SPEED of ATOMIC PARTICLES

and

PHYSICAL CONSTANTS

Second edition

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Speed of atomic particles and physical constants

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Cover image: **Comet 17P**

The image was taken by the NASA/ESA Hubble Space Telescope and reveals the Comet Holmes's bright core. It shows the coma, the cloud of dust and gas encircling the comet. The image was taken 31 October 2007.

Credit: URL "http://www.nasa.gov" NASA, URL "http://www.esa.int" ESA, and H. Weaver (The Johns Hopkins University Applied Physics Laboratory).

Prologue at second edition

Due to the difficult task of correction and my anxiety to emit this work sooner, I forgot to include the necessary references that were left as last task.

I have taken advantage of this opportunity to insert new details, as well as the development that you can see in the first annex.

My sincere excuses to the readers and involved honorable scientists,

Cordoba – Argentina, February 28, 2008

Prologue at first edition

This work was created without ending and publishing for more than three years, due to several requests by e-mail about questions on atomic particles speeds, I decided to conclude this report and to carry out a publication. If you see in the constants published in "Dimensional and constant units" section, that could be understandable because the big delay that took the publishing of this work, I have attributed the mistake to myself, now I know that this, it is not like this.

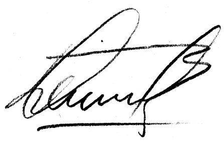
With the acquired experience during the research of nuclear stability of hydrogen family and helium family, I have already been able to determine with great precision the magnetic constant correlation taking as to the other well-known fundamental constants, solving an old question about the mysterious one "*Fine-structure constant*".

Also, I give an appropriate answer to the question on trajectory of atomic particles in orbit to the speed of the light, because in their displacement the helix forms a toroidal magnetic field, the resulting force of this magnetic field establishes the equilibrium in magnetic-dynamics form with enormous inertial resultant of particles in orbit and determined by the traverse component of spin vector speed on the spin, near to the speed of the light.

I hope that the present work will reach a milestone in the understanding of physical phenomenon-logics. Due to the present beliefs I know that this will cost a lot of time and effort.

Sincerely,

Cordoba – Argentina, January 31, 2008



Daniel Eduardo Caminoa Lizarralde

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This work is dedicated to my small and dear grandsons:

Tomás

Dessirèe

Nicolás

Federico

and

Agustina

Speed of atomic particles and physical constants

In the following study I carry out the analysis of three possible situations: when the orbit radius of particles are bigger than the cardinal orbit (quantum state bigger to the unit - In the atom this state exists in all electron and nuclear proton), when the orbit radius of particles are exactly the cardinal orbit (unitary quantum state - This situation is not given in any case in the atoms) and lastly when the orbit radius are smaller to the cardinal orbit (quantum state smaller to the unit - In the atom it occurs only in the case of negatrons, the most internal layer in the atomic nucleus), seen the previous publications "*QEDa Theory – The atom and their nucleus*" (12), "*The hydrogen family – Stability and gyromagnetic ratios*" (13) and "*The helium family – Stability and gyromagnetic ratios*" (14).

Analysis of speeds

Because atomic particles travels to the speed of the light describing a helix around the trajectory in orbit, the resulting vector can be decomposed in two vectors: one normal and tangential to orbit, that gives us the speed tangential medium, and another that is transverse to orbit and tangent to the torus helix of spin, that gives us the speed of spin tangential medium.

Starting from the Law of Bohr(1) (extended postulate of Bohr), I have determined the expression of calculation of the cardinal orbit radius and the expression of calculation of any other radius of atomic orbit. In the annex 1 you can see the calculation of the cardinal radius deduced with Einstein's relationship(2) and De Broglie(3).

$$\underbrace{m \cdot v \cdot r = \frac{h \cdot n}{2 \cdot \pi}}_{\text{Postulate of Bohr}} \qquad \underbrace{m_x \cdot c \cdot r_x = \frac{h}{2 \cdot \pi} \cdot n \quad \text{and} \quad n \ \text{(Real number)}}_{\text{Law of Bohr}}$$

then

$$\text{(smaller than the cardinal radius)} \quad n = \frac{Q_x^v}{Q_x^r} = \frac{1}{Q_x^r} \prec 1 \quad \therefore \quad r_x = \frac{h}{2 \cdot \pi \cdot c \cdot m_x} \cdot \frac{1}{Q_x^r} \qquad 1$$

$$\text{(cardinal radius)} \quad n = \frac{Q_x^v}{Q_x^r} = \frac{1}{1} = 1 \quad \therefore \quad r_x^{cd} = \frac{h}{2 \cdot \pi \cdot c \cdot m_x} \qquad 2$$

