

# New Theory and New Energy Levels in the Atom

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**Abstract** This article introduces a new vision by using simple mathematical process, this process created new theoretical quantized energy levels which leads to new theory. There are new ninety energy levels among the old seven energy levels in Hydrogen atom have been concluded. This new vision not only concluded and verified all previous energy levels, but also, is used to conclude and verify all known experimental ionization energy of elements in the periodic table. We introduce more acceptance explaining the completely dark lines appear in absorption line spectrum. These new energy levels can be used to explaining different physical and chemical phenomena. At last, the theoretical atomic physics will be in the front of experimental physics.

**Key words** Bohr Theory, Atomic Physics, Spectroscopy

## 1. Introduction

Niels Bohr was the first leadership of atomic physics[1], he concluded the energy levels of the Hydrogen atom's electron and gave us the first module of atomic structure[2,3]. Bohr theory couldn't explain the emission spectra of any element except Hydrogen only. So that, quantum mechanics scientists and specialists used Schrödinger equation and generated three quantum numbers addition to the principle quantum number to create new energy levels, these energy levels have been used to explain the emission and absorption spectrum of elements[4]. But all explanations about absorption line spectra up till now tells us that, the *completely dark lines*[3] because of, the electron absorbs photon with energy equals the difference between two energy levels. This is not convincing explanation because, if that is the true, then we must observe gray line(s) not completely dark line(s), because, the electron will lose its energy and back to its origin energy level by emitting photon, these emitted photons from several atoms will dispersed in all directions, it isn't acceptable we imagine the emitted photons will be in all directions except the direction of our detecting screen. There is other phenomenon, why the kinetic energy -related to the temperature- of material increases by passing electromagnetic wave through it?. Kinetic energy increasing means that, the atom absorbs energy without re-emitting, it's not acceptable to say that, the nucleus -its mass  $\geq 1836$  electron's mass- will affected by photons more than the electron. We need new energy levels to answer these questions. Our new vision depends on Bohr's

assumption, so that, there is shortly mentioned on his work and his derivation of energy levels of Hydrogen atom.

## 2. Overview

First, classical common universal equation of electron's total energy "kinetic energy and electric potential"[2,3], is given by,

$$E = \frac{1}{2} m_e v^2 - \frac{Ze^2}{4\pi\epsilon_0 r} \quad (1)$$

Where, ( $Z=1$ ) is the atomic number of Hydrogen atom, ( $v$ ) is the velocity of electron around the nucleus and ( $r$ ) is the radius of the electron's orbit.

Second, centrifugal force equals attractive Coulomb force[2,3], this equation is given by,

$$\frac{m_e v^2}{r} = \frac{Ze^2}{4\pi\epsilon_0 r^2} \quad (2)$$

At last, Bohr assumption is given by[2,3],

$$2\pi m_e v r = n h \quad (3)$$

where ( $n$ ) is a integer number. ( $n$ ) is called principle quantum number

By using equations(1,2 and 3), Bohr concluded the radius and energy of Hydrogen atom,

$$r = \frac{n^2 h^2 \epsilon_0}{m Z e^2 \pi} \quad (4)$$

$$E = \frac{-Z e^2}{8\pi\epsilon_0 r} \quad (5)$$

$$\text{or } E = \frac{m Z^2 e^4}{8 h^2 \epsilon_0^2} \cdot \frac{1}{n^2} \quad (6)$$

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where (m) is the reduced mass[2,3].

$$m = \frac{m_e \times Zm_p}{m_e + Zm_p} \quad (7)$$

### 3. New Energy Levels

These new energy levels have been concluded by using Bohr assumption with equation (1) to get the equation of electron's total energy in this form.

$$E = \frac{n^2 h^2}{8m\pi^2} \cdot \frac{1}{r^2} - \frac{Ze^2}{4\pi\epsilon_0} \cdot \frac{1}{r} \quad (8)$$

*According to Newton's first law*, the electron will stay in its stationary state unless it's affected by external force, in other words, the electron will change its radius if its energy changed. Mathematically it means the differential of energy (E) to the radius (r) in equation (8) must equal zero,

$$\frac{dE}{dr} = \left( \frac{-n^2 h^2}{4m\pi^2} \cdot \frac{1}{r^3} \right) + \left( \frac{e^2}{4\pi\epsilon_0} \cdot \frac{1}{r^2} \right) = 0 \quad (9)$$

The result of differential process in equation(9) will be the radius of electron, it's as same as Bohr radius in equation(4), consequently, this differential process gives the energy of electron by substitution in equation(5) the result will be as same as equation(6).

