Original Paper

Discussion on the Problems of Bohr's Hydrogen Atom Theory in Basic Theory

Yuan Lixin[1]

[1] ShenZhen TELLUS holding co., ltd. Guang Dong China

E-mail: wyyw112233@163.com

Abstract

According to the charge momentum and charge kinetic energy, it is proved that the key problem of the basic theory of Bohr hydrogen atom is that equation $m\left(\dfrac{v^2}{r}\right) = \dfrac{e^2}{4\pi\varepsilon_0 r^2}$ does not hold. For the same electron of the hydrogen atom, the left side of the equation is the mechanical kinetic energy, the right side of the equation is the charge energy, the fundamental properties and the concept of energy are split. Based on experiments, this paper analyzes and calculates the combined energy of hydrogen, lithium and oxygen atoms, hydrogen atom radius $r_H = 1.9772 \times 10^{-10} m$ and the ground state energy of hydrogen atom $E_H = -3.6223 eV$ are obtained. This ground state energy E_H is basically consistent with the Balmer system of hydrogen atomic spectrum $-3.4 eV$; Electron around the nuclear velocity $V_e = 2.6917(m/s)$. hydrogen atom radius $r_H = 1.9772 \times 10^{-10} m$ is calculated by using energy E_H, which verifies the correctness of charge momentum and charge kinetic energy and their experimental basis. The ground state energy atom $-13.6 eV$ and radius $r = 5.29 \times 10^{-11} m$ of Bohr hydrogen is derived under the condition that the basic theory has problems and the theoretical formula is set to $n = 1$, which has no experimental basis. The fundamental problem of quantum mechanics is that the theoretical formula of photoelectric effect is not correct, which is demonstrated in this paper. The relationship between the structure of hydrogen atom and the evolution of the universe is also discussed.

Keywords

problems, Bohr's hydrogen atom theory, basic theory, charge momentum, charge kinetic energy, evolution of material structure, hydrogen atom radius, ground state energy, around the nuclear

velocity, quantum mechanics

1. Preface

Although great achievements have been made in the field of quantum mechanics, in fact, there are still serious problems in the basic theory. The "tunnel effect" is a typical non conservation theory of energy in quantum mechanics, and is the product of problems in the basic theory. The theoretical formula (Yang, 2014) $\frac{1}{2}mV^2 = h\nu - \phi$ of photoelectric effect is the basis of quantum mechanics "tunnel effect" and Bohr hydrogen atom theory. Because the formula of photoelectric effect theory is not correct, the "tunnel effect" and Bohr hydrogen atom theory have serious theoretical problems.

Based on the charge momentum and charge kinetic energy (Yuan, 2015, 2016), this paper analyzes and studies the basic theoretical problems of Bohr hydrogen atom theory, "tunnel effect" and photoelectric effect theory. At the same time, the internal consistency and stages (Yuan, 2018) of the evolution of the energy structure of hydrogen atom and the evolution of the universe are discussed through the evolution of the material structure energy (Yuan, 2013, 2014).

2. Charge Operation Mechanism Constructed by Charge Momentum and Charge Kinetic Energy

Construction of Charge Momentum and Charge Kinetic Energy Mechanism (Yuan, 2015, 2016)

Charge Momentum: $P = QV$ (1)

Charge Kinetic Energy: $W = \frac{1}{2}QV^2$ (2)

Where: Q is the charge and V is the charge velocity.

According to equation (2), the equation of electron kinetic energy accelerated by electric field U can be established:

$$\frac{1}{2}eV^2 = eU \tag{3}$$

The electron velocity $V = \sqrt{2U}$ is obtained from equation (3).

According to the momentum and kinetic energy properties of the charge, the centripetal force of the charge moving in a circle and the coulomb force equilibrium formula:

$$e\frac{V^2}{r} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{e^2}{r^2} \tag{4}$$

Get: $r = \frac{1}{4\pi\varepsilon_0} \cdot \frac{e}{V^2}$

Substituting $V = \sqrt{2U}$ into the above formula, the solution is:

$$r_e = \frac{1}{8\pi\varepsilon_0} \cdot \frac{e}{U} \tag{5}$$

In formula (5), the atomic radius r_e is marked with angle mark e because this radius is the result of deduction and calculation by electronic charges (3) and (4). In this paper, the related physical quantities determined by Bohr's theory are marked with mass angle m, such as the radius r_m of hydrogen atom, without further explanation.