$$\text{(bigger than the cardinal radius)} \quad n = \frac{Q_x^v}{Q_x^r} = \frac{Q_x^v}{1} \succ 1 \quad \therefore \quad r_x = \frac{h}{2 \cdot \pi \cdot c \cdot m_x} \cdot Q_x^v \qquad 3$$

where m_x is the inertial mass of particle *x* (*e*: electron, *p*: proton and *n*: negatron), c is the speed of light, r_x is the orbit radius of particle *x*, n is the quantum state (it's always a real number), r_x^{cd} is the cardinal orbit radius of particle *x* (when the quantum state of particle is exactly equal to the unit, that it's a physical constant characteristic of each atomic particle), Q_x^v is the quantum vectorial number calculated with the stability expression for the particle *x* and Q_x^r is the quantum radial number calculated with the stability expression for the particle *x*.

The traveling time of an once orbit is:

$$\text{time} = \frac{\text{real space (minimum is cardinal orbit or bigger but multiple)}}{\text{speed of the light}} \quad \text{and} \quad \text{step or pass} = P_x \ \text{(integer number)}$$

$$\text{then} \quad t_x = \frac{2 \cdot \pi \cdot r_x^{cd} \cdot P_x}{c} = \frac{2 \cdot \pi \cdot \dfrac{h}{2 \cdot \pi \cdot c \cdot m_x} \cdot P_x}{c} = \frac{h}{c^2 \cdot m_x} \cdot P_x \qquad 4$$

$$\text{(smaller than the cardinal radius)} \quad \text{spin turns} = P_x = I_x^r \succ 1$$

$$\text{but real space} = 2 \cdot \pi \cdot r_x^{cd} \ \text{(constant)} \quad \therefore \quad t_x = \frac{h}{c^2 \cdot m_x} \qquad 5$$

$$\text{(cardinal radius)} \quad \text{spin turns} = P_x = 1 \quad \therefore \quad t_x = \frac{h}{c^2 \cdot m_x} \qquad 6$$

$$\text{(bigger than the cardinal radius)} \quad \text{spin turns} = P_x = \left(I_x^v\right)^2 \succ 1 \quad \therefore \quad t_x = \frac{h}{c^2 \cdot m_x} \cdot \left(I_x^v\right)^2 \qquad 7$$

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where t_x it's the time in traveling an orbit of particle *x* and l_x^v is the quantum state of the particle *x* (the bigger integer most closest where by the value Q_x^v has been calculated).

The inertial resultant to the speed tangential medium ($\overline{v_x}$) on atomic particles is due always to the equilibrium in form dynamics-potential, just as we have already seen in the analysis of atomic and nuclear equilibrium except in cardinal radius that it is magnetic-dynamic, the mathematical expressions are:

$$\text{medium speed} = \frac{\text{longitude of orbit or space}}{\text{time}} \qquad \text{then}$$

(smaller than the cardinal radius) $$\overline{v_x} = \frac{2\cdot\pi\cdot\dfrac{h}{2\cdot\pi\cdot c\cdot m_x\cdot Q_x^r}}{\dfrac{h}{c^2\cdot m_x}} = \frac{c}{Q_x^r} \qquad 8$$

(cardinal radius) $$\overline{v_x} = \frac{2\cdot\pi\cdot\dfrac{h}{2\cdot\pi\cdot c\cdot m_x}}{\dfrac{h}{c^2\cdot m_x}} = c \qquad 9$$

(bigger than the cardinal radius) $$\overline{v_x} = \frac{2\cdot\pi\cdot\dfrac{h}{2\cdot\pi\cdot c\cdot m_x}\cdot Q_x^v}{\dfrac{h}{c^2\cdot m_x}\cdot\left(l_x^v\right)^2} = c\cdot\frac{Q_x^v}{\left(l_x^v\right)^2} \qquad 10$$

where l_x^v is the quantum state of the particle *x* (the bigger integer most closest where by the value Q_x^v has been calculated), for that reason always l_x^v is bigger than Q_x^v.

The magnitude of speed vector of the spin tangential medium ($\overline{v_{sx}}$) was easily determined by Pythagoras relationship, knowing that the speed on the helix is always equal to the speed of the light and then their mathematical expression is:

$$\overline{v_{sx}} = \sqrt{c^2 - \left(\overline{v_x}\right)^2} \qquad \text{then}$$

(cardinal radius) $$\overline{v_{sx}} = \sqrt{c^2 - \left(\frac{c}{1}\right)^2} \quad \therefore \quad \overline{v_{sx}} \to 0 \qquad 11$$

(smaller than the cardinal radius) $$\overline{v_{sx}} = \sqrt{c^2 - \left(\frac{c}{Q_x^r}\right)^2} = c\cdot\sqrt{1 - \frac{1}{\left(Q_x^r\right)^2}} \qquad 12$$

