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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 (δ <r²>) 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):

you may search for (Z), (A) or (Z and A)

type	Z		
type	A		
	Search	Clear	

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 Atom	ic Data His	tory of Br				
				⁷² Br ⁷³ E	r ⁷⁴ Br ⁷⁵	Br ⁷⁶ Br	⁷⁷ Br ⁷⁸ Br	r ⁷⁹ Br	⁸⁰ Br	⁸¹ Br		
				⁸² Br ⁸⁴ E	r							
					1					C	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
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	10.1080/00268970802018367	
										2001BI17	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	e (Z=53)	>						
						wikip	edia X	(-rays A	Atomic Data	a Histo	ry 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	132I	¹³³ I	¹³⁵ I					
Isotope	Mass Excess	[keV] Ene	ergy [keV]	t _{1/2}	Spin	Parity	μ [nm]	Q [b]	R [fm]	Ref. Std	Method	NSR	keyword	doi	Com	ment
122 _I	-86080 ±	5	0.	3.63 m	n :	+	0.94(3)		[^{131,132} I]	NO/S	198	6GR06	10.1016/0370-2693(86)902	29-7	
							+ve sign				NO/S	198	8AS06	10.1007/BF02398330		
							<	< Xenor	n (Z=54)	>						
						wikipe	dia X-	rays At	tomic Data	Histor	y of Xe					
				¹¹⁶ Xe	¹¹⁷ Xe	¹¹⁸ Xe	¹¹⁹ Xe		¹²¹ Xe	¹²² Xe	¹²³ Xe	¹²⁴ Xe	¹²⁵ Xe			
				¹²⁶ Xe	¹²⁷ Xe	¹²⁸ Xe	¹²⁹ Xe	130Xe	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			
Isoto	•		57 -	,			μ [nm]] Q[b]	R [fm]		Std Meth		R keyword		Comme	ent
Isoto 122	•		Energy [ke	v] t_{1/} 20.1		n/Parity 0 ⁺			4.759(59)	itd Meth		R keyword 013AN02	doi 10.1016/j.adt.2011.12.00		ent
	•		57 -	,		0+	<	Caesiu	4.759(59 m (Z=55) >						ent
	•		57 -	20.1	Lh	0 ⁺ wikipe	<	Caesiu rays At	4.759(59 m (Z=55 tomic Data)) > Histor	y of Cs	2	013AN02			ent
	•		57 -	20.1	119Cs	0 ⁺ wikipe	 dia X- ¹²¹Cs 	Caesiu rays At	4.759(59 m (Z=55 tomic Data) > Histor ¹²⁴ Cs	y of Cs	2 ¹²⁶ Cs	013AN02			ent
	•		57 -	20.1	119Cs	0+ wikipe 120Cs 130Cs	<pre>dia X- 121Cs 131Cs</pre>	Caesiu rays At 122Cs 132Cs	4.759(59 m (Z=55 tomic Data ¹²³ Cs ¹³³ Cs) > Histor ¹²⁴ Cs ¹³⁴ Cs	y of Cs 125Cs 135Cs	2 126Cs 136Cs	013AN02			ent
	•		57 -	20.1	119Cs	0+ wikipe 120Cs 130Cs	<pre></pre>	Caesiu rays At 122Cs 132Cs	4.759(59 m (Z=55 tomic Data ¹²³ Cs ¹³³ Cs) > Histor ¹²⁴ Cs	y of Cs	2 ¹²⁶ Cs	013AN02			ent