Can we use the mathematical differential process again? Can we get the radiuses and energy levels from the second, third, fourth .... and (n-order) -"n isn't the same term in radius and energy equations, which is called principle quantum number in quantum physics"- differential equations?.

Let us do it and test the results. The second available radius is concluded from the second differential for equation (8) will be,

$$r = \frac{3}{2} \cdot \frac{n^2 h^2 \epsilon_0}{mZe^2 \pi} \quad (10)$$

The third radius is concluded from the third differential,

$$r = 2 \cdot \frac{n^2 h^2 \epsilon_0}{mZe^2 \pi} \quad (11)$$

every new radius gives us new energy level. The general equation of available radiuses can be concluded and is given by,

$$r = D \frac{n^2 h^2 \epsilon_0}{mZe^2 \pi}, \quad (12)$$

$$D = (1, \frac{3}{2}, 2, \frac{5}{2}, \dots, \frac{d+1}{2})$$

where (D) is the numbers those generated due to differential process, it's called differential generated numbers with symbol (D) because of its generation by Differential process. By substituting from the last equation into equation (5) we got :-

**The Modified form of Energy Equation**

$$E = \frac{1}{D} \cdot \frac{mZ^2 e^4}{8n^2 h^2 \epsilon_0^2}, D = (1, \frac{3}{2}, 2, \frac{5}{2}, \dots, \frac{d+1}{2}) \quad (13)$$

It's clear that, the energy and radius depend on two terms (D) and (n), (D) increases slower than (n), where, D is not square term but, (n) is squared, this leads to more energy levels and more flexibility dealing with electron.

### 4. New Energy Levels for Hydrogen Atom

**Table (1).** Energy levels of Hydrogen atom those concluded by differential mathematical process

D	E (eV)	D	E (eV)	D	E (eV)
1	13.59829*	18	0.75546	35	0.38852
1.5	9.06552	18.5	0.73504	35.5	0.38305
2	6.79914	19	0.71570	36	0.37773*
2.5	5.43931	19.5	0.69735	36.5	0.37256
3	4.53276	20	0.67991	37	0.36752
3.5	3.88522	20.5	0.66333	37.5	0.36262
4	3.39957*	21	0.64754	38	0.35785
4.5	3.02184	21.5	0.63248	38.5	0.35320
5	2.71966	22	0.61810	39	0.34867
5.5	2.47242	22.5	0.60437	39.5	0.34426
6	2.26638	23	0.59123	40	0.33996
6.5	2.09204	23.5	0.57865	40.5	0.33576
7	1.94261	24	0.56660	41	0.33167
7.5	1.81310	24.5	0.55503	41.5	0.32767
8	1.69979	25	0.54393*	42	0.32377
8.5	1.59980	25.5	0.53327	42.5	0.31996
9	1.51092*	26	0.52301	43	0.31624
9.5	1.43140	26.5	0.51314	43.5	0.31260
10	1.35983	27	0.50364	44	0.30905
10.5	1.29507	27.5	0.49448	44.5	0.30558
11	1.23621	28	0.48565	45	0.30218
11.5	1.18246	28.5	0.47713	45.5	0.29886
12	1.13319	29	0.46891	46	0.29561
12.5	1.08786	29.5	0.46096	46.5	0.29244
13	1.04602	30	0.45328	47	0.28933
13.5	1.00728	30.5	0.44585	47.5	0.28628
14	0.97131	31	0.43865	48	0.28330
14.5	0.93781	31.5	0.43169	48.5	0.28038
15	0.90655	32	0.42495	49	0.27752*
15.5	0.87731	32.5	0.41841	49.5	0.27471
16	0.84989*	33	0.41207	50	0.27197
16.5	0.82414	33.5	0.40592	50.5	0.26927
17	0.79990	34	0.39995	51	0.26663
17.5	0.77704	34.5	0.39415	51.5	0.26404

First, let us substituting (Z=1), (n=1 "which is called principle quantum number in quantum mechanics") and (D = all available numbers) in equation(13), the other terms are given previously. The results have been tabulated in table(1). All bold data those marked with (\*) in agreement and coincident with Bohr results[2,3]. Italic data are addition data, where D=49 as same as n=7 in quantum mechanics.

It is clear from table(1) that, this process generated Bohr's

energy levels, in other words the old module of atom where ( $D = 1, 4, 9, 16, 25, 36$  and  $49$ ), equivalent to ( $n=1, 2, 3, 4, 5, 6$  and  $7$ ) respectively.