(bigger than the cardinal radius) $$\overline{v_{sx}} = \sqrt{c^2 - \left(c\cdot\frac{Q_x^v}{\left(l_x^v\right)^2}\right)^2} = c\cdot\sqrt{1 - \frac{\left(Q_x^v\right)^2}{\left(l_x^v\right)^4}} \qquad 13$$

Analysis of inertial resultants

According to Newton Laws[4] the inertial resultants are always given by the following expressions. The inertial resultants for the speed tangential medium (F_x^i) is:

$$F_x^i = \frac{m_x\cdot\left(\overline{v_x}\right)^2}{r_x} \qquad \text{then}$$

(cardinal radius) $$F_x^i = \frac{m_x\cdot c^2}{\dfrac{h}{2\cdot\pi\cdot c\cdot m_x}} = \frac{2\cdot\pi\cdot c^3\cdot m_x^2}{h} \qquad 14$$

(smaller than the cardinal radius) $$F_x^i = \frac{m_x\cdot\left(\dfrac{c}{Q_x^r}\right)^2}{\dfrac{h}{2\cdot\pi\cdot c\cdot m_x\cdot Q_x^r}} = \frac{2\cdot\pi\cdot c^3\cdot m_x^2}{h}\cdot\frac{1}{Q_x^r} \qquad 15$$

(bigger than the cardinal radius) $$F_x^i = \frac{m_x\cdot\left(c\cdot\dfrac{Q_x^v}{\left(l_x^v\right)^2}\right)^2}{\dfrac{h\cdot Q_x^v}{2\cdot\pi\cdot c\cdot m_x}} = \frac{2\cdot\pi\cdot c^3\cdot m_x^2}{h}\cdot\frac{Q_x^v}{\left(l_x^v\right)^4} \qquad 16$$

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This inertial resultant in all the cases it's balanced by the potential resultants, for this reason it was included inside the atomic and nuclear calculation expressions, except the expression No. 14 of the cardinal radius that doesn't correspond to any particle in atomic orbit.

The spin radius can be determined by Pythagoras relationship.

$$r_{sx} = \sqrt{(Sh_x)^2 - (Lp_x)^2} \qquad \text{then}$$

(cardinal radius)

$$r_{sx} = \sqrt{\left(r_x^{cd}\right)^2 - \left(\frac{r_x}{P_x}\right)^2} = \sqrt{\left(r_x^{cd}\right)^2 - \left(\frac{r_x^{cd}}{1}\right)^2} \quad \therefore \quad r_{sx} \to 0 \qquad 17$$

(smaller than the cardinal radius) being $P_x = l_n^r$ and space traveled $= 2 \cdot \pi \cdot r_x^{cd}$ (constant)

$$r_{sn} = \frac{1}{l_n^r} \cdot \sqrt{\left(r_n^{cd}\right)^2 - \left(\frac{r_n}{P_n}\right)^2} = \frac{1}{l_n^r} \cdot \sqrt{\left(\frac{h}{2 \cdot \pi \cdot c \cdot m_n}\right)^2 - \left(\frac{\frac{h}{2 \cdot \pi \cdot c \cdot m_n \cdot Q_n^r}}{1}\right)^2} = \frac{h}{2 \cdot \pi \cdot c \cdot m_n \cdot l_n^r} \cdot \sqrt{1 - \frac{1}{\left(Q_n^r\right)^2}} \qquad 18$$

(bigger than the cardinal radius)

$$r_{sx} = \sqrt{\left(r_x^{cd}\right)^2 - \left(\frac{r_x}{P_x}\right)^2} = \sqrt{\left(\frac{h}{2 \cdot \pi \cdot c \cdot m_x}\right)^2 - \left(\frac{\frac{h}{2 \cdot \pi \cdot c \cdot m_x} \cdot Q_x^v}{\left(l_x^v\right)^2}\right)^2} = \frac{h}{2 \cdot \pi \cdot c \cdot m_x} \cdot \sqrt{1 - \frac{\left(Q_x^v\right)^2}{\left(l_x^v\right)^4}} \qquad 19$$

where Sh_x it's the space traveled by step of helix spin of particle *x*, Lp_x it's the longitude of each step of spin helix of particle *x* and l_x^r is the quantum state of the particle *x* (the smaller integer most closest where by the value Q_x^r has been calculated), for that reason always l_x^r is smaller than Q_x^r.

The radius of the spin helix for the cardinal orbit tends to zero because it is unitary quantum state and one only spin turn on which is completed an orbit and for that reason toroidal magnetic field in cardinal orbit doesn't exist.