1225	•		0.	20.1	119Cs	0+ wikipe 120Cs 130Cs 140Cs	 4 iai X- 121Cs 131Cs 141Cs 	Caesiu rays At 122Cs 132Cs	4.759(59 m (Z=55 tomic Data ¹²³ Cs ¹³³ Cs) > Histor ¹²⁴ Cs ¹³⁴ Cs ¹⁴⁴ Cs	y of Cs 125Cs 135Cs 145Cs	2 126Cs 136Cs	013AN02	10.1016/j.adt.2011.12.00		ent
122y	(e -85355	± 11	0.	20.1 ¹¹⁸ Cs ¹²⁸ Cs ¹³⁸ Cs 2 Spin	L h ¹¹⁹ Cs ¹²⁹ Cs ¹³⁹ Cs	0+ wikipe 120Cs 130Cs 140Cs	<pre></pre>	Caesiu rays At 122Cs 132Cs 142Cs	4.759(59 m (Z=55 tomic Data 1 ²³ Cs 1 ³³ Cs 1 ⁴³ Cs	 Histor Histor 124Cs 134Cs 144Cs Rem 	y of Cs 125Cs 135Cs 145Cs ef. Std	2 126Cs 136Cs 146Cs	013AN02	10.1016/j.adt.2011.12.00	16	Comme
122y	s Excess [keV]	± 11 Energy [k	0. keV] t _{1/}	20.1 ¹¹⁸ Cs ¹²⁸ Cs ¹³⁸ Cs 2 Spin	119Cs 129Cs 139Cs	0 ⁺ wikipe 120Cs 130Cs 140Cs	<pre></pre> <dia pre="" x-<=""> 121Cs 131Cs 141Cs m] 3(9)</dia>	Caesiu rays At 122Cs 132Cs 142Cs	4.759(59 m (Z=55 tomic Data 1 ²³ Cs 1 ³³ Cs 1 ⁴³ Cs) > Histor ¹²⁴ Cs ¹³⁴ Cs ¹⁴⁴ Cs m] R (y of Cs 125Cs 135Cs 145Cs ef. Std	2 126Cs 136Cs 146Cs Method	013AN02	vord doi 06 10.1016/j.adt.2011.12.00	96 31)90274-8	Comme
122y	s Excess [keV]	± 11 Energy [k	0. keV] t _{1/}	20.1 ¹¹⁸ Cs ¹²⁸ Cs ¹³⁸ Cs 2 Spin	119Cs 129Cs 139Cs	0 ⁺ wikipe 120Cs 130Cs 140Cs μ [mi -0.133	 i¹²¹Cs i¹³¹Cs i¹⁴¹Cs m] 3(9) (2) 	Caesiu rays At 122Cs 132Cs 142Cs	4.759(59 m (Z=55 tomic Data 123Cs 133Cs 143Cs R [fi) > Histor ¹²⁴ Cs ¹³⁴ Cs ¹⁴⁴ Cs [¹ [¹ [¹	y of Cs 125Cs 135Cs 145Cs ef. Std 133Cs]	2 126Cs 136Cs 146Cs ABLS	013AN02 127Cs 137Cs NSR keyw 1981TH	i0.1016/j.adt.2011.12.00 word doi 06 10.1016/0375-9474(8 02 10.1103/0375-9474(7	96 31)90274-8	Comme
122y	s Excess [keV]	± 11 Energy [k	0. keV] t _{1/}	20.1 ¹¹⁸ Cs ¹²⁸ Cs ¹³⁸ Cs 2 Spin	119Cs 129Cs 139Cs	0 ⁺ wikipe 120Cs 130Cs 140Cs μ [mi -0.133	 idia X- 121Cs 131Cs 141Cs 141Cs (2) -0 	Caesiu rays At 122Cs 132Cs 142Cs Q [b]	4.759(59 m (Z=55 tomic Data 123Cs 133Cs 143Cs R [fi) > Histor ¹²⁴ Cs ¹³⁴ Cs ¹⁴⁴ Cs [1 [1 [1] [1]	y of Cs ¹²⁵ Cs ¹³⁵ Cs ¹⁴⁵ Cs ¹⁴⁵ Cs ¹⁴⁵ Cs ¹⁴⁵ Cs ¹³³ Cs] ¹³³ Cs] ¹³³ Cs]	2 126Cs 136Cs 146Cs ABLS	013AN02 127Cs 137Cs NSR keyw 1981TH 1977EK	doi doi 06 10.1016/0375-9474(8 02 10.1103/0375-9474(7 7Z 72	96 31)90274-8 77)90363-3	Comme