3. Basic Theoretical Problems in the Construction of Bohr's Hydrogen Atom Theory

3.1 Two Basic Formulas of Bohr's Hydrogen Atom Theory

Coulomb force of electrons running around the nucleus: $m\dfrac{V^2}{r_m} = \dfrac{e^2}{4\pi\varepsilon_0 r_m^2}$ (6)

Quantization of orbital conditions: $L = mVr_m = n_m\hbar$ (7)

The radius r_m of hydrogen atom is obtained from Formula (6) and (7): $r_m = n_m^2\left(\dfrac{\varepsilon_0 h^2}{\pi m e^2}\right)$

$(n = 1,2,\cdots)$ (8)

Let $n_m = 1$ in Formula (8), get: $r_m = 5.29 \times 10^{-11} m$

3.2 The Energy of Hydrogen Atom in Bohr Theory

When the electron is running on a radius r_m orbit, the distance is selected as the zero point of the electrostatic potential energy of the system, and its electrostatic kinetic energy and potential energy are respectively (Jing, Du, & Jin, 2008):

$$E_k = \frac{1}{2}mV^2 = \frac{e^2}{8\pi\varepsilon_0 r_m}; \quad E_p = -\frac{e^2}{4\pi\varepsilon_0 r_m}$$

Its total energy is: $E_m = E_k + E_p = \dfrac{e^2}{8\pi\varepsilon_0 r_m} - \dfrac{e^2}{4\pi\varepsilon_0 r_m} = -\dfrac{e^2}{8\pi\varepsilon_0 r_m}$ (9)

Substituting the radius r_m of formula (8) into formula (9), the energy of hydrogen atom:

$$E_m = -\frac{1}{n_m^2}\left(\frac{me^4}{8\varepsilon_0^2 h^2}\right)$$ (10)

Let $n_m = 1$ obtain from equation (10): $E_m = -\dfrac{me^4}{8\varepsilon_0^2 h^2}$ (11)

The solution is: $E_m = -13.6eV$

3.3 On the Basic Theoretical Problems of Bohr's Hydrogen Atom Theory

Bohr's theory of hydrogen atom is based on the theory of photoelectric effect, and the problem lies in the basic theory of photoelectric effect.

"According to Einstein, when light hits the metal surface, the photon with energy hv is absorbed by the electron. The electron uses part of this energy to overcome its binding on the metal surface, and the other part is the kinetic energy of the electron after leaving the metal surface. This energy relationship can be written as:

$$\frac{1}{2}mV^2 = hv - \phi \tag{12}$$

That is, the energy hv of the photon minus the binding energy (stripping work) of the electron in the metal is equal to the maximum kinetic energy of the electron."

As we know, electrons have mass and charge at the same time. The left side of formula (6) is the centripetal force of electron mass, and the right side is the coulomb force of electron. The left side of formula does not consider the movement of electron charge, but artificially establishes an equivalent physical relationship between the centripetal force of electron mass and the coulomb force of electron charge.

The theoretical formula of photoelectric effect is based on the balance between photon mass kinetic energy $\frac{1}{2}mV^2$ and electric field energy $hv - \phi$, while ignoring the main term of electric field energy balance of electron charge kinetic energy $\frac{1}{2}QV^2$. As a result, the ultra-high-speed running state of electron mass around the core is artificially caused, and the relativistic thinking of electron motion is introduced, which leads to the so-called "tunnel effect" and other basic theoretical problems in quantum mechanics.

Considering the basic fact that electric charge flows to form current, how powerful electric energy will be generated when the outer electrons of hydrogen atom circle the nucleus at super high speed! Obviously, the ultrahigh speed movement of electrons around the nucleus is incorrect, and the theoretical formula of photoelectric effect is invalid. The energy non conservation of Bohr hydrogen atom theory and "tunnel effect" is the result of the problems in the basic theory of photoelectric effect.