Knowing the calculation expression of the spin radius, we can determine the inertial resultants for the speed of spin tangential medium (F_{sx}^i) in all quantum state.

$$F_{sx}^i = \frac{m_x \cdot \left(\overline{v_{sx}}\right)^2}{r_{sx}} \qquad \text{then}$$

(cardinal radius)

$$\overline{v_{sx}} \to 0 \quad \therefore \quad F_{sx}^i \to 0 \qquad 20$$

(smaller than the cardinal radius)

$$F_{sn}^i = \frac{m_n \cdot \left(c \cdot \sqrt{1 - \frac{1}{\left(Q_n^r\right)^2}}\right)^2}{\frac{h}{2 \cdot \pi \cdot c \cdot m_n \cdot l_n^r} \cdot \sqrt{1 - \frac{1}{\left(Q_n^r\right)^2}}} = \frac{2 \cdot \pi \cdot c^3 \cdot m_n^2 \cdot l_n^r}{h} \cdot \sqrt{1 - \frac{1}{\left(Q_n^r\right)^2}} \qquad 21$$

(bigger than the cardinal radius)

$$F_{sx}^i = \frac{m_x \left(c \cdot \sqrt{1 - \frac{\left(Q_x^v\right)^2}{\left(l_x^v\right)^4}}\right)^2}{\frac{h}{2 \cdot \pi \cdot c \cdot m_x} \cdot \sqrt{1 - \frac{\left(Q_x^v\right)^2}{\left(l_x^v\right)^4}}} = \frac{2 \cdot \pi \cdot c^3 \cdot m_x^2}{h} \cdot \sqrt{1 - \frac{\left(Q_x^v\right)^2}{\left(l_x^v\right)^4}} \qquad 22$$

The inertial resultant for the speed of spin tangential medium for radius smaller or bigger than the cardinal radius is not included inside the atomic and nuclear calculation expressions because there is an auto-equilibrium of magnetic-dynamic type as we will see later inside this work.

The expressions No. 18 and No. 21 only correspond with the negatron, because it's the unique atomic particle with smaller orbit than the cardinal radius orbit.

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Analysis of electric intensities

The frequency to pass particles is directly proportional to the speed and inversely proportional to the traveled space.

being step $P_x = \left(l_x^v\right)^2$ and cardinal radius $r_x^{cd} = \dfrac{h}{2\cdot\pi\cdot c\cdot m_x}$ then

(smaller or cardinal radius) $$f_x = \frac{c}{2\cdot\pi\cdot r_x^{cd}\cdot P_x} = \frac{c}{2\cdot\pi\cdot\dfrac{h}{2\cdot\pi\cdot c\cdot m_x}\cdot 1} = \frac{c^2\cdot m_x}{h} \qquad 23$$

(bigger than the cardinal radius) $$f_x = \frac{c}{2\cdot\pi\cdot r_x^{cd}\cdot P_x} = \frac{c}{2\cdot\pi\cdot\dfrac{h}{2\cdot\pi\cdot c\cdot m_x}\cdot\left(l_x^v\right)^2} = \frac{c^2\cdot m_x}{h\cdot\left(l_x^v\right)^2} \qquad 24$$

where f_x is frequency to pass particles, P_x is quantity of step or pass of the spin helix (quantity of spires) and r_x^{cd} is the cardinal orbit radius, per $2\cdot\pi$ is longitude of each step.

The electric intensity is directly proportional to the frequency particles way per elementary charge according to the Ampere Law(6), is given for:

.

(smaller or cardinal radius) $$I_x = q\cdot f_x = q\cdot\frac{c^2\cdot m_x}{h} \qquad 25$$

(bigger than the cardinal radius) $$I_x = q\cdot f_x = q\cdot\frac{c^2\cdot m_x}{h\cdot\left(l_x^v\right)^2} \qquad 26$$

Therefore the electric intensity (I_x) is constant for smaller or cardinal orbit and bigger that the cardinal orbit, are being inversely proportional to the quantum state and for this reason the electric intensity diminishes in the measure that increases the orbit radius of the particle.

Magnitude analysis in magnetic forces resultant

1 – In cardinal orbit – Unitary quantum state.

