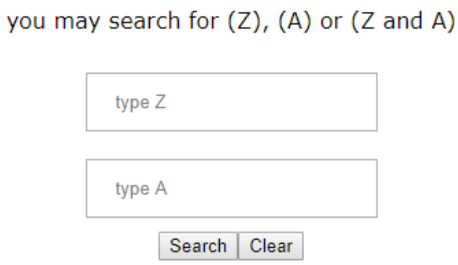

Figure 2. *The main user interface*

By selecting an isotope based on its atomic number, all the available data for each of the known energy levels will be displayed.

< Bromine (Z=35) >

wikipedia | X-rays | Atomic Data | History of Br

^{72}Br ^{73}Br ^{74}Br ^{75}Br ^{76}Br ^{77}Br ^{78}Br ^{79}Br ^{80}Br ^{81}Br ^{82}Br ^{84}Br

Isotope	Mass Excess [keV]	Energy [keV]	$t_{1/2}$	Spin/Parity	μ [nm]	Q [b]	R [fm]	Ref. Std	Method	NSR keyword	doi	Comment
^{79}Br	-76068.1 ± 1.3	0.	stable	3/2$^-$	+2.106400(4)			[^{2}H]	NMR	1972BL07		
						+0.313(3) R		[calc efg]	R	2008PY02 2001BI17	10.1080/00268970802018367 10.1103/PhysRevA.64.052507	
						0.318(5)			R	2004AL08	10.1103/PhysRevB.69.125101	
						+0.305(5) st			AB , R	2000HA64	10.1103/PhysRevB.61.13588	
						+0.331(4) st			AB , R	1998SE09	10.1103/PhysRevLett.80.5289	
							4.1629(21)			2013AN02	10.1016/j.adt.2011.12.006	
		217.	47 ps	5/2$^-$	1.0(3)				TF	1994SP05	10.1016/0375-9474(94)90981-4	
		523.	1.91 ps	5/2$^-$	2.8(8)				TF	1994SP05	10.1016/0375-9474(94)90981-4	
		761.	1.50 ps	7/2$^-$	1.9(3)				TF	1994SP05	10.1016/0375-9474(94)90981-4	

Figure 3 *Data for a specified atomic number*

Searching based on the mass number will display information for a group of isobars.

< Iodine (Z=53) >

wikipedia | X-rays | Atomic Data | History of I

^{117}I ^{118}I ^{119}I ^{120}I ^{121}I ^{122}I ^{123}I ^{124}I ^{125}I ^{126}I ^{127}I ^{128}I ^{129}I ^{130}I ^{131}I ^{132}I ^{133}I ^{135}I

Isotope	Mass Excess [keV]	Energy [keV]	$t_{1/2}$	Spin/Parity	μ [nm]	Q [b]	R [fm]	Ref. Std	Method	NSR keyword	doi	Comment
^{122}I	-86080 ± 5	0.	3.63 m	1$^+$	0.94(3)			[^{131,132}I]	NO/S	1986GR06	10.1016/0370-2693(86)90229-7	
					+ve sign				NO/S	1988AS06	10.1007/BF02398330	

< Xenon (Z=54) >

wikipedia | X-rays | Atomic Data | History of Xe

^{116}Xe ^{117}Xe ^{118}Xe ^{119}Xe ^{120}Xe ^{121}Xe ^{122}Xe ^{123}Xe ^{124}Xe ^{125}Xe ^{126}Xe ^{127}Xe ^{128}Xe ^{129}Xe ^{130}Xe ^{131}Xe ^{132}Xe ^{133}Xe ^{134}Xe ^{135}Xe ^{136}Xe ^{137}Xe ^{138}Xe ^{139}Xe ^{140}Xe ^{141}Xe ^{142}Xe ^{143}Xe ^{144}Xe ^{146}Xe

Isotope	Mass Excess [keV]	Energy [keV]	$t_{1/2}$	Spin/Parity	μ [nm]	Q [b]	R [fm]	Ref. Std	Method	NSR keyword	doi	Comment
^{122}Xe	-85355 ± 11	0.	20.1 h	0$^+$			4.759(59)			2013AN02	10.1016/j.adt.2011.12.006	

< Caesium (Z=55) >

wikipedia | X-rays | Atomic Data | History of Cs

^{118}Cs ^{119}Cs ^{120}Cs ^{121}Cs ^{122}Cs ^{123}Cs ^{124}Cs ^{125}Cs ^{126}Cs ^{127}Cs ^{128}Cs ^{129}Cs ^{130}Cs ^{131}Cs ^{132}Cs ^{133}Cs ^{134}Cs ^{135}Cs ^{136}Cs ^{137}Cs ^{138}Cs ^{139}Cs ^{140}Cs ^{141}Cs ^{142}Cs ^{143}Cs ^{144}Cs ^{145}Cs ^{146}Cs

