Statistical analysis of stable and long-lived isotopes using deuteron cluster
Isayev R.
Статистический анализ стабильных и долгоживущих изотопов с использованием дейтронного кластера
Исаев Р. Ш.

Исаев Рафаэль Шахбаз оглу / Isayev Rafael – бакалавр,
кафедра общей и неорганической химии, химический факультет,
Бакинский государственный университет, г. Баку, Азербайджанская Республика

Abstract: *this research represents the statistical analysis of stable and long-lived isotopes of chemical elements where the atomic nucleus appears as a model of the deuteron clusters and a definite numbers of neutrons, binding these clusters in a unified structure. This clustering shows a certain periodicity in the structure of atomic nuclei and provides a possible physical explanation of radioactivity. Based on this periodicity, it is possible to show a stability island for super-heavy elements.*

Аннотация: *данное исследование выступает как статистический анализ стабильных и долгоживущих изотопов химических элементов, в которых атомное ядро выступает как модель из дейтронных кластеров и определенного количества нейтронов, связывающих эти кластеры в единую структуру. Такая кластеризация показывает определенную периодичность в строении атомных ядер и дает возможное физическое объяснение радиоактивности. На основе этой периодичности возможно показать остров стабильности для сверхтяжелых элементов.*

Keywords: *periodicity, hydrogen model, deuteron cluster, neutron.*
Ключевые слова: *периодичность, водородная модель, дейтронный кластер, нейтрон.*

DOI: 10.20861/2304-2338-2016-52-002

1. Introduction

This study serves as a statistical analysis of stable and long-lived isotopes in which the nucleus is represented as a system of deuterium nuclei and a certain number of neutrons that bind deuterons into a single structure. In this case we call such system a conditional Hydrogen model of atomic nucleus. The specialty of this model is that the hydrogen is considered as a primary matter and atoms of other elements are formed from it by nucleosynthesis. In the Hydrogen model the atomic mass of hydrogen was taken as 2 which corresponds to the mass of its isotope deuterium. Use of deuterons as clusters interconnected by neutrons in Hydrogen model reveals definite periodicity in structural nucleus.

Russian scientist D. Mendeleev in his final article «Periodic legality of chemical elements» gave the following definition of Periodicity law: «The properties of simple bodies, and also shapes and features of element compounds, and as a result, features of simple and complex bodies formed by them are in periodic relevance of their atomic masses» [2].

Atomic number which is, according to Holland physicist A. Van den Broek in 1911 [3] with the value of positive charge of atomic nucleus has become a basis for chemical elements classification. In 1920 English physicist J. Chadwick experimentally confirmed the hypothesis of A. Van den Broek [4]; thereby the meaning of serial number of element in Periodical table was revealed. Periodical law then acquired its modern formulation: «The properties of simple substances and also shapes and properties of elements compounds are in periodical dependence on atomic nucleus charge of elements» [5]. The basis for classification in Hydrogen model are deuteron clusters quantitatively equal to nucleus charge which in its turn reflects the relations with Periodical law.

The difference of Periodical law from other fundamental laws is that it does not have mathematical equation. Periodical law describes periodicity in composition and properties of chemical elements, which is demonstrated in statistical analysis of stable and long-lived isotopes.

2. Analysis

To calculate and describe hydrogen structure of nucleus mathematical expression was used:

$$\mathbf{y = 2x \pm z} \qquad (1.0)$$

Where **y** - atomic mass, **x** - the number of deuteron clusters which is equal to the nuclear charge, **z** – neutron remnant.

The expression (2.0) and (2.1) exposes the physical meaning of equation (1.0).

$$^{2}_{1}\mathrm{H} = {}^{1}_{1}\mathrm{p} + {}^{1}_{0}\mathrm{n} \qquad (2.0)$$