In the cardinal orbit magnetic torus field doesn't exist, because their spin radius and speed vector of the spin tangential medium tend to zero. The magnitude of magnetic vector $\overline{B_x}$ transverse at the orbit plane (an only spire) according to the Biot and Savart Law(7) is given by the following expression:

$$\overline{B_x} = k_m\cdot\frac{2\cdot\pi\cdot I_x}{r_x} = k_m\cdot\frac{2\cdot\pi\cdot q\cdot\dfrac{c^2\cdot m_x}{h}}{\dfrac{h}{2\cdot\pi\cdot c\cdot m_x}}\cdot = k_m\cdot\frac{4\cdot\pi^2\cdot c^3\cdot m_x^2\cdot q}{h^2} \qquad 27$$

where k_m is a magnetic constant. Then, the magnitude of the magnetic force resultant F_x^m is given by the following expression:

$$F_x^m = I_x\cdot L_x\cdot\overline{B_x} = q\cdot\frac{c^2\cdot m_x}{h}\cdot 2\cdot\pi\cdot\frac{h}{2\cdot\pi\cdot c\cdot m_x}\cdot k_m\cdot\frac{4\cdot\pi^2\cdot c^3\cdot m_x^2\cdot q}{h^2} = k_m\cdot\left(\frac{2\cdot\pi\cdot c^2\cdot q\cdot m_x}{h}\right)^2 \qquad 28$$

where L_x it's the space traveled by each orbit or also longitude of the spire.

2 – Equilibrium condition of all atomic particles in cardinal orbit

The condition is magnetic-dynamics, the resultant inertial (expression No. 14) dependent of speed tangential medium should be exactly equal to the magnetic resultant (expression No. 28), because both vectors are annulled among themselves, just as I show in the following expression:

$F_x^i = F_x^m$ being $Q_x^v \to 1$ and $l_x^v \to 1$

then $$\frac{2\cdot\pi\cdot c^3\cdot m_x^2}{h} = k_m\cdot\left(\frac{2\cdot\pi\cdot c^2\cdot q\cdot m_x}{h}\right)^2 \qquad 29$$

Therefore, we can make the following operation to know the magnitude of the magnetic constant and to verify this equality

$$\text{Solve for } k_m \text{ in } \quad \frac{2\cdot\pi\cdot c^3\cdot m_x^2}{h} = k_m\cdot\left(\frac{2\cdot\pi\cdot c^2\cdot q\cdot m_x}{h}\right)^2$$

$$\text{then} \quad k_m \rightarrow \frac{h}{2\cdot\pi\cdot c\cdot q^2} = 1.37035999694076\times10^{-5}\ \text{N.A}^{-2} \qquad 30$$

and magnitudes in cardinal radius are

$$\text{Electron} \quad F_e^i = F_e^m = 0.21156441702105\ \text{Newton} \qquad 31$$

$$\text{Proton} \quad F_p^i = F_p^m = 712384.994103690\ \text{Newton} \qquad 32$$

$$\text{Negatron} \quad F_n^i = F_n^m = 1.90407975318941\ \text{Newton} \qquad 33$$

In order to establish the difference among NIST[5] and QEDa[12] magnetic constant; we calculate the existent relationship among their magnitudes and we reach the conclusion that the difference is exactly the inverse magnitude of the denominated "fine-structure constant" in NIST[5].

$$\text{Relationship} \quad \frac{k_m}{\mu_0/4\cdot\pi} = \frac{h/2\cdot\pi\cdot c\cdot q^2}{10^{-7}} =$$

$$= \frac{6.62606896\times10^{-34}}{2\times\pi\times10^{-7}\times299792458.\times\left(1.602176487\times10^{-19}\right)^2} = 137.035999694076 =$$

$$= \frac{1}{\alpha} = 137.036\ (\text{exact inverse "Fine-structure constant" - NIST}) \qquad 34$$

The established correlation of magnetic constant with other constants is fundamental, as you can appreciate in the section "Determination of dimensional constant". The expression No. 30 is of fundamental importance because it correlates Newton[4], Ampere[6], Biot and Savart[7] Laws.

3 – Electrons and protons in atomic orbit.

The atomic particles make an orbit trajectory in helix form (spin helix) at the speed of the light, whenever their quantum state is smaller or bigger to the unit, which creates a magnetic torus field content inside it.

The magnitude of magnetic vector $\overline{B_{sx}}$ (tangent at orbit) of the toroidal magnetic field formed by the spin helix, is given by the following expression:

$$\overline{B_{sx}} = k_m\cdot\frac{2\cdot\pi\cdot P_x}{r_x^{cd}}\cdot I_x = k_m\cdot\frac{2\cdot\pi\cdot\left(l_x^v\right)^2}{\dfrac{h}{2\cdot\pi\cdot c\cdot m_x}}\cdot q\cdot\frac{c^2\cdot m_x}{h\cdot\left(l_x^v\right)^2} = k_m\,\frac{4\cdot\pi^2\cdot q\cdot c^3\cdot m_x^2}{h^2} \qquad 35$$

where P_x is the quantity step or pass of the spin helix (quantity of spires) and r_x^{cd} is the cardinal orbit radius, per $2\cdot\pi$ is longitude of each step or pass.