The new energy levels are these energy levels with values ( $D \neq 1, 4, 9, 16, 25, 36$  and  $49$ ) came directly from the differential process, the electron transition between two energy levels will be discussed later. It is clearly that, using series differential process gives us all old energy levels

addition to new energy levels among the old energy levels in Hydrogen atom. At last, we need more evidence to trust in this differential process. So, we'll conclude the ionization energy of other elements.

## 5. Ionization Energy of Elements

**Table (2).** Experimental ionization energy ( $E_{\text{Exp}}$ ) of elements from "NIST" comparing with theoretical ionization energy ( $E_{\text{Th}}$ ) at differential order ( $D$ )

Z	Ele	D	$E_{\text{Th}}$	$E_{\text{Exp}}$
1	H	1	13.5983	13.5984
2	He	2	27.2040	24.5874
3	Li	22.5	5.4413	5.3917
4	Be	23.5	9.2622	9.3227
5	B	41	8.2953	8.2980
6	C	43.5	11.2589	11.2603
7	N	45.5	14.6511	14.5341
8	O	64	13.6048	13.6181
9	F	63.5	17.3542	17.4228
10	Ne	63	21.5952	21.5645
11	Na	320.5	5.1364	5.1391
12	Mg	256	7.6529	7.6462
13	Al	384	5.9877	5.9858
14	Si	327	8.1548	8.1517
15	P	292	10.4835	10.4867
16	S	336	10.3659	10.3600
17	Cl	303	12.9766	12.9676
18	Ar	279.5	15.7714	15.7596
19	K	1131.5	4.3407	4.3407
20	Ca	890	6.1148	6.1132
21	Sc	914.5	6.5609	6.5615
22	Ti	964.5	6.8274	6.8281
23	V	1067	6.7453	6.7462
24	Cr	1158	6.7674	6.7665
25	Mn	1144	7.4330	7.4340
26	Fe	1164	7.9014	7.9024
27	Co	1258.5	7.8811	7.8810
28	Ni	1396	7.6409	7.6399
29	Cu	1481	7.7260	7.7264
30	Zn	1303.5	9.3939	9.3942
31	Ga	2179.5	5.9990	5.9993
32	Ge	1763.5	7.9002	7.8994
33	As	1513.5	9.7895	9.7886
34	Se	1612.5	9.7538	9.7524
35	Br	1408.5	11.8330	11.8318
36	Kr	1259.5	13.9998	13.9996
37	Rb	4459	4.1772	4.1771
38	Sr	3450	5.6946	5.6949
39	Y	3328.5	6.2172	6.2173
40	Zr	3281.5	6.6338	6.6339
41	Nb	3384	6.7585	6.7589
42	Mo	3384	7.0922	7.0924
43	Tc	3455.5	7.2802	7.2800
44	Ru	3578.5	7.3607	7.3605
45	Rh	3693.5	7.4594	7.4589
46	Pd	3453	8.3375	8.3369
47	Ag	3967	7.5762	7.5762
48	Cd	3485.5	8.9936	8.9938
49	In	5645.5	5.7864	5.7864

**Table (2).** Experimental ionization energy ( $E_{\text{Exp}}$ ) of elements from "NIST" comparing with theoretical ionization energy ( $E_{\text{Th}}$ ) at differential order (D)