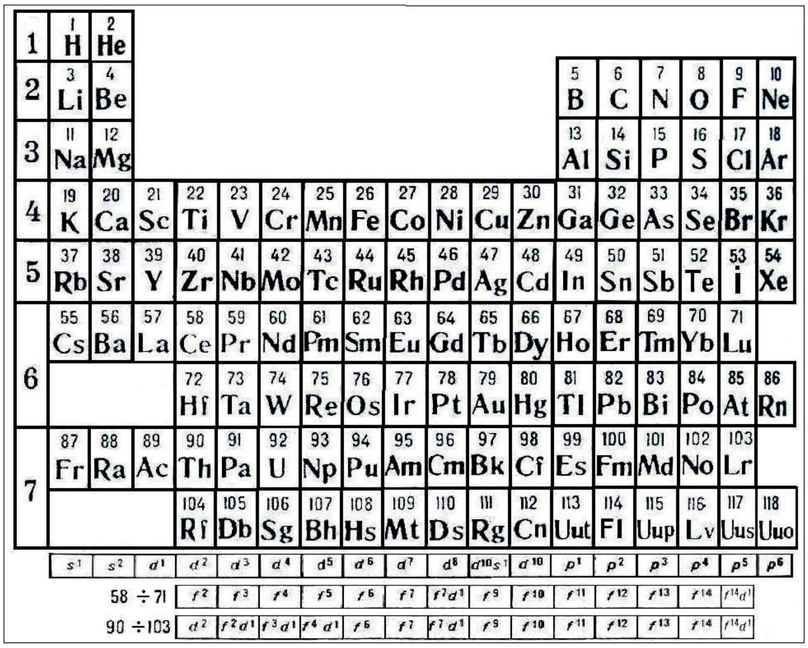
Put «D» in (2.0) instead of $_1^2$H for the convenience of writing.

$$\mathbf{A} = \mathrm{D} \pm {}^{1}_{0}\mathrm{n} \qquad (2.1)$$

Where A-atomic mass, D- deuteron, $_0^1$n-neutron

Example: Oxygen atom possesses three stable isotopes with atomic masses 16, 17 and 18. Nucleus charge of oxygen is equal to 8. Using the equation (1.0) we will get the following configurations for stable nucleus of oxygen accordingly: 8D, 8D+1n and 8D+2n.

I used the above calculations **for stable isotopes from beginning to 82nd element. After the lead the most long-lived isotopes** of the elements were taken [1] and added the results to Table 1.



1	1 H	2 He																
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu	
				72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	
				104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Fl	115 Uup	116 Lv	117 Uus	118 Uuo
	s^1	s^2	d^1	d^2	d^3	d^4	d^5	d^6	d^7	d^8	$d^{10}s^1$	d^{10}	p^1	p^2	p^3	p^4	p^5	p^6
			58 ÷ 71	f^2	f^3	f^4	f^5	f^6	f^7	f^7d^1	f^9	f^{10}	f^{11}	f^{12}	f^{13}	f^{14}	$f^{14}d^1$	
			90 ÷ 103	d^2	f^2d^1	f^3d^1	f^4d^1	f^6	f^7	f^7d^1	f^9	f^{10}	f^{11}	f^{12}	f^{13}	f^{14}	$f^{14}d^1$	

Fig. 1. Chemical elements in the table are located in accordance with their electronic configurations. In order to avoid order violation Lanthanides and Actinides were not excluded from Mendeleev's periodic table

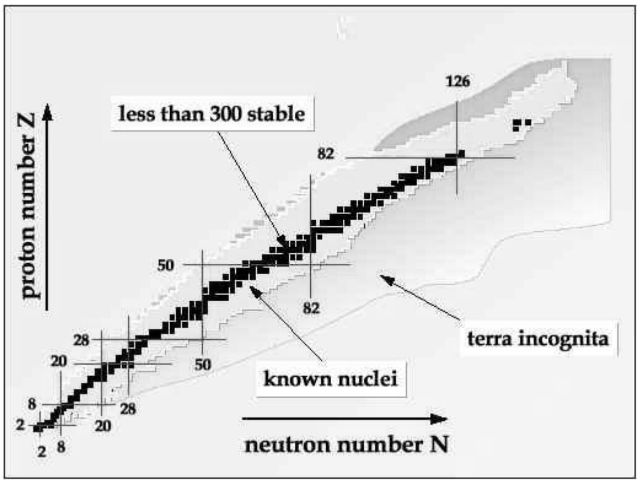


Fig. 2. The chart of nuclides showing the landscape of all the atomic nuclei. The black dots represent nuclei stable against beta-decay and the extreme boundaries the proton and neutron drip-lines. There are around 300 stable nuclei and a total of about 6000 nuclei [1]