The magnitude of magnetic force resultant (F_{sx}^m) of the toroidal magnetic field formed by the spin helix is given by the following expression:

$$F_{sx}^m = I_x\cdot L_x\cdot\overline{B_{sx}} = I_x\cdot2\cdot\pi\cdot r_{sx}\cdot P_x\cdot\overline{B_{sx}} =$$

$$= q\cdot\frac{c^2\cdot m_x}{h\cdot\left(l_x^v\right)^2}\cdot2\cdot\pi\cdot\frac{h}{2\cdot\pi\cdot c\cdot m_x}\sqrt{1-\frac{\left(Q_x^v\right)^2}{\left(l_x^v\right)^4}}\cdot\left(l_x^v\right)^2\cdot k_m\,\frac{4\cdot\pi^2\cdot q\cdot c^3\cdot m_x^2}{h^2} =$$

$$= k_m\cdot\frac{4\cdot\pi^2\cdot c^4\cdot q^2\cdot m_x^2}{h^2}\sqrt{1-\frac{\left(Q_x^v\right)^2}{\left(l_x^v\right)^4}} \qquad 36$$

This resultant is exactly opposed to the inertial resultants for the speed of spin tangential medium (F_{sx}^{i}) calculated with the expression No. 22.

4 – Equilibrium condition of electrons and protons in atomic orbit

The electron and the proton only remain in orbit if these two conditions are necessarily satisfied:

- The first condition is dynamics-potential, the resultant inertial (expression No. 16) dependent of the speed tangential medium plus the potential resultant of electron or proton among each other should be exactly equal to the potential resultant; condition that we have already seen in the previous publications "*QEDa Theory – The atom and their nucleus*" [(12)], "*The hydrogen family – Stability and gyromagnetic ratios*" [(13)] and "*The helium family – Stability and gyromagnetic ratios*" [(14)].
- The second condition is magnetic-dynamics, the inertial resultants for the speed of spin tangential medium F_{sx}^{i} (expression No. 22) dependent of the vector speed of spin tangential medium (v_{sx}) should be equal to the magnitude resultant of magnetic force F_{sx}^{m} (expression No. 36), due to the exact opposition of vectors, just as I show in the following equation:

$$F_{sx}^{i} = F_{sx}^{m} \qquad \text{being} \qquad l_x^v \succ Q_x^v \succ 1$$

$$\text{if for hypothesis} \qquad \frac{2\cdot\pi\cdot c^3\cdot m_x^2}{h}\cdot\sqrt{1-\frac{\left(Q_x^v\right)^2}{\left(l_x^v\right)^4}} = k_m\cdot\frac{4\cdot\pi^2\cdot c^4\cdot q^2\cdot m_x^2}{h^2}\sqrt{1-\frac{\left(Q_x^v\right)^2}{\left(l_x^v\right)^4}} \qquad 37$$

$$\text{and being} \qquad k_m = \frac{h}{2\cdot\pi\cdot c\cdot q^2} \qquad \text{then it is verified}$$

$$\frac{2\cdot\pi\cdot c^3\cdot m_x^2}{h}\cdot\sqrt{1-\frac{\left(Q_x^v\right)^2}{\left(l_x^v\right)^4}} = \frac{\cancel{h}}{\cancel{2}\cdot\cancel{\pi}\cdot\cancel{c}\cdot\cancel{q^2}}\cdot\frac{\cancel{4}\,2\cdot\pi^{\cancel{2}}\cdot c^{\cancel{4}\,3}\cdot\cancel{q^2}\cdot m_x^2}{h^{\cancel{2}}}\sqrt{1-\frac{\left(Q_x^v\right)^2}{\left(l_x^v\right)^4}} \qquad 38$$

5 – Negatrons – Quantum states in atomic orbit.

The negatrons have a smaller orbit radius than the cardinal radius, then always the quantity of steps or pass of the spin helix is equal to the quantum status, and the orbit longitude travel of the negatrons it is always equal to the longitude of cardinal radius orbit.

The magnitude of magnetic vector $\overline{B_{sn}}$ (tangent at orbit) of the toroidal magnetic field formed by the spin helix, is given by the following expression:

$$\overline{B_{sn}} = k_m\cdot\frac{2\cdot\pi\cdot l_n^r}{r_n^{cd}}\cdot I_n = k_m\cdot\frac{2\cdot\pi\cdot l_n^r}{\frac{h}{2\cdot\pi\cdot c\cdot m_n}}\cdot q\cdot\frac{c^2\cdot m_n}{h} = k_m\,\frac{4\cdot\pi^2\cdot q\cdot c^3\cdot m_n^2\cdot l_n^r}{h^2} \qquad 39$$