122y	s Excess [keV]	± 11 Energy [k	0. keV] t _{1/}	20.1 ¹¹⁸ Cs ¹²⁸ Cs ¹³⁸ Cs 2 Spin	119Cs 129Cs 139Cs	0 ⁺ wikipe 120Cs 130Cs 140Cs μ [mi -0.133	 idia X- 121Cs 131Cs 141Cs 141Cs (2) -0 	Caesiu rays At 122Cs 112Cs 112Cs 1142Cs Q [b] .179(10)	4.759(59 m (Z=55 tomic Data 123Cs 133Cs 143Cs R [fi) > Histor ¹²⁴ Cs ¹³⁴ Cs ¹⁴⁴ Cs m] Re [¹ [¹ [¹ [¹	y of Cs 125Cs 135Cs 145Cs ef. Std N 133Cs] 133Cs] 133Cs]	2 126Cs 136Cs 146Cs Method ABLS AB	013AN02 127Cs 137Cs NSR keyw 1981TH 1977EK 2013ST.	vord doi 10.1016/j.adt.2011.12.00 vord 10.1016/0375-9474(8 10.1103/0375-9474(7 ZZ 06 10.1016/0375-9474(8	31)90274-8 31)90274-8 31)90274-8	Comme
122y	s Excess [keV]	± 11 Energy [k	0. keV] t _{1/}	20.1 118Cs 128Cs 138Cs 2 Spin 8 S	119Cs 129Cs 139Cs	0 ⁺ wikipe 120Cs 130Cs 140Cs μ [mi -0.133	<pre></pre> <pre><</pre>	Caesiu rays At 122Cs 112Cs 112Cs 1142Cs Q [b] .179(10)	4.759(59 m (Z=55 tomic Data 123Cs 133Cs 143Cs R [fr R st) > Histor ¹²⁴ Cs ¹³⁴ Cs ¹⁴⁴ Cs [1 [1 [1 [1 [1 [2 [1 [1 [1 [1 [1 [1 [1 [1] [1]	y of Cs 125Cs 135Cs 145Cs ef. Std N 133Cs] 133Cs] 133Cs] 133Cs] 133Cs]	2 126Cs 136Cs 146Cs Method ABLS AB	013AN02 127Cs 137Cs NSR keyv 1981TH 1977EK 2013ST. 1981TH	Io.1016/j.adt.2011.12.00 vord doi 06 10.1016/0375-9474(8 02 10.1103/0375-9474(7 2Z 06 10.1016/0375-9474(8 02 10.1016/0375-9474(8	81)90274-8 77)90363-3 81)90274-8 1.12.006	Comm
122y	s Excess [keV]	± 11 Energy [k 0.	0. keV] t _{1/} 21.14	20.1 118Cs 128Cs 138Cs 2 Spin 8 S	119Cs 129Cs 139Cs n/Parity 1+	0 ⁺ wikipe 120Cs 130Cs 140Cs 140Cs 0.133 0.133	<pre></pre> <pre><</pre>	Caesiu rays At 122Cs 112Cs 112Cs 1142Cs Q [b] .179(10)	4.759(59) m (Z=55) tomic Data 123Cs 133Cs 143Cs R [fr R st 4.7773)) >) + Histor 124Cs 134Cs 144Cs [1 [1 [1 [1 [3 (70) [1]	y of Cs ¹²⁵ Cs ¹³⁵ Cs ¹⁴⁵ Cs ¹⁴⁵ Cs ¹³³ Cs] ¹³³ Cs] ¹³³ Cs] ¹³³ Cs] ¹³³ Cs]	2 126Cs 136Cs 146Cs 4ethod ABLS AB	013AN02 127CS 137CS NSR keyw 1981TH 1977EK 2013ST. 1981TH 2013AN	vord doi 06 10.1016/j.adt.2011.12.00 06 10.1016/0375-9474(8 02 10.1103/0375-9474(7 7Z 06 06 10.1016/0375-9474(8 02 10.1016/0375-9474(8 02 10.1016/0375-9474(8 02 10.1016/0375-9474(8 02 10.1016/0375-9474(8	81)90274-8 77)90363-3 81)90274-8 1.12.006	Comm

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.

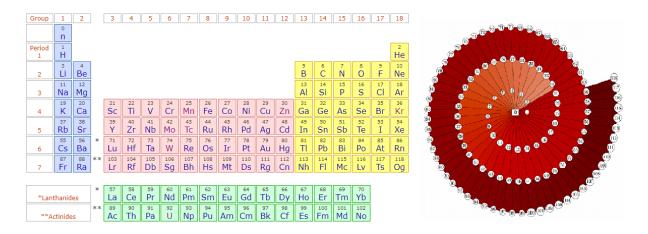


Figure 5 The periodic table (left) and the Z-helix (right)

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.

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