Table 1. Deuteron-cluster structure of even isotopes

1	p 1D H								
2	3D 3D+1n Li						5D 5D+1n B	7D 7D+1n N	9D+1n F
3	11D+1n Na						13D+1n Al	15D+1n P	17D+1n 17D+3n Cl
4	19D+1n 19D+3n K	21D+3n Sc	23D+5n V	25D+5n Mn	27D+5n Co	29D+5n 29D+7n Cu	31D+7n 31D+9n Ga	33D+9n As	35D+9n 35D+11n Br
5	37D+11n Rb	39D+11n Y	41D+11n Nb	43D+11n 43D+12n 43D+13n Tc	45D+13n Rh	47D+13n 47D+15n Ag	49D+15n 49D+17n In	51D+19n 51D+21n Sb	53D+21 I

6	55D+23n Cs	57D+25n La	59D+23n Pr	61D+23n 61D+24n 61D+25n Pm	63D+25n 63D+27n Eu	65D+29n Tb	67D+31n Ho	69D+31n Tm	71D+33n Lu
			73D+35n Ta	75D+35n 75D+37n Re	77D+37n 77D+39n Ir	79D+39n Au	81D+41n 81D+43n Tl	83D+43n Bi	85D+39n 85D+40n 85D+41n At
7	87D+49n Fr	89D+49n Ac	91D+49n Pa	93D+51n Np	95D+51n 95D+53n Am	97D+53n Bk	99D+54n Es	101D+56n Md	103D+56n Lr

Continuation of Table 1. Deuteron-cluster structure of even isotopes

1	D+p 2D He								
2	4D+1n Be						6D 6D+1n C	8D 8D+1n 8D+2n O	10D 10D+1n 10D+2n Ne
3	12D 12D+1 12D+2 Mg						14D 14D+1n 14D+2n Si	16D 16D+1n 16D+2n 16D+4n S	18D 18D+1n 18D+2n 18D+4n Ar
4	20D 20D+1n 20D+2n 20D+3n 20D+4n 20D+6n 20D+8n Ca	22D+2n 22D+3n 22D+4n 22D+5n 22D+6n Ti	24D+2n 24D+4n 24D+5n 24D+6n Cr	26D+2n 26D+4n 26D+5n 26D+6n Fe	28D+2n 28D+4n 28D+5n 28D+6n 28D+8n Ni	30D+4n 30D+6n 30D+7n 30D+8n 30D+10n Zn	32D+6n 32D+8n 32D+9n 32D+10n 32D+12n Ge	34D+6n 34D+8n 34D+9n 34D+10n 34D+12n 34D+14n Se	36D+6n 36D+8n 36D+10n 36D+11n 36D+12n 36D+14n Kr
5	38D+8n 38D+10n 38D+11n 38D+12n Sr	40D+10n 40D+11n 40D+12n 40D+14n 40D+16n Zr	42D+8n 42D+10n 42D+11n 42D+12n 42D+13n 42D+14n 42D+16n Mo	44D+8n 44D+10n 44D+11n 44D+12n 44D+13n 44D+14n 44D+16n Ru	46D+10n 46D+12n 46D+13n 46D+14n 46D+16n 46D+18n Pd	48D+10n 48D+12n 48D+14n 48D+15n 48D+16n 48D+17n 48D+18n 48D+19n 48D+20n Cd	50D+12n 50D+14n 50D+15n 50D+16n 50D+17n 50D+18n 50D+19n 50D+20n 50D+22n 50D+24n Sn	52D+16n 52D+18n 52D+19n 52D+20n 52D+21n 52D+22n 52D+24n 52D+26n Te	54D+16n 54D+18n 54D+20n 54D+21n 54D+22n 54D+23n 54D+24n 54D+26n 54D+28n Xe
6	56D+18n 56D+20n 56D+22n 56D+23n 56D+24n 56D+25n 56D+26n Ba	58D+20n 58D+22n 58D+24n 58D+26n Ce	60D+22n 60D+23n 60D+24n 60D+25n 60D+26n 60D+28n 60D+30n Nd	62D+20n 62D+22n 62D+23n 62D+24n 62D+25n 62D+26n 62D+28n 62D+30n Sm	64D+24n 64D+26n 64D+27n 64D+28n 64D+29n 64D+30n 64D+32n Gd	66D+24n 66D+26n 66D+28n 66D+29n 66D+30n 66D+31n 66D+32n Dy	68D+26n 68D+28n 68D+30n 68D+31n 68D+32n 68D+34n Er	70D+28n 70D+30n 70D+31n 70D+32n 70D+33n 70D+34n 70D+36n Yb	
		72D+30n 72D+32n 72D+33n 72D+34n 72D+35n 72D+36n Hf	74D+32n 74D+34n 74D+35n 74D+36n 74D+38n W	76D+32n 76D+34n 76D+35n 76D+36n 76D+37n 76D+38n 76D+40n Os	78D+34n 78D+36n 78D+38n 78D+39n 78D+40n 78D+42n Pt	80D+36n 80D+38n 80D+39n 80D+40n 80D+41n 80D+42n 80D+44n Hg	82D+40n 82D+42n 82D+43n 82D+44n Pb	84D+36n 84D+37n 84D+38n 84D+39n 84D+40n 84D+41n 84D+42n Po	86D+38n 86D+39n 86D+50n 86D+51n 86D+52n Rn
7	88D+47n 88D+48n 88D+49n 88D+50n 88D+52n Ra	90D+48n 90D+49n 90D+50n 90D+52n Th	92D+48n 92D+49n 92D+50n 92D+51n 92D+52n 92D+54n U	94D+48n 94D+50n 94D+51n 94D+52n 94D+53n 94D+54n 94D+56n Pu	96D+50n 96D+51n 96D+52n 96D+53n 96D+54n 96D+55n 96D+56n 96D+58n Cm	98D+53n 98D+54n 98D+55n 98D+56n Cf	100D+57n Fm	102D+55n No	