4. Calculate Hydrogen Atomic Radius with Chemical Reaction Energy of Hydrogen Oxide (Water) and Lithium Oxide

"It has been proved from various experiments that the atomic radius is of the order of 10^{-10}. Therefore, the radius of the electron orbit will not be reduced to the size of the atomic nucleus, and the electron must run in a stable orbit with a radius of order of $10^{-10} m$" (Zhu, 1979). The radius of the

Bohr hydrogen atom is $r_m = 5.29 \times 10^{-11} m$, which is much smaller than the average atomic radius,

and it is very unusual.

Therefore, it is necessary to confirm the radius of hydrogen atom on the basis of physical experiment.

4.1 The Basis of Analogy between Hydrogen Atom and Lithium Atom

Both hydrogen atom and lithium atom have a single electron in their outer shell, which is the closest in

atomic structure and is highly comparable to each other in the periodic table.

4.2 The Covalent Bonding Energy between the Elements is Determined by the Outer Electrons of
Chemical Elements (Li & Feng, 1965). The Combination of Hydrogen and Lithium Atoms with Oxygen
Atoms is Considered as the Combination Energy of the Outer Electrons of the Two Atoms with Oxygen

Generation of hydrogen oxide (water):

At $25^0 C$ and 1 atmospheric pressure, 1 Grammolecule of hydrogen combines with $\dfrac{1}{2}$

Grammolecule of oxygen to form 1 Grammolecule of water:

$$H_2 + \frac{1}{2} O_2 = H_2O + 68.4 Kcal / Grammolecule \tag{13}$$
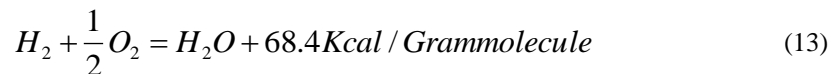
Generation of lithium oxide (Ge, 1966):

$$2Li + \frac{1}{2} O_2 \rightarrow Li_2O + 143 Kcal / Grammolecule \tag{14}$$

Hydrogen atomic charge energy: $E_H = -\dfrac{1}{8\pi\varepsilon_0} \cdot \dfrac{e^2}{r_H}$ \hfill (15)

Lithium atomic charge energy: $E_{Li} = -\dfrac{1}{8\pi\varepsilon_0} \cdot \dfrac{e^2}{r_{Li.}}$ \hfill (16)

Let the outer electron charge energy of oxygen atom be: E_O, Charge energy of the water molecules:

E_{H_2O}, Charge energy of lithium oxide molecules: E_{Li_2O}, Because the molecular charge energy is

mainly determined by a single electron in the outer layer of hydrogen and lithium, so that

$E_{H_2O} = E_{Li_2O}$, From the above:

Combined energy of hydrogen and oxygen: $E_H + E_O = E_{H_2O} + 2.6819 \times 10^5 J$ \hfill (17)

Combined energy of lithium and oxygen: $E_{Li} + E_O = E_{Li_2O} + 5.9858 \times 10^5 J$ \hfill (18)

Formula (18) minus Formula (17): $E_{Li} - E_H = 3.3039 \times 10^5 J$ \hfill (19)

4.3 Hydrogen Atom Radius Determined by Combining Energy

Substitute formula (15) and (16) into formula (19), and divide by the number of Grammolecule:

$$\frac{1}{8\pi\varepsilon_0}\cdot\frac{e^2}{r_{Li}}-\frac{1}{8\pi\varepsilon_0}\cdot\frac{e^2}{r_H}=\frac{3.3039\times10^5 J}{6.02\times10^{23}} \tag{20}$$

Substitute relevant physical constants and lithium atomic radius (Yang, Zhu, Zhao, & Lin, 1982)

$$r_{Li}=152pm$$

into formula (20), and get hydrogen atom radius:

$$r_H=1.9772\times10^{-10}m \tag{21}$$

Substitute hydrogen atom radius $r_H=1.9772\times10^{-10}m$ into formula (15) to get Ground state

energy of hydrogen atom: $E_H=-3.6223eV$

The spectral energy level $-3.4eV$ of Balmer spectrum in the contrast experiment is basically consistent. That is, the spectral energy level of Balmer spectrum is the ground state energy level of hydrogen atom.