Isotope	Mass Excess [keV]	Energy [keV]	$t_{1/2}$	Spin/Parity	μ [nm]	Q [b]	R [fm]	Ref. Std	Method	NSR keyword	doi	Comment
^{122}Cs	-78140 ± 30	0.	21.18 s	1$^+$	-0.1333(9)			[^{133}Cs]	ABLS	1981TH06	10.1016/0375-9474(81)90274-8	
					0.133(2)			[^{133}Cs]	AB	1977EK02	10.1103/0375-9474(77)90363-3	
						-0.179(10) R		[^{133}Cs]		2013STZZ		
						-0.190(10) st		[^{133}Cs]	ABLS	1981TH06	10.1016/0375-9474(81)90274-8	
							4.7773(70)			2013AN02	10.1016/j.adt.2011.12.006	
		140	3.7 m	8(-)	+5.41(3)			[^{133}Cs]	ABLS	1981TH06	10.1016/0375-9474(81)90274-8	
						+3.09(8) R		[^{133}Cs]		2013STZZ		
						+3.29(8) st		[^{133}Cs]	ABLS	1981TH06	10.1016/0375-9474(81)90274-8	

Figure 4. *Data for a group of isobars with the same mass number*

Alternatively, the user can select to use either the periodic table or the Z helix, which provide access to the same results.

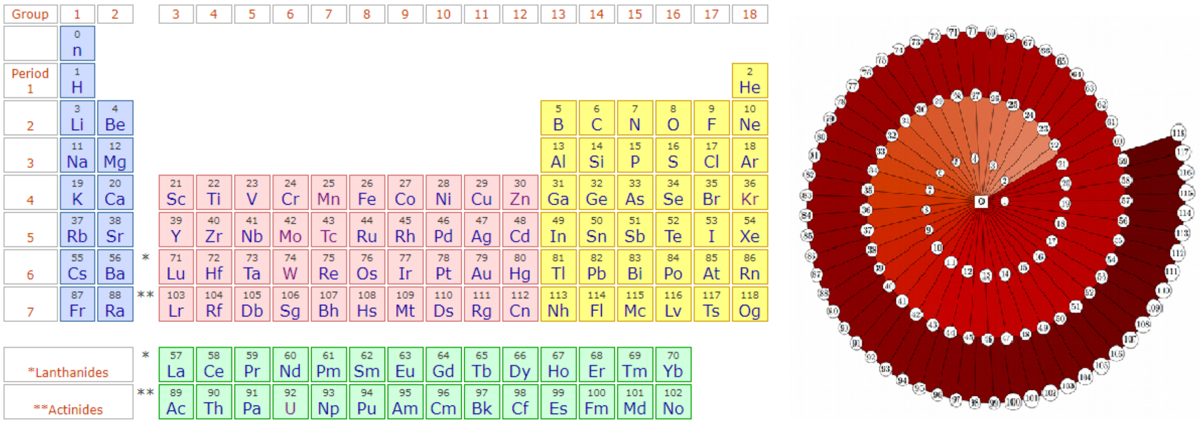

Figure 5 *The periodic table (left) and the Z-helix (right)*

The database is accompanied by a blog, in which the user can view updates and recommended citations, alongside with a help option including information for the experimental deduction methods, how to use the database and annotations. The option to directly sumbit new or re-evaluated data is, additionally, available.

CONCLUSIONS AND FUTURE WORK

Collectively, the current upgrade offers the most up-to-date experimentally deduced data. Future work will focus on more systematic updates concerning the mentioned databases, as well as syncing data with older tabulations, such as those by Fuller [5] and Raghavan [6], which have been left out of recent evaluations, generating some discussion among experts. An effort will be placed on providing plotting capabilities of systematics, as well as, on the design of an easy–to–use mobile app.

References

[1] The NUMOR magnetic moments database, URL: http://magneticmoments.info
[2] The Evaluated Nuclear Structure Data Files (ENSDF), URL: https://www.nndc.bnl.gov/ensdf/
[3] Nuclear Science References (NSR), URL: https://www-nds.iaea.org/nsr/
[4] M. Tanabashi et al. Phys. Rev. D 98, 030001 (2018)
[5] G.H. Fuller, J. Phys. Chem. Ref. Data, 5, 835 (1976)
[6] P. Raghavan, At. Data, Nucl. Data Tables 42, 189 (1989)
[7] T.J. Mertzimekis et al. NIM A 807, 56 (2016)
[8] J.F. Ziegler et al., Nucl. Inst. Meth. Phys. Res. B **268**, 1818 (2010)