Z	Ele	D	$E_{\text{Th}}$	$E_{\text{Exp}}$
50	Sn	4631.5	7.3440	7.3439
51	Sb	4111	8.6081	8.6084
52	Te	4083.5	9.0093	9.0096
53	I	3657	10.4506	10.4513
54	Xe	3271	12.1290	12.1298
55	Cs	10569.5	3.8939	3.8939
56	Ba	8187	5.2116	5.2117
57	La	7926.5	5.5768	5.5769
58	Ce	8263.5	5.5387	5.5387
59	Pr	8653.5	5.4730	5.4730
60	Nd	8865	5.5251	5.5250
61	Pm	9069.5	5.5820	5.5820
62	Sm	9267	5.6437	5.6437
63	Eu	9523	5.6705	5.6704
64	Gd	9062	6.1497	6.1498
65	Tb	9803	5.8639	5.8638
66	Dy	9979.5	5.9388	5.9389
67	Ho	10143	6.0214	6.0215
68	Er	10300.5	6.1077	6.1077
69	Tm	10474.5	6.1842	6.1843
70	Yb	10659.5	6.2543	6.2542
71	Lu	12640.5	5.4259	5.4259
72	Hf	10334	6.8252	6.8251
73	Ta	9603.5	7.5498	7.5496
74	W	9474	7.8641	7.8640
75	Re	9770	7.8333	7.8335
76	Os	9313	8.4383	8.4382
77	Ir	8996	8.9670	8.9670
78	Pt	9239.5	8.9590	8.9588
79	Au	9204	9.2256	9.2255
80	Hg	8342.5	10.4376	10.4375
81	Tl	14614	6.1083	6.1082
82	Pb	12335	7.4166	7.4167
83	Bi	12865	7.2856	7.2855
84	Po	11409.5	8.4141	8.4140
86	Rn	9362	10.7485	10.7485
87	Fr	25285.5	4.0727	4.0727
88	Ra	19961	5.2784	5.2784
89	Ac	20029	5.3807	5.3807
90	Th	17474	6.3068	6.3067
91	Pa	19128.5	5.8901	5.8900
92	U	18592	6.1939	6.1939
93	Np	18781	6.2656	6.2657
94	Pu	19950	6.0260	6.0260
95	Am	20555	5.9738	5.9738
96	Cm	20928	5.9915	5.9914
97	Bk	20654.5	6.1979	6.1979
98	Cf	20801.5	6.2817	6.2817
99	Es	20941.5	6.3677	6.3676
100	Fm	20931.5	6.5001	6.5000
101	Md	21093	6.5800	6.5800
102	No	21286	6.6500	6.6500

The first ionization "which means the energy required to extract one electron from the outer orbit outside the atom" energy of elements according to National Institute of Standards and Technology (NIST)[7] is symbolized by ( $E_{\text{Exp}}$ ) in table(2). Theoretical ionization energies is symbolized by ( $E_{\text{Th}}$ ) in table(2), ( $E_{\text{Th}}$ ) has been concluded by using

differential mathematical process. We substituted in equation(13) with ( $n=1$ ), ( $Z$  = atomic number of element) and reduced mass ( $m$ ).

It is clear that from table(2) ( $E_{\text{Th}}$ ) in agreement with ( $E_{\text{Exp}}$ ) for all elements except Helium. These data incentive us to trust the differential process seriously because, it gives us all

data we need and more.

## 6. Results and Discussion

It's clear that, this simple sequence differential equation process not only concluded, approved and verified all experimental data, but also, concluded new quantized energy levels. Now, we need use these data to explain one physical phenomenon at least. The first step of our discussion is the module of Hydrogen atom. The electron can occupy one of these energy levels by absorbing or emitting energy. The ground state in the new module as same as the ground state in Bohr module. The squared values of D numbers (1, 4, 9, ... etc.) as same as Bohr results ( $n=1, 2, 3$ , etc.) respectively. Now the first explaining emission-absorption line spectra mechanism will different from the old module as the following:-

*The absorption line spectra* can be explained according to the following, The absorbed photon by the electron leads to transferring the electron to higher energy level, for example, let the electron transfers from  $D=1$  to  $D=9$  (it was in Bohr module  $n=1$  to  $n=3$ ). After that, according to the new vision the electron will lose its energy by series emissions processes-not single emission photon- or series collisions process, or both of these two processes. The detail as the following: -

First case, series of emission processes means that, the electron maybe transfers to lower energy level  $D=8$  or  $D=7$  .... etc., after that, the electron transfers to lower energy level again  $D=6$  or  $D=5$  .... etc., and so on till it backs to its ground state. every transition generates photon with wavelength longer than the wavelength of absorbed photon. So, we expect the experimental data will detect more intensity of wavelength(s) in range longer than the range of the absorbed photon. Experimental detection will compare between in incident electromagnetic waves intensity over all its wavelengths before passing through the gas and its intensity after passing through the gas, we predict increasing the intensity in some wave lengths rang after passing of photons through the gas.

Second case, the electron maybe loses energy by emitting photon(s) as same as first case but, during its transfer among these new energy levels it maybe stay in suitable energy level -one of these new energy levels only- which leads to the increasing of kinetic energy, this means that, it will not back to its ground state fast, but it will late, its energy will transfer to the nucleus due to changing the position of center of mass. This explains the kinetic energy increasing by electromagnetic waves. Where, the electron can interacts with the photon easier than the nucleus, the energy transfers from the electron to the nucleus, this is more acceptable than the interaction between the photon with nucleus directly.

