Bohr Model is Self-refuted

Abstract Bohr model and Planck constant are destructive to each other.

Key Words electron, orbit, quantum. Photon, Mohr radius

****

Laying its foundation on how it believes a hydrogen atom should be the Bohr model requires the following assumptions for it to elaborate how light is produced:

1. The electron must travel on stable circular orbits of various radius about a proton. It is the centrifugal force out of this orbital movement that prevents the electron from sinking toward the proton. Conversely, it is the Coulomb force that sustains the electron's circular movement.
2. The smaller the radius of an orbit is, the more stable the orbit would be. An electron in stable orbit will not radiate. Classical mechanics can be used to describe the electron's movement on these orbits.
3. Radiation is emitted only when the electron jumps between orbits, but not during its orbital movement. Radiation is portrayed by the production of photons. So, the frequency of the photon is independent of the rate of the orbital movement of the electron per unit time. But instead, the light's frequency is dependent on the change of energy level between the two orbits.
4. The size, or the radius r, of each allowed orbit is singularly determined by the electron's orbital angular momentum $\boldsymbol{P}$ with respect to the proton. More precisely, the relationship between r and $\boldsymbol{P}$ is governed by the following relationship: an integral n multiple of $h/2\pi$, where h is the Planck constant. So, Bohr model gives

$$P = m_e v r = {}^{nh}\!/_{2\pi} \qquad (Eq.\ 01)$$

where $m_e = 9.11 \times 10^{-31} kg$ is the mass of the electron, v is the tangential linear speed of the orbiting electron, $n = 1, 2, 3, \ldots$ all none zero integers.

For an electron orbiting about a proton at a distance of r with a tangential speed v, the Coulomb force F_e acting on the electron is

$$F_e = -k\frac{q^2}{r^2} \qquad (Eq. \quad 2a)$$

where $|q|$ =1.6 × 10^{-19}C is the electrical charge that the electron and the proton each carries, $k = 9 \times 10^9 N \cdot \frac{m^2}{C^2}$ is the Coulomb constant.

The potential energy and kinetic energy that the electron possesses with respect to the proton adding together would be

$$E = K + U = \frac{1}{2}m_e v^2 - k\frac{q^2}{r} \qquad (Eq. \quad 2b)$$

The centrifugal force F_c experienced by this electron is

$$F_c = m_e\frac{v^2}{r} \qquad (Eq. \quad 03)$$

Taking from Eq. 01 we have

$$P = m_e v r \qquad (Eq. \quad 04)$$

If v is replaced with $v = \omega\, r = 2\pi f r$, where ω is angular velocity and f is the rate of orbit repetition expressed as cycles per unit time, we have

$$P = m_e 2\pi f r^2 \qquad (Eq. \quad 05)$$

Rearranging Eq. 03 to have $F_c\, r = m_e\, v^2$, we have

$$F_c\, r = m_e(2\pi f r)^2 \qquad (Eq. \quad 06)$$

Rearrange Eq. 06, relying on $F_c = F_e$, we have

$$f^2 = \frac{F_c}{4\pi^2 m_e r} = \frac{kq^2}{4\pi^2 m_e r^3} \qquad (Eq. \quad 07)$$

Since Eq. 01 and Eq. 05 together can lead us to have

$$m_e 2\pi f r^2 = {}^{nh}/_{2\pi} \qquad \text{(Eq.} \quad \text{08)}$$

Then further, we have

$$f = \frac{nh}{4\pi^2 m_e r^2} \qquad (Eq. \quad 09)$$

or

$$f^2 = (\frac{nh}{4\pi^2\, m_e r^2})^2 \qquad (Eq. \quad 10\,)$$

Eq. 07 (from pure Newtonian mechanism) and Eq. 10 (legitimized by Bohr model) are supposed to mean the same thing, so, we have

$$\frac{kq^2}{4\pi^2 m_e r^3} = \left(\frac{nh}{4\pi^2\, m_e r^2}\right)^2 \qquad (Eq.\quad 11)$$

Let n_1=1, Eq. 11 becomes

$$\frac{kq^2}{4\pi^2 m_e\, r^3} = \left(\frac{h}{4\pi^2\, m_e r^2}\right)^2$$

$$\frac{kq^2}{r} = \frac{h^2}{4\pi^2 m_e\, r^2} \qquad (Eq.\quad 12)$$

Rearranging Eq. 12 leads to

$$h^2 = 4\pi^2 kq^2 m_e r$$

$$h = 2\pi q\sqrt{km_e r} \qquad (Eq.\quad 13)$$

As n_1=1, r is the commonly accepted Bohr radius [1], and it has the value $r = 0.0529nm$. Therefore, Eq. 13 lets us have

$$h = 2\pi(1.6\times10^{-19}\mathrm{C})\sqrt{\left(9\times10^9 N\cdot\frac{m^2}{\mathrm{C}^2}\right)(9.11\times10^{-31}kg)(0.0529\times10^{-9}m)}$$

$$= 4.358\times10^{-34} J\cdot s \qquad (Eq.\quad 14)$$

The commonly accepted Planck constant is 6.626×10^{-34} J·s. So, the value shown in Eq. 14 has a deviation of 34% from it. No serious scientist will take either value as a proper choice to confirm a phenomenon until more supportive evidence is found to favor one over another.

Suppose we have two electrons and each move on the orbit of radius r_1 and r_2 respectively, where $r_1 < r_2$. In the upcoming calculation, all physical quantities for theses two electrons will be marked with corresponding subscripts.

Based on Eq. 01, we have

$$m_e v_1 r_1 = {}^{n_1 h}\!/_{2\pi} \qquad (Eq.\quad 15)$$

Following the similar derivation of Eq. 09, we can have

$$f_1 = \frac{n_1 h}{4\pi^2 m_e r_1^2} \qquad (Eq.16)$$

Similarly, for the orbit of r_2, we will have

$$f_2 = \frac{n_2 h}{4\pi^2 m_e r_2^2} \qquad (Eq.17)$$

Now, divide Eq. 16 by Eq. 17, we have

$$\frac{f_1}{f_2} = \frac{n_1 r_2^2}{n_2 r_1^2} \qquad (Eq. 18)$$

According to what Bohr model advocates, we can always have $r_2 = n_2^2 r_1$ if $n_1 = 1$. Then, Eq. 18 leads us to

$$\frac{f_1}{f_2} = \frac{n_1 r_2^2}{n_2 r_1^2} = n_2^3 \qquad (Eq. \quad 19a)$$

Because of $2\pi f_1 r_1 = v_1$ and $2\pi f_2 r_2 = v_2$, if $n_1 = 1$, Eq. 19a can lead us to have

$$\frac{v_1}{v_2} = n_2 \qquad (Eq. \quad 19b)$$

Parallel to Eq 2b, for the electron on orbit of r_1, we have

$$E_1 = K_1 + U_1 = \frac{1}{2} m_e v_1^2 - k\frac{q^2}{r_1} \qquad (Eq. \quad 20a)$$

Similarly, for the electron on orbit of r_2, we have

$$E_2 = K_2 + U_2 = \frac{1}{2} m_e v_2^2 - k\frac{q^2}{r_2} \qquad (Eq. \quad 20b)$$

Between the energy state E_2 to E_1, with the help of Eq. 19b, the energy difference ΔE is

$$\Delta E = E_2 - E_1 = \frac{1}{2} m_e (v_2^2 - v_1^2) - \left(k\frac{q^2}{r_2} - k\frac{q^2}{r_1}\right)$$

$$= \frac{1}{2} m_e \left[\left(\frac{v_1}{n_2}\right)^2 - v_1^2\right] - \left(k\frac{q^2}{n_2^2 r_1} - k\frac{q^2}{r_1}\right)$$

$$= \frac{1}{2} m_e v_1^2 \left(\frac{1}{n_2^2} - 1\right) - k\frac{q^2}{r_1}\left(\frac{1}{n_2^2} - 1\right)$$

$$= -\left(\frac{1}{2} m_e v_1^2 - k\frac{q^2}{r_1}\right)\left(1 - \frac{1}{n_2^2}\right) \qquad (Eq. \quad 21)$$

Due to

$$m_e \frac{v_1^2}{r_1} = k\frac{q^2}{r_1^2} \quad or \quad m_e v_1^2 = k\frac{q^2}{r_1} \qquad (Eq. \quad 22)$$

Eq. 20a equivalently becomes

$$E_1 = -\frac{kq^2}{2r_1} \qquad (Eq. \quad 23)$$

Subsequently, Eq. 21 can become

$$\Delta E = E_1 \left(1 - \frac{1}{n_2^2}\right) = \frac{kq^2}{2r_1}\left(1 - \frac{1}{n_2^2}\right) \qquad (Eq. \quad 24)$$

According to the Bohr model, ΔE is the energy that the electron releases when it jumps from a higher energy orbit to a lower one. This batch of energy so lost by the electron expresses itself as photon and emits. Therefore, as expressed by Eq. 24, and if quantum physics holds, it must lead to

$$h\upsilon = \Delta\, E \; = \frac{kq^2}{2r_1}\left(1 - \frac{1}{n_2^2}\right) \qquad (Eq. \quad 25)$$

where υ is the frequency of the light emitted, h is the Planck constant, and $h\upsilon$ is therefore the energy of one photon.

From the perspective of Bohr model and the overall view of quantum physics, the higher the value of n_2 is, the higher the energy a photon would possess and thus the higher frequency the photon would show. So, according to Eq. 25, the highest energy a photon can ever own would be

$$h\upsilon = \Delta\, E \; = \frac{kq^2}{2r_1} \qquad (Eq. \quad 26)$$

Then,

$$\upsilon = \frac{\Delta\, E}{h} = \frac{kq^2}{2r_1 h}$$

$$= \frac{9 \times 10^9 N \cdot \frac{m^2}{C^2}(1.6 \times 10^{-19}\mathrm{C})^2}{2 \cdot 0.0529nm \cdot 6.63 \times 10^{-34} Js}$$

$$= 3.29 \times 10^{15} Hz \qquad (Eq. 27)$$

The wavelength matching this frequency is *91 nm.*

On the other hand, when $n_2 = 2$, the energy released by the electron due to orbit jump would be the smallest, because the outcome of any other nonzero integer minus 1 would be larger than 1. Eq. 25 thus gives

$$h\upsilon = \Delta\, E \; = \frac{0.75\, kq^2}{2r_1}$$

$$\upsilon = \frac{0.75 \; \times 9 \times 10^9 N \cdot \frac{m^2}{C^2}(1.6 \times 10^{-19}\mathrm{C})^2}{2 \cdot 0.0529nm \cdot 6.63 \times 10^{-34} Js}$$

$$= 2.47 \times 10^{15} Hz \qquad (Eq. 28)$$

The wavelength matching this frequency is *121 nm.*

Neither *91nm* nor *121* nm as wavelength is found in Fig. 01 [2], which shows the spectral lines emitted by hydrogen. Both they are way out of the range that can be shown in this diagram.

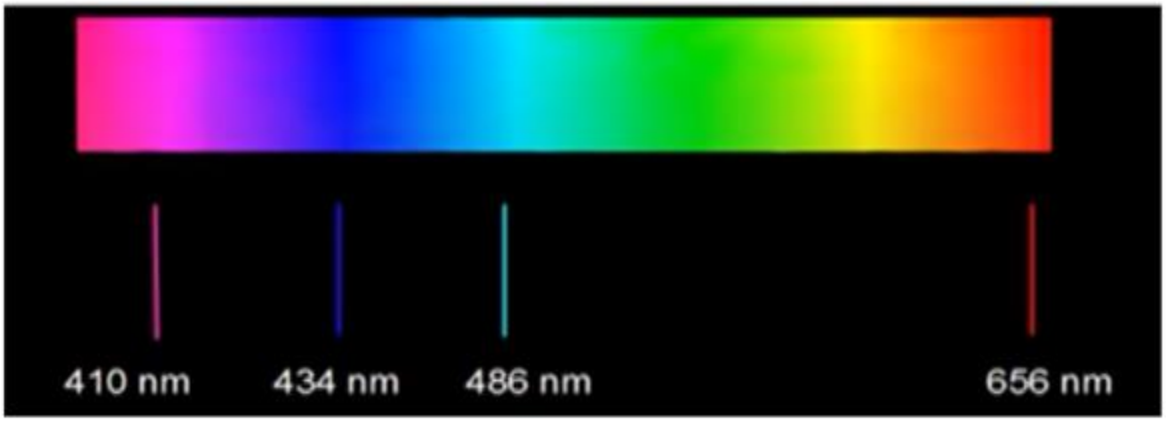

Fig. 01

On the other hand, if we take from Fig 01 the wavelength *656 nm*, to which the light frequency matching is $\upsilon = 0.457 \times 10^{15} Hz$. Then Eq. 26 will give us

$$h = \frac{\Delta E}{\upsilon} = \frac{kq^2}{2r_1\upsilon}$$

$$= \frac{9 \times 10^9 N \cdot \frac{m^2}{C^2} (1.6 \times 10^{-19} C)^2}{2 \cdot 0.0529 nm \cdot 0.457 \times 10^{15} Hz}$$

$$= 47.6 \ \times 10^{-34} Js \qquad (Eq. \quad 29)$$

If we take from Fig 01 the wavelength *410 nm*, to which the light frequency matching is $\upsilon = 0.732 \times 10^{15} Hz$, the procedure leading to Eq. 29 will similarly lead us to

$$h = \frac{9 \times 10^9 N \cdot \frac{m^2}{C^2} (1.6 \times 10^{-19} C)^2}{2 \cdot 0.0529 nm \cdot 0.732 \times 10^{15} Hz}$$

$$= 29.77 \ \times 10^{-34} Js \qquad (Eq. \quad 30)$$

Eq. 14, 29, and 30 together tell us one tendency of the Bohr model: the Planck constant becomes smaller as *n*, the integer corresponding to the size of an orbit, becomes larger—if we ignore the result that the frequencies of the photon deemed by this model are unfound in Fig. 01. Now, such question must pop up in the science world:

Has the Planck constant been hostile to Bohr model or Bohr model hostile to Planck constant? Or could it even be that neither one has ever been valid?

On the Bohr radius, the Coulomb force that an electron receives from the proton is

$$
\begin{aligned}
F_e &= k\frac{q^2}{r_2^2} \\
&= 9\times 10^9 N\cdot\frac{m^2}{C^2}\cdot\frac{(1.6\times 10^{-19}C)^2}{(0.0529nm)^2} \\
&= 0.825\times 10^{-5}N \qquad\qquad (Eq.\quad 31)
\end{aligned}
$$

The centrifugal force F_e produced by this electron's orbital movement is

$$F_c = m_e\frac{v_1^2}{r_1} = m_e(2\pi f)^2 r_1 \qquad\qquad (Eq.\quad 32)$$

Given $F_e = F_c$, Eq. 32 would lead us to have

$$f = \frac{1}{2\pi}\sqrt{\frac{F_e}{m_e r_1}}$$

$$f = \frac{1}{2\pi}\sqrt{\frac{0.825\times 10^{-5}N}{9.11\times 10^{-31}kg\times\ 0.0529nm}}$$

$$
\begin{aligned}
&= \frac{4.14\times 10^{17}}{2\pi}\frac{cycles}{second} \\
&= 0.66\ \times 10^{17}\ Hz \qquad\qquad (\,Eq.\quad 33)
\end{aligned}
$$

If light is produced by the electron's orbital movement, and one cycle of orbit repetition corresponds to one period of EM waves, the above frequency falls in the range of X-ray and gamma ray. However, no evidence is found supportive to that X-rays can be produced by hydrogen. This would add another fact for us to raise the following question:

Does electrons orbiting about nuclei ever happen?

Of course, Bohr's model already stipulates, for no creditable reason, that no EM waves of any frequency can be produced by an electron's orbital movement itself. The problem is that this is an assumption that violates commonly known facts. For this assumption to stand, it must give believable reason to convince and prove to people why the fact stated in the next paragraph cannot happen in the world of atoms:

An electric field must establish itself in the vicinity of an electrical particle; any electron is a particle that carries electrical characteristics. The electric field strength at any point is found remaining the same if the electron stays at rest; the strength at the same point away from this electron must vary if the electron ever moves. The variation may express itself as a pulse or a continuous wave, depending on how the electron moves. The assumption that a continuously circulating electron can cause no variation of electric field in the vicinity of its movement actually requires the readers to first reject the above facts before continuing their reading on the explanation of Bohr model. More astonishingly, according to the model, the light is produced during a one-time jump of the electron between two orbits. This is equivalently an assertion that a onetime movement of the electron is not to produce a pulse to be sensed but a continuous wave of electromagnetism in the order of tera-Hz. All electricity knowledge accumulated in the science realm before the debut of Bohr model thus must become worthless for this model to set sail.

The most fundamental knowledge in physics about electricity also further guarantees that any variation of electric field must be accompanied with variation of a magnetic field at the same pace as the electric field. Therefore, placing another electron at a distance from the orbiting electron, this supposedly at rest electron must be forced to respond to the movement of the orbiting electron, both to the variation of the electric field and the corresponding magnetic field. That this becomes true means that the electron at rest is inevitably responding to an electromagnetic wave. Unless Bohr model can show creditable reason to convince us that the electron at rest must be immune to the variation of EM field in its vicinity, it can only convince us that the third assumption of Bohr model is baseless.

So, Bohr model adds another self-refuted concept to modern physics, which already embraces the following self-refuted concepts:

(1) Length contraction and time dilation advocated by Einstein's relativity [3],
(2) Photon [4].

In fact, if centrifugal force can be proven incapable of supporting an electron to keep a distance from a nucleus, it is time for us to look for new answer for the source providing such force. In this author's view, overwhelming evidence has provided us with inferences to a good candidate: **Aether** [4].

Reference

[1] Bohr radius, Bohr model, https://en.wikipedia.org/wiki/Bohr_model

[2] https://www.khanacademy.org/science/ap-chemistry/electronic-structure-of-atoms-ap/bohr-model-hydrogen-ap/v/emission-spectrum-of-hydrogen

[3] Relativity is self-refuted, c=0, —So "Proven" by Special Relativity, by *Cameron Rebigsol* ,

https://vixra.org/pdf/1912.0453v1.pdf

[4] Third Evidence of Aether, by *Cameron Rebigsol* , https://vixra.org/pdf/2011.0173v1.pdf