Note*: Chemical elements in the Table 1 are located in accordance with their electronic configurations. In order to avoid order violation Lanthanides and Actinides were not excluded from Mendeleev's periodic table as it is shown in Figure1.*

Analysis of *Table 1* shows that periodicity occurs in the nucleus structures at a transition from period to period as well as in the period itself.

- At a transition from the first to the second period a number of neutrons bonding deuteron clusters increases for 1-2 units;
- At a transition from the second to the third period a number of neutrons bonding deuteron clusters increases for 1-4 units;
- At a transition from the third to the forth a number of neutrons bonding deuteron clusters increases for 2-8 units;
- At a transition from the fourth to the fifth a number of neutrons bonding deuteron clusters increases for 8-10 units;
- At a transition from the fifth to the sixth and sixth to seventh a number of neutrons bonding deuteron clusters increases for 12-14 units.

Based on this periodicity in nuclear structures in Table 1 shows the stability range for the elements with a nuclear charge 104-118, by adding 12-14 neutrons, binding clusters, to items of the first row of the seventh period.

According to Nuclear Shell model the element Flerovium has the magic number of protons Z = 114 which corresponds to the filled proton nuclear envelope and is, hereby, at the stability island zone. Number of neutrons for ^{298}Fl isotope is also magic number N = 184 and this theoretically must lead to the organization of stable double-magic nucleus [6] [7]. As it is seen from Table 8, hydrogen model of nucleus also shows that ^{298}Fl isotope with nucleus structure 114D+70n will be in the area of stability of Flerovium element. Thus, the Nuclear shell model gives mathematical confirmation Hydrogen model .If this data is confirmed experimentally, we can make a suggestion that elements of eighth period of Mendeleev table will differ from elements of seventh period by 16-18 bonding neutrons. This means that increasing a number of deuterons the one will need an increased number of neutrons for retention of nucleus stability.

Considering the information about isotopes of elements one can see a clear pattern related to a number of neutrons and deuterons in a nucleus. This is an argument for an idea of neutrons bonding deuteron clusters in a unified structure. If the nucleus is neutron-deficient it will be subjected to positron decay or other types of decay which increase the number of neutrons towards deuteron clusters inside the nucleus. If the nucleus is neutron excess it is subjected to beta-decay or other decay types which decrease number of neutrons towards deuteron. This can serve as a physical explanation of radioactive decay.

Example: To demonstrate the above mentioned statement we will review the Tables 2-5 where hydrogen structures and isotopes bonding energies for nitrogen, oxygen, fluorine and neon are given [1].

Table 2. Azote

Z	**A**	**Structure**	**Decay**	**Binding Energy MeV[1]**
7	10	**7D-4n**	p	3,64366
7	11	**7D-3n**	p	5,36405
7	12	**7D-2n**	β+	6,17011
7	13	**7D-1n**	β+	7,23886
7	14	**7D**	Stabile	7,47561
7	15	**7D+1n**	Stabile	**7,69946**
7	16	**7D+2n**	β-	7,37381
7	17	**7D+3n**	β-	7,28615
7	18	**7D+4n**	β-	7,03849
7	19	**7D+5n**	β-	6,94824
7	20	**7D+6n**	β-	6,70924
7	21	**7D+7n**	β-	6,60810
7	22	**7D+8n**	β-	6,36609
7	23	**7D+9n**	β-	6,16400
7	24	**7D+10n**	n	5,86200

Table 3. Oxigene

Z	**A**	**Structure**	**Decay**	**Binding Energy MeV[1]**
8	12	**8D-4n**	p	4,87909
8	13	**8D-3n**	β+	5,81199
8	14	**8D-2n**	β+	7,05231
8	15	**8D-1n**	β+	7,46369
8	16	**8D**	Stabile	**7,97621**
8	17	**8D+1n**	Stabile	7,75073
8	18	**8D+2n**	Stabile	7,76703
8	19	**8D+3n**	β-	7,56639
8	20	**8D+4n**	β-	7,56851
8	21	**8D+5n**	β-	7,38933
8	22	**8D+6n**	β-	7,36482
8	23	**8D+7n**	β-	7,16385

8	24	**8D+8n**	β-	7,01594

Table 4. Fluorine

Z	A	Structure	Decay	Binding Energy MeV[1]
9	15	**9D-3n**	p	6,48355
9	16	**9D-2n**	p	6,96373
9	17	**9D-1n**	β+	7,54233
9	18	**9D**	β+	7,63161
9	19	**9D+1n**	Stabile	**7,77902**
9	20	**9D+2n**	β-	7,72013
9	21	**9D+3n**	β-	7,73829
9	22	**9D+4n**	β-	7,62429
9	23	**9D+5n**	β-	7,62041
9	24	**9D+6n**	β-	7,46296
9	25	**9D+7n**	β-	7,33876
9	26	**9D+8n**	β-	7,09774
9	27	**9D+9n**	β-	6,88732
9	28	**9D+10n**	β-	6,63300
9	29	**9D+11n**	β-	6,43900

Table 5. Neon

Z	A	Structure	Decay	Binding Energy MeV[1]
10	15	**10D-5n**	p-p	6,08257
10	16	**10D-4n**	p	6,64283
10	17	**10D-3n**	β+	7,34128
10	18	**10D-2n**	β+	7,34128
10	19	**10D-1n**	β+	7,56738
10	20	**10D**	Stabile	8,03224
10	21	**10D+1n**	Stabile	7,97171
10	22	**10D+2n**	Stabile	**8,08047**
10	23	**10D+3n**	β-	7,95526
10	24	**10D+4n**	β-	7,99332
10	25	**10D+5n**	β-	7,84270
10	26	**10D+6n**	β-	7,75389
10	27	**10D+7n**	β-	7,51971
10	28	**10D+8n**	β-	7,39032
10	29	**10D+9n**	β-	7,17886
10	30	**10D+10n**	β-	7,04047

3. Conclusion

Based on the statistical analysis of stable and long-lived isotopes can be given to the following conclusions:

1. Using the idea of clustering deuterons showed the periodicity of the structure of atomic nuclei. This periodicity is observed in a horizontally of the periodic table of chemical elements and at the vertically transition from one period to next one but in vertical transition the number of neutrons which connect clusters increases 2-4 units.

2. It offers a possible physical explanation of radioactivity as a result of the surplus or deficit of neutrons in relation to clusters.

3. Showed isotopes of island of stability based on nuclear periodicity.

«Properties of atomic nucleus are in periodical dependence on deuteron clusters quantitatively equal to nucleus charge and number of neutrons which bond these clusters into unified structure».

All substances surrounding consist of hydrogen in one or another form.

Acknowledgements

The author would like to express his gratitude to his colleagues who have worked for the development of both experimental and theoretical ideas contained in this review.

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