Third case, the electron maybe loses all or quantized part of its energy by collision(s) with an other atom, the electron of the second atom which will acquire the energy and will transfer to higher energy level and start lose its energy

according one or more cases, those have been explained before.

According to this new mechanism and new vision it is acceptable explanation completely dark line(s) appear(s) in absorption line spectra process. In other words "the path of going up is not the same path to back.

*The emission line spectra* phenomenon can be explained according to new vision as the following:-

When the gas is excited by external energy like electric potential or flame ...etc. then, the electron will acquire energy and transfer to high energy level then there are two possibilities,

First possibility if the electron transferred to one of these new energy levels only then, there are two cases, first case, it will jump to other higher energy level by acquiring more energy this process happens till the electron arrives to one of the old energy level (squared number of D numbers like  $D=4$  or  $D=9$  ....etc.) , then, the electron will lose its energy suddenly in the form emitted photon. This leads to emission line spectrum.

Second case, the electron loses its energy by collision only and back to its ground state.

Second possibility, if the electron transferred to one of these old energy levels only (squared number of D numbers like  $D=4$  or  $D=9$  ....etc.) then, it will lose its energy suddenly in the form emitted photon. In other words again "the path of going up is not the same path to back.

The energy levels can be divided into two categories. First category the critical energy levels that allow electron lose its energy in forms different from -external applied energy- the acquiring energy. If the applied energy was electromagnetic waves then the electron loses its energy through these energy levels by other energy forms, so we observe completely dark lines in absorption line spectrum. If the applied energy was for example electric energy then the electron loses its energy through these energy levels by other energy forms, one of these forms is electromagnetic energy so we observe bright lines in emission line spectrum.

New vision to quantization of kinetic energy

The variation of electron radius leads to the variation the center of mass between the nucleus and the electron. There are many new energy levels allow the electron to stay so long time this leads to more shift to the nucleus position -means vibration- we know this shift is so extremely very small, but the repeating this process millions times leads to noticeable vibration which leads to the temperature increasing. This is new vision for quantized kinetic energy of the atom.

**The most important thing in this paper is that " the differential process approved generated new energy levels and concluded all previous energy ".**

**Elsheekh Vision.**

Emission and absorption phenomena are non-reversible processes to each other.

**Elsheekh Theory.**

Mathematical differential process for electron's energy equation generates new energy levels addition to the old

energy levels are suggested to be occupied by the atom's electron(s).

At last, the theoretical atomic physics now in the front of the experimental atomic physics, this is due to the so many numbers of energy levels which we can use them to explain currently and the next lab. observations.

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Physical constants have be used[5,6].

Dielectric constant  $\epsilon_0 = 8.854187817 \times 10^{-12}$  F/m

Electron rest mass  $m_e = 9.10938291 \times 10^{-31}$  kg

Proton rest mass  $m_p = 1.672621777 \times 10^{-27}$  kg

Elementary charge  $e = 1.602176565 \times 10^{-19}$  C

Planck's constant  $h = 6.62606957 \times 10^{-34}$  J.s

Constant (Pi)  $\pi = 3.14159265$

## REFERENCES

- [1] N. Bohr, Philos. Mag. 26, 1 (1913).
- [2] Alan Giambattista, Betty Richardson and Robert C. Richardson on., Cornell University -Ithaca. College Physics., 4th Ed., ISBN-13 97800735 12143. (2013). [http://dev5.mhhe.com/tbern/public\\_html/0073404470/pdf/ch27\\_07.pdf](http://dev5.mhhe.com/tbern/public_html/0073404470/pdf/ch27_07.pdf)
- [3] Arthur Beiser., Concepts of Modern Physics, 2nd Ed., ISBN 0-07004363-4. (1973).
- [4] Nigel G. Adams et al., Gordon W. F. Drake (Ed.) Springer Handbooks of Atomic, Molecular, and Optical Physics., ISBN-13: 978-0-387-20802-2. (2006).
- [5] Peter J. Mohr, Barry N. Taylor, and David B. Newell., National Institute of Standards and Technology, Gaithersburg, Maryland 20899-8420, USA. (2012). <http://physics.nist.gov/cuu/Constants/Preprints/lsa2010.pdf>.
- [6] National Institute of Standers and Technology. (NIST). <http://physics.nist.gov/constants>
- [7] National Institute of Standers and Technology. (NIST), Atomic Properties of the Elements., (2010). [http://www.nist.gov/pml/data/upload/periodic\\_table\\_composite\\_2010.pdf](http://www.nist.gov/pml/data/upload/periodic_table_composite_2010.pdf)