4.4 Testing Hydrogen Atom Radius r_e in Formula (5) by Ground State Energy E_H of Hydrogen

Atom

Formula (5) is the result of the inference of charge momentum and charge kinetic energy. Through

ground state energy E_H of hydrogen atom, hydrogen atom radius r_e determined by Formula (5) is

also a test of whether charge momentum and charge kinetic energy are correct or not.

Substitute voltage $U=3.6223V$ of ground state energy into formula (5),

$$r_e=\frac{1}{8\pi\varepsilon_0}\cdot\frac{e}{U}=\frac{1}{8\pi\times8.9\times10^{-12}}\cdot\frac{1.602\times10^{-19}}{3.6223}\approx1.9772\times10^{-10}(m)$$

That is, $r_e=r_H$

Therefore, charge momentum and charge kinetic energy have experimental basis and are correct.

5. Analysis of the Operation of Hydrogen Atom by Kinetic Energy of Charge

5.1 Hydrogen Atom Radius r_e and Hydrogen Atom Energy E_n Determined by Kinetic Energy of Charge

5.1.1 Analysis of the Movement of Hydrogen Atom Electrons around the Nucleus by Kinetic Energy of Charge

Set to hydrogen atom radius r_e, and by formula (4), the electron runs around the core:

$$e\frac{V^2}{r_e} = \frac{e^2}{4\pi\varepsilon_0 r_e^2} \tag{22}$$

Let the electron charge orbit condition be quantized: $L_e = eVr_e = n_e\hbar$ (23)

According to formulas (22) and (23), there are: $r_e = n_e^2 \cdot \frac{\varepsilon_0 h^2}{\pi e^3}$ (24)

5.1.2 Hydrogen Atomic Energy E_e

When the electron runs on the orbit with radius r_e, the distance ∞ is selected as the zero point of electrostatic potential energy, and its electrostatic kinetic energy and potential energy are respectively (Yuan, 2015; Jing, Du, & Jin, 2008):

$$E_k = \frac{1}{2}eV^2 = \frac{e^2}{8\pi\varepsilon_0 r_e}, \qquad E_p = -\frac{e^2}{4\pi\varepsilon_0 r_e}$$

Total energy:

$$E_e = E_k + E_p = \frac{e^2}{8\pi\varepsilon_0 r_e} - \frac{e^2}{4\pi\varepsilon_0 r_e} = -\frac{e^2}{8\pi\varepsilon_0 r_e} \tag{25}$$

Substitute hydrogen atom radius of formula (24) into formula (25) to get E_e:

$$E_e = -\frac{1}{n_e^2}\left(\frac{e^5}{8\varepsilon_0^2 h^2}\right) \tag{26}$$

5.2 Discussion on the Value of $n_m = n_e = 1$

The related data of Bohr's hydrogen atom, such as ground state energy, radius and spectrum, are derived from Bohr's hydrogen atom theory under the condition of $n_m = 1$. Therefore, the objective existence and rationality of the setting of Bohr's hydrogen atom theory $n_m = 1$ should be analyzed and judged.

5.2.1 Discussion on Hydrogen Atom Theory Corresponding to $n_m = n_e = 1$

Let $n_e = 1$, according to formula (26): $E_e = -2.39 \times 10^{12} eV$

Compare $E_m = -13.6eV$ with $E_e = -2.39 \times 10^{12} eV$, The system energy of the same substance

should be the same, but under the condition of $n_m = n_e = 1$, there is a huge energy difference between hydrogen atoms electron mass kinetic energy and electron charge kinetic energy in the same system, which is obviously illogical.

Let $n_e = 1$, according to formula (24), hydrogen atom radius:

$$r_e = 3.0248 \times 10^{-22} m$$

Divide equation (8) by equation (25): $\dfrac{r_m}{r_e} = \dfrac{n_m^2}{n_e^2} \cdot \dfrac{e}{m}$ \hfill (27)

5.2.2 Analysis of Equation (27)

(1) The correlation between radius r_m and r_e determined by equation (27)

Let $r_m = r_e$, $n_m = 1$, then formula (27): $\dfrac{1}{n_e^2} \cdot \dfrac{e}{m} = 1$, solve:

$$n_e = \sqrt{\dfrac{e}{m}} \tag{28}$$

(2) Substituting hydrogen's ground state energy $E_H = -3.6223 eV$ into the formula (26), solve:

$$n_e = \dfrac{1}{\sqrt{3.6223}} \cdot \dfrac{e^2}{2\sqrt{2}\varepsilon_0 h} = 8.0861 \times 10^5 \tag{29}$$

Substituting $n_e = 8.0861 \times 10^5$ into (26) is as follows:

$$E_e = -\dfrac{1}{\left(8.0861 \times 10^5\right)^2} \left(\dfrac{e^5}{8\varepsilon_0^2 h^2}\right) \tag{30}$$

According to the general expansion of hydrogen atom spectrum by formula (30), the spectral frequency corresponding to the energy level is:

When $k = 1$, it is the Balmer system spectrum

$$\tilde{\nu} = \dfrac{1}{ch}\left(E_n - E_k\right) = \dfrac{1}{\left(8.0861 \times 10^5\right)^2}\left(\dfrac{e^5}{8\varepsilon_0^2 h^3 c}\right)\left(\dfrac{1}{k^2} - \dfrac{1}{n^2}\right) \quad (n = 2,3,4,\cdots) \tag{31}$$

5.2.3 Discussion on the Physical Meaning of When $n = 1$

From the quantization of the electron mass orbital condition a, when $n = 1$ is the starting point of the quantization condition. The implicit premise of setting $n = 1$ is to treat the hydrogen atom as an immutable structure, that is, the present hydrogen atom structure is still at its original starting point.Does the structure of the hydrogen atom not evolve for billions of years? This is obviously

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inconsistent with the fact that the structure of matter can evolve (Yuan, 2013), the decay (Yuan, 2009) of nuclides and the decay (Guo, Zhao, & Peng, 2010) of element β .

Thinking about $n_{m_0} = n_e = 1$ is equivalent to thinking about the current state of the hydrogen atom as the beginning of the evolution of the universe, the beginning of the process. How is it possible to determine the ground state energy of a hydrogen atom exactly in terms of $n_{m_0} = n_e = 1$? It is

precisely because the ground state energy $-13.6eV$ of the hydrogen atom given by $n_m = 1$ is

that it will be abnormally different from its similar alkali metal work out (Wang & Zhou, 2008): lithium (Li) 2.49 eV , natrium (Na) 2.28 eV , and kalium (K) 2.22 eV .

The evolution of the universe is a process, so is the evolution of the material structure (Yuan, 2018). How can we think that today, billions of years after the evolution of the universe, the structure of the

hydrogen atom can be set to $n_m = 1$ for calculation? Therefore, the actual physical meaning implied

by the initial state value is worthy of careful study.

Physics is based on experiments and exists in reality. The historical process of material evolution has been merged into the constants of physical formulas through physical experiments. In other words, the essential meaning of physical constants is the historical precipitation in the process of material evolution, which is the bridge between the present and history. The evolution of the universe and the change of the structure and energy of matter determine that it is impossible for Bohr's theory of hydrogen atom to coincide with the actual state of the current evolution of the universe under the condition of $n = 1$.

5.3 The Discussion about Electron Mass Kinetic Energy and Electron Charge Kinetic Energy

When electron e moves in electric field (Yuan, 2015) $U = E_2 - E_1$, the kinetic energy of electron motion should be the sum of electron mass kinetic energy and electron charge kinetic energy.

Formula (3) shall be expressed as:

$$\frac{1}{2}(m+e)V^2 = eU \tag{32}$$

Then the total energy of the electron is:

$$\frac{1}{2}(m+e)V^2 = \frac{e^2}{8\pi\varepsilon_0 r} \tag{33}$$

Because $\frac{1}{2}eV^2 >> \frac{1}{2}mV^2$, ignore $\frac{1}{2}mV^2$, equation c can be rewritten as:

$$\frac{1}{2}eV^2 = \frac{e^2}{8\pi\varepsilon_0 r} \tag{34}$$

By formula (32) and (34), there are: $U = \dfrac{e}{8\pi\varepsilon_0 r}$ (35)

5.4 A Discussion of the Electron Velocity of Hydrogen Atom around the Nucleus as Determined by Equations (4) and (6)

Hydrogen atom radius is $r_e = 1.9772\times10^{-10}\,m$ in Equation (4), and hydrogen atom radius is radius

$r_m = 5.29\times10^{-11}\,m$ in Equation (6),

From Equation (4), we can get:

$$V_e = \sqrt{\frac{e}{4\pi\varepsilon_0 r_e}} = \sqrt{\frac{1.6021\times10^{-19}}{4\pi\times8.9\times10^{-12}\times1.9772\times10^{-10}}} = 2.6917(m/s) \qquad (36)$$

From Equation (6), we can get:

$$V_m = \frac{e}{\sqrt{4\pi m_0\varepsilon_0 r_m}} = \frac{1.6021\times10^{-19}}{\sqrt{4\pi\times9.1\times10^{-31}\times8.9\times10^{-12}\times5.29\times10^{-11}}} = 2.1846\times10^6(m/s) \quad (37)$$

Compared with the calculation results of formula (36) and formula (37), the velocity deviation between

$V_e = 2.6917(m/s)$ and $V_m = 2.1846\times10^6(m/s)$ is huge, and the electron velocity V_m

calculated by formula (6) can't explain the Huge electric field energy problem caused by electron charge in such high-speed motion.

It can be seen that the thinking of Formula (6) is unreasonable. According to Equation (4), the motion

velocity $V_e = 2.6917\,m/s$ of the electron around the nucleus can be obtained. It can be seen that the

motion of the electron around the nucleus is very low, so there is no need to consider relativity.

6. Conclusion and Discussion

This paper demonstrates the problems existing in the basic theory of Bohr's theory of hydrogen atom through two ways.

First, it demonstrates the ground state energy E_e of the hydrogen atom, hydrogen atom radius r_e, the

motion velocity V_e of the electron around the nucleus, and hydrogen atom spectrum with the theory

construction of charge momentum and charge kinetic energy, and demonstrates the irrationality of these four physical quantities of Bohr's theory of hydrogen atom theory. And from the aspect of evolution of the universe, the irrationality of the condition setting of Bohr's theory of hydrogen atom theory n equals 1 is demonstrated.

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Second, the experiment of hydrogen atom structure is demonstrated by the combined reaction energy of hydrogen oxide (water) and lithium oxide. the ground state energy E_e of the hydrogen atom and hydrogen atom radius r_e were calculated, and the experimental basis of hydrogen atom theory was constructed.

It is proved that hydrogen atom radius r_e and r_H obtained by the two approaches are equal, which also proves the correctness of the construction of charge momentum and charge kinetic energy theory and its experimental basis. According to ground state energy E_H of the hydrogen atom obtained in this paper, when hydrogen atom obtains the ground state excited energy $3.6223eV$, it will radiate Balmer spectrum, and it is impossible to appear the excited radiation state of the energy $13.6eV$.

In theory construction, a theory construction chain phenomenon is often formed. If there are problems in the basic theory of this construction chain, it may become an insurmountable obstacle of theoretical research chain, which not only produces some wrong understanding, but also leads the artificial interpretation of relevant

experimental data. In the aspect of physics research and the solution of related problems, we will find that people tend to use equivalence, fitting and empirical formula consciously or unconsciously to bypass the problems existing in the basic theory and solve the problems encountered in an empirical way. For example, "tunneling" is used to explain nonconservation of energy (Yuan, 2018) that cannot be explained by quantum mechanics. In astrophysics, empirical formulas are fitted with experimental data to solve the problems of satellite orbit (Yuan, 2012). Such thinking and analysis methods not only affect our theoretical thinking, but also affect our correct analysis of experimental results.

We should pay careful attention to the thinking of problems in basic theory, which is the root of theoretical construction. We should not be too confident in the construction of basic theory. We should re-examine and rethink the basic theory, including the construction of the basic theory of astrophysics (Yuan, 2022).

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