Then, the magnitude of magnetic force resultant (F_{sn}^{m}) of the toroidal magnetic field formed by the spin helix is given by the following expression:

$$F_{sn}^{m} = I_n\cdot L_n\cdot P_n\cdot\overline{B_{sn}} = q\cdot\frac{c^2\cdot m_n}{h}\cdot 2\cdot\pi\cdot\frac{h}{2\cdot\pi\cdot c\cdot m_n\cdot l_n^r}\sqrt{1-\frac{1}{\left(Q_n^r\right)^2}}\cdot l_n^r\cdot k_m\,\frac{4\cdot\pi^2\cdot q\cdot c^3\cdot m_n^2\cdot l_n^r}{h^2} =$$

$$= k_m\cdot\frac{4\cdot\pi^2\cdot c^4\cdot q^2\cdot m_n^2\cdot l_n^r}{h^2}\sqrt{1-\frac{1}{\left(Q_n^r\right)^2}} \qquad 40$$

6 – Equilibrium condition of negatrons in atomic orbit

The negatron remains in orbit and only a condition should be necessarily to be completed:

- The magnetic-dynamic equilibrium (expression No. 21 and No. 40) is absolute and with dynamics-potential condition, the inertial resultant (expression No. 15) of the speed medium plus the potential resultant of negatrons among each other should be exactly equal to the potential resultant of proton layer, condition that we have already seen in the previous publications "*QEDa Theory – The atom and their nucleus*" [12], "*The hydrogen family – Stability and gyromagnetic ratios*" [13] and "*The helium family – Stability and gyromagnetic ratios*" [14].

$$F_{sn}^{i} = F_{sn}^{m} \qquad \text{being} \qquad k_m = \frac{h}{2\cdot\pi\cdot c\cdot q^2}$$

$$\text{then} \qquad \frac{2\cdot\pi\cdot c^3\cdot m_n^2\cdot l_n^r}{h}\cdot\sqrt{1-\frac{1}{\left(Q_n^r\right)^2}} = k_m\cdot\frac{4\cdot\pi^2\cdot c^4\cdot q^2\cdot m_n^2\cdot l_n^r}{h^2}\sqrt{1-\frac{1}{\left(Q_n^r\right)^2}} \qquad 41$$

7 – Magnitudes in the toroidal magnetic field of spin.

In the following table I have calculated the magnitude of spin inertial resultants and the magnitude of spin magnetic force for electrons, protons and negatrons in the whole hydrogen family and helium family, based on the calculations of atomic and nuclear equilibrium that I published in "*The hydrogen family – Stability and gyromagnetic ratios*" [13] and "*The helium family – Stability and gyromagnetic ratios*" [14].

Subst.	Part.	Quantum status Q_x	Quantum Status l_x	Eq. 21 (Negatron) Eq. 22 Other Newton	Eq. 40 (Negatron) Eq. 36 Other Newton	Eq. 14 or 28 Newton
^{1}H	e	136.938256	137.	0.21155878601844	0.21155878601844	0.21156441702105
^{2}H	e	136.988002	137.	0.21155878192646	0.21155878192646	0.21156441702105
^{3}H	e	136.988002	137.	0.21155878192646	0.21155878192646	0.21156441702105
^{3}He	e	174.027086	175.	0.21156100118010	0.21156100118010	0.21156441702105
^{4}He	e	174.027086	175.	0.21156100118010	0.21156100118010	0.21156441702105
^{5}He	e	174.027086	175.	0.21156100118010	0.21156100118010	0.21156441702105
^{6}He	e	174.027086	175.	0.21156100118010	0.21156100118010	0.21156441702105
^{1}H	p(1)	1.	1.	712384.994103690	712384.994103690	712384.994103690
^{2}H	p	16.8663483	17.	711170.762621838	711170.762621838	712384.994103690
^{3}H	p	27.2912587	28.	711953.245046967	711953.245046967	712384.994103690
^{3}He	p	19.1709924	20.	711566.334071844	711566.334071844	712384.994103690
^{4}He	p	15.0098732	16.	711159.439643385	711159.439643385	712384.994103690
^{5}He	p	20.9041768	21.	711584.205490141	711584.205490141	712384.994103690
^{6}He	p	17.3160236	18.	711366.868079563	711366.868079563	712384.994103690
^{2}H	n	59.4390551	59.	112.324805549187	112.324805549187	1.90407975318941
^{3}H	n	38.3397410	38.	72.3304148033896	72.3304148033896	1.90407975318941
^{3}He	n	55.9161416	55.	104.707637838710	104.707637838710	1.90407975318941
^{4}He	n	66.8150628	66.	125.655187860325	125.655187860325	1.90407975318941
^{5}He	n	44.5813289	44.	83.7584298281914	83.7584298281914	1.90407975318941
^{6}He	n	54.8352982	54.	102.803207913155	102.803207913155	1.90407975318941

Notes

(1) The proton is in the cardinal radius (quantum unitary status); all calculations are carried out with expressions No. 14 or No. 28.

Speed of atomic particles and physical constants

We see in this chart that the resulting magnitudes in electrons and protons vary in very small magnitude, independent of the quantum state of the same one, maintaining the existent conditions of stability in the quantum unitary state and calculated with the equation No. 29. While in the negatrons the auto-balanced resultants are being exactly equal to the product of the magnitude given for the orbit of cardinal radius in the expression No. 14 or No. 28 per the quantum state of the negatronic layer.
In the case of the electrons that there are liberated of the orbital one that they occupied inside the atom, for any external action, these after a certain time always changes their energy state until arriving to the rest and occupying some inter-atomic interstice in the quantum unitary state, due to the collisions with the atoms of their domain and assuming finally in rest on the cardinal radius orbit.

Determination of dimensional constants

Knowing the relationship of magnetic constant (k_m) and electric constant (k_e) with the speed of the light we can determine the expression of electric constant.

$$\text{being} \quad c = \sqrt{\frac{k_e}{k_m}} \quad \text{and} \quad k_m = \frac{h}{2\cdot\pi\cdot c\cdot q^2} \quad \text{then} \quad k_e = \frac{c\cdot h}{2\cdot\pi\cdot q^2} \qquad 42$$

We know that the Ampere[6] and Faraday Laws[15] in simultaneous form fulfill and knowing their relationship with the speed of the light, we can establish the calculation expressions of the permeability of free space (μ_0) and the permittivity of free space (ε_0):

$$\text{being} \quad c = \frac{1}{\sqrt{\mu_0\cdot\varepsilon_0}} \;; \quad \mu_0 = 4\cdot\pi\cdot k_m \quad \text{and} \quad \varepsilon_0 = \frac{1}{\mu_0\cdot c^2} \quad \text{then} \quad \mu_0 = \frac{2\cdot h}{c\cdot q^2} \qquad 43$$

$$\text{and} \quad \varepsilon_0 = \frac{q^2}{2\cdot c\cdot h} \qquad 44$$

Finally with the relationships already well-known of these constants, we can obtain the magnitude of impedance of free space (Z_0):

$$\text{being} \quad Z_0 = \frac{\overline{E}}{\overline{H}} = \sqrt{\frac{\mu_0}{\varepsilon_0}} \qquad 45$$

$$\text{then} \quad Z_0 = \sqrt{\frac{\frac{2\cdot h}{c\cdot q^2}}{\frac{q^2}{2\cdot c\cdot h}}} = \frac{2\cdot h}{q^2} = 51625.6151202962\ \Omega \qquad 46$$

The mass of the electron was calculated starting from the value of the frequency of wave $2.466061413318734(0.03)\ \times 10^{15}$ Herz for Lyman's quantum skip ${}^1S \leftarrow {}^2S$, with enormous precision, obtained by Udem, Huber, Gross, Reichert, Prevedelli, Weitz and Hansch[8]. The calculation expression of the inertial mass of electron is:

$$m_e = \frac{8\cdot 137^2\cdot h\ (\mathrm{J.s})\cdot 2.46606141318724\times 10^{15}\ (\mathrm{Hz})}{3\cdot c^2\left(\mathrm{m.s^{-1}}\right)^2} = 9.09972567274628\times 10^{-31}\ \mathrm{kg.} \qquad 47$$

The relationship of elementary charge (q) with of the constant of Planck[9], the speed of the light and the electric constant or magnetic constant are:

$$q = \sqrt{\frac{h}{2\cdot\pi\cdot c\cdot k_m}} \quad \text{or} \quad q = \sqrt{\frac{c\cdot h}{2\cdot\pi\cdot k_e}} \qquad 48$$

Speed of atomic particles and physical constants

Starting up from expression No. 14, the total energy of each particle could be calculated, in this case equal to their kinetic energy because it is in the cardinal radius orbit (quantum unitary state), making the product of the resulting force per the corresponding distance, the following magnitudes can be obtained in each case in this way:

$$\boldsymbol{E}_x = \boldsymbol{K}_x = \boldsymbol{F}_x^i \times \text{distance} = \boldsymbol{F}_x^i \times \boldsymbol{r}_x = \overbrace{\frac{2\cdot\pi\cdot\boldsymbol{c}^3\cdot\boldsymbol{m}_x^2}{\boldsymbol{h}}}^{\text{Force - Newton}} \cdot \overbrace{\frac{\mathrm{h}}{2\cdot\pi\cdot\boldsymbol{c}\cdