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Hydrogen like atom The Bohr atom Atom under External Magnetic Flux (Quantum Magnetic Flux)

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Introduction

The Schrödinger equation solve the Hydrogen-like Atom, the solution is very complicate mathematically and supply a very little understanding why the atom behave so.
In 1913 Bohr proposed a very simple model of the hydrogen atom. I extend this model to see what happens to the atom under a magnetic field. The results obtained using my simple approach are almost the same results obtained from Schrödinger equation with the endless solution, but the physical explanation is entirely different. I leave you the task to check what the correct explanation to the Hydrogen Atom is
See also

QUANTUM MECHANICS Solved using only Newtonian Mechanics

http://vixra.org/abs/1305.0078

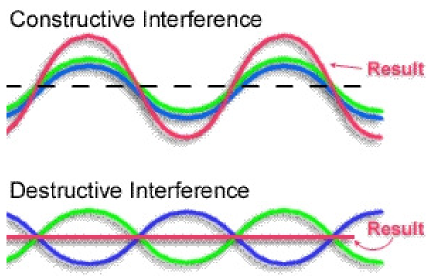
Abbreviations

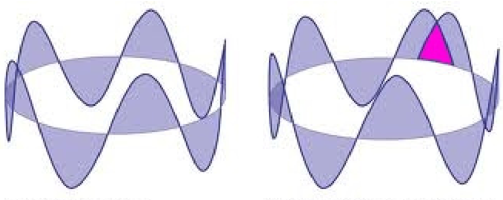
B	*magnetic field*
E_f	*electric field*
Φ	*magnetic flux*
c	speed of light
K	Coulomb Constant
m, m_0	moving mass/rest mass
V	velocity
$p=mV$	momentum
Z	number of protons, Atomic number
$\lambda_e = \frac{h}{m \cdot V} = \frac{h}{p}$	De Borglie wavelength
$\lambda_c = \frac{h}{m_0 \cdot c} = \frac{h}{p_0}$	Compton wavelength
$\alpha = \frac{V_1}{c} = \frac{2\pi K e_p e}{hc}$	Fine structure constant
f	frequency

Introduction
Wave's interference

Wave interference is a phenomenon that occurs when two waves meet while traveling along the same path

1. If two sine wave are in phase the interference is constructive
2. If two sine wave are 180^0 out of phase the interference is destructive
3. In between, the out of phase can be any degree





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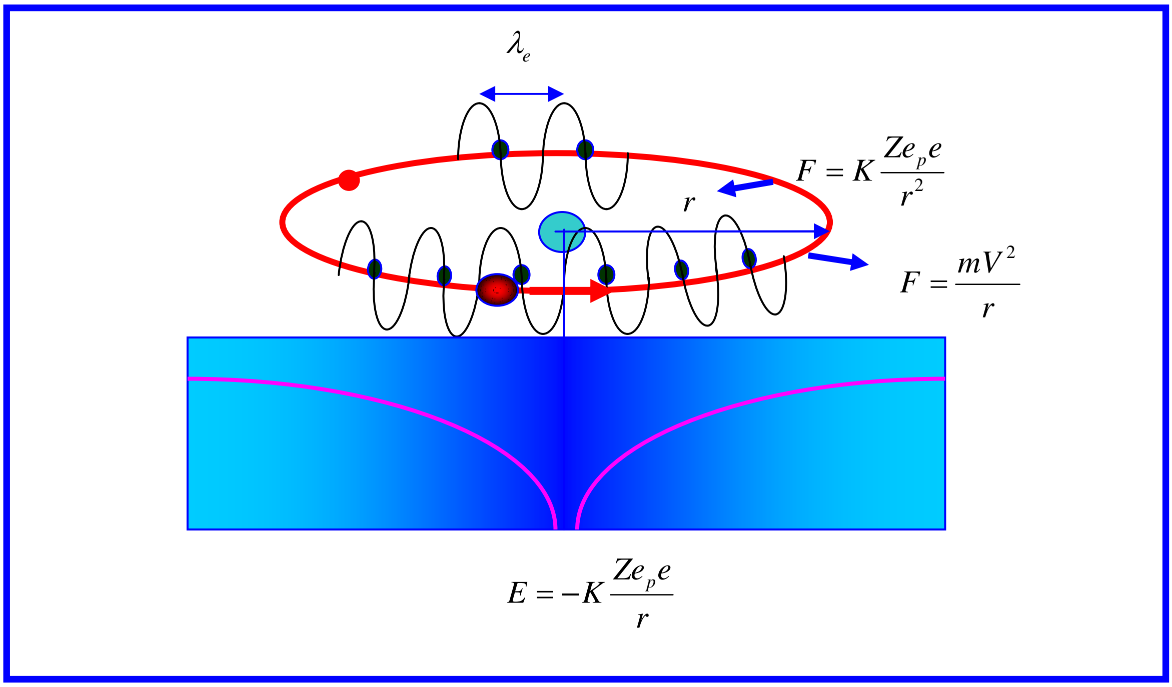
Hydrogen like atom The Bohr atom

The force maintaining the electron in it circular orbit around the nuclei of the atom is the attractive Coulomb force

The Coulomb force is given in the classical form and the second form is using the definition of the "Fine structure constant"

1]
$$F = Z\frac{Ke_pe}{r^2} = \frac{Z}{r^2}\frac{Ke_pe2\pi}{hc}\frac{hc}{2\pi} = \frac{Z}{r^2}\alpha\frac{hc}{2\pi}$$
$$\alpha = \frac{V_1}{c} = \frac{2\pi Ke_pe}{hc}$$

Were e is the electron and proton charge and Z is an integer that indicates how many protons are in the nuclei of the atom (Atomic number).
And α is the fine structure constant



The wave along the trajectory of the electron is a standing wave that obey De Borglie Hypothesis
In order to avoid destructive interference

2] $$2\pi r = n\cdot\lambda_e \qquad n = 1,2,3........$$

where the momentum of the wave associated with the electron is

3] $$\lambda_e = \frac{h}{p}$$

The centrifugal force of the orbiting electron is balance by the Coulomb electric force

4] $$\frac{mV^2}{r} = \frac{(mV)^2}{mr} = \frac{p^2}{mr} = Z\frac{Ke_pe}{r^2} = \frac{Z}{r^2}\alpha\frac{hc}{2\pi}$$

or

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5] $$p^2 = mZ\alpha\frac{hc}{2\pi r} = mZ\alpha\frac{hc}{n\lambda_e} = mZ\alpha\frac{hc}{n\frac{h}{p}}$$

The particle momentum is

5] $$p_n = mV_n = mZ\alpha\frac{c}{n}$$

And the electron velocity around the nuclei is

6] $$V_n = Z\alpha\frac{c}{n}$$

The largest velocity is when *n=1* in that case the electron is near the nuclei. Electrons far from the nuclei move slower *(n>1)*

And the particle energy is

7] $$E_n = \frac{p_n^2}{2m} = \frac{mV_n^2}{2} = \frac{mZ^2\alpha^2c^2}{2\cdot n^2}$$

From the last three equations it is clear that the momentum, velocity and energy are quantized and depend on *n*

To compute the radius of the electron orbit from eq-4

8] $$\frac{p^2}{mr} = Z\frac{Ke_pe}{r^2}$$

Or

9] $$r = mZ\frac{Ke_pe}{p^2}$$

After the following manipulations

10] $$r_n = \frac{mZKe_pe}{\left[mZ\alpha\frac{c}{n}\right]^2} = \frac{Ke_pen^2}{mZ\alpha^2c^2} = \frac{\alpha hc}{2\pi}\frac{n^2}{mZ\alpha^2c^2} = \frac{h}{m\alpha c}\frac{n^2}{2\pi Z}$$

What is found

11] $$2\pi r_nZ = \frac{h}{m\alpha c}n^2 = \frac{h}{mV_1}n^2 = \frac{h}{\frac{mV_1}{n}}n = \frac{h}{p_n}n = \lambda_nn$$

Conclusion

As *r* changes the wavelength changes but still $2\pi r = n\cdot\lambda_e$

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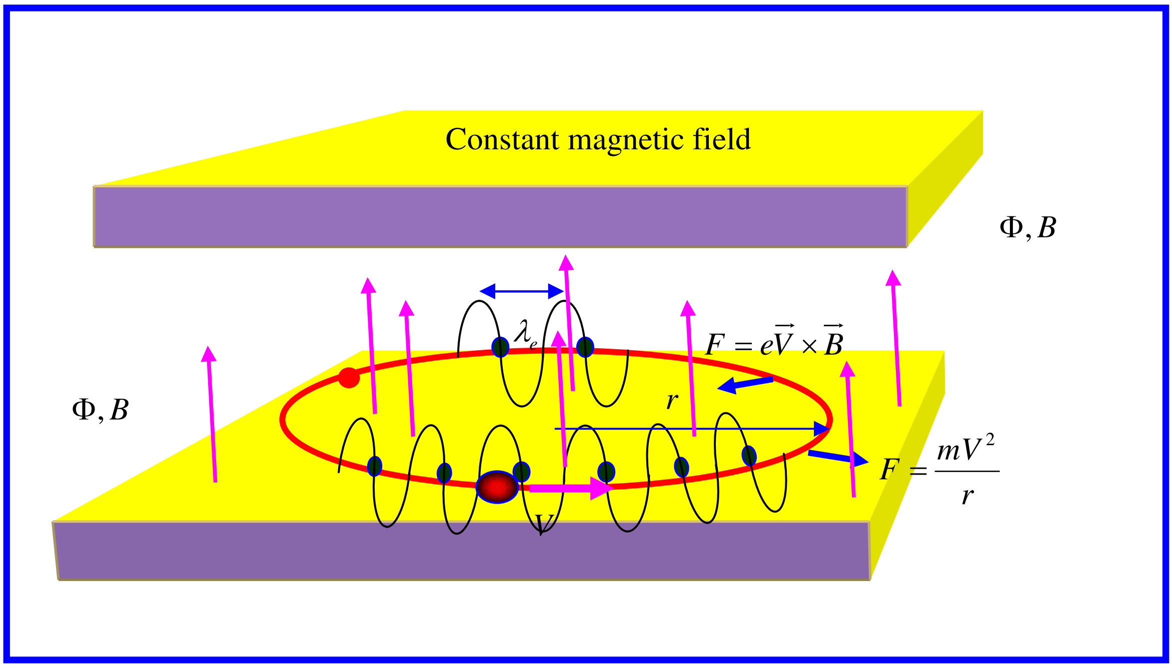
Magnetic Field Quantization
Quantum Magnetic Flux



Suppose now that the electrostatic Coulomb force is replaced by a magnetic force of the same magnitude and direction (see Einstein Equivalence principle)

1] $$F = Z\frac{Ke_p e}{r^2} = eV \cdot B$$

The electrostatic force from eq-1 in the previous chapter, is

2] $$F = Z\frac{Ke_p e}{r^2} = \frac{Z}{r^2}\alpha\frac{hc}{2\pi}$$

Hence

3] $$\frac{Z}{r^2}\alpha\frac{hc}{2\pi} = eVB$$

And the total flux passing threw the circle of the rotating electron is

4] $$\Phi = \pi r^2 B = \frac{Z}{eV}\alpha\frac{hc}{2}$$

In eq-6 in the previous chapter the quantized velocity was found
In this chapter the index n was changed to *l*
l describe magnetic quantization
n describe electrostatic quantization

5] $$V_l = Z\alpha\frac{c}{l}$$

or

6] $$V_l\frac{l}{c} = Z\alpha$$

From eq-4 and eq-6

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7] $$\Phi_l = \pi r^2 B = \frac{V_l \frac{l}{c}}{eV_l} \frac{hc}{2} = l\frac{h}{2e}$$ l=0,1,2,3.....

eq -7 describe what is the exact values of the flux that can be used instead of the Coulomb force

In other word: we can cheat the atom and use magnetic force instead of electrostatic force, we can also use both forces at the same time. But because of the dimension of the atom we must use quantum state.

Let compute the velocity of the electron due to the magnetic flux

8] $$F_l = Z\frac{Ke_p e}{r_l^2} = eV_l \cdot B_l = \frac{eV_l}{\pi r_l^2} \cdot \pi r_l^2 B_l = \frac{eV_l}{\pi r_l^2} \cdot \Phi_l = \frac{eV_l}{\pi r_l^2}\frac{hl}{2e} = \frac{V_l}{\pi r_l^2}\frac{hl}{2}$$

So

9] $$Z\frac{Ke_p e}{r_l^2} = \frac{V_l}{\pi r_l^2}\frac{hl}{2}$$

and finally

10] $$V_l = \frac{2\pi Z K e_p e}{hl}$$

And from eq-3 the momentum is

9] $$p_l = mV_l = m\left[KZe_p\right]\frac{2e}{hn} \cdot \pi = m\left[KZe_p\right]\frac{\pi}{\Phi_l}$$

Conclusion

$\Phi_l = l\frac{h}{2e}$ Is the Quantum Magnetic Flux that

1. can replace the Coulomb force
2. or if a coulomb force F_l keep the circulating electron in its trajectory and a quantized flux Φ_l in opposite direction is applied the electron may escape from its stable trajectory and change energy state or leave the nuclei.
3. The magnetic field produces similar effect as the electrostatic field does, A magnetic field can replace the atom nuclei

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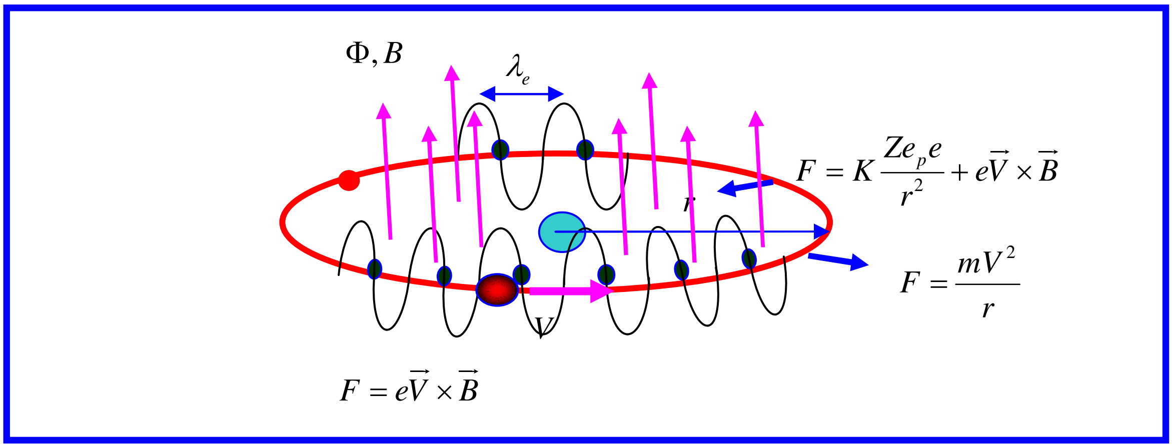
Electron Motion Under Electrostatic and Magnetic Fields



Usually the force that attracts the electron to the nuclei is an electrostatic force. If an external magnetic field is applied the centrifugal force on the electron can increase or decrease depend of the direction of the external magnetic vector B

The net forces acting on the electron is

1] $$K\frac{Ze_p e}{r^2} = \frac{mV^2}{r} \pm eVB$$

From the previous chapter

2] $$\Phi = \pi r^2 B$$

Now let multiply eq-1 by $2\pi r^2$,
 what we get is

3] $$K\frac{2\pi r^2 Ze_p e}{r^2} = \frac{2\pi r^2 mV^2}{r} + 2\pi r^2 eVB$$

The last equation is reduced to

4] $$2\pi ZKe_p e = 2\pi rmV^2 + 2eV\Phi$$

Where

5] $$\Phi = \pi r^2 B$$

Now we remember that according to quantum mechanics the wave along the trajectory of the electron is a standing wave that obey De Borglie Hypothesis

6] $$2\pi r = q\lambda = q\frac{h}{p} \qquad q=1,2,3.......$$

Eq-3 can be modified

7] $$2\pi ZKe_p e = 2\pi r\frac{m^2V^2}{m} + 2eV\Phi = 2\pi r\frac{p^2}{m} + 2eV\Phi$$

Now let use eq-6 in eq-7

8] $$V = \frac{2\pi ZKe_p e}{h\left(q + \frac{2e}{h}\Phi\right)}$$

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But for an electron in an electrostatic field

9] $$V_n = \frac{2\pi Z K e_p e}{hn}_{\text{atom with electrostatic field only}} = \frac{2\pi Z K e_p e}{h\left(q + \frac{2e}{h}\Phi\right)}_{\text{atom with magnetic and electrostatic field}}$$

Therefore the right side of the following equation must be an integer because *n* on the left side is an integer

10] $$n = q + \frac{2e}{h}\Phi$$

conclusion

11] $$n = q + l$$

so

12] $$\Phi_l = \frac{h}{2e} l$$

This result was found in the previous chapter so if a magnetic field is applied on the atom, only quantized flux Φ_l affect the atom by changing electron velocity and changing its radius of rotation

13] $$V_n = Z\alpha \frac{c}{n}_{\text{atom with electrostatic field only}} = Z\alpha \frac{c}{q + l}_{\text{atom with magnetic and electrostatic field}}$$

The magnetic field can be applied in two directions; therefore it is more accurate to write

14] $$V_n = Z\alpha \frac{c}{n} = Z\alpha \frac{c}{q \pm l}$$

Now let check what quantum numbers q *& l* are allowed

If *q=0* the electrostatic field is zero because no nuclei exist in the center of the atom. What we get is a cloud of electrons without nuclei. This paper does not fit such a situation.

So *q* must be at least 1 and *l* is limited

15] $$0 \le l \le n - 1$$

Now if

16] $$n + 1 > q + l > n$$

If the quantum number grow by 1, the number of combination grow

17] $$V_{n+1} = Z\alpha \frac{c}{n+1} = Z\alpha \frac{c}{q \pm l}$$

So *q* must be at least 1 and *l* is limited now to

15] $$0 \le l \le n$$

and so on

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	n	*q*	*l*
	1	1	0
	2	2	0
	2	1	1
	3	3	0
	3	2	1
	3	1	2
	4	4	0
	4	3	1
	4	2	2
	4	1	3

Summery

The suggested solution to the quantum states of the Hydrogen like Atom is the most simplest, And base entirely of classical electromagnetism Newtonian mechanics and De Borglie Hypothesis.
The consequence of Schrödinger solution to this problem is a bit different. And it is your task to check what the physical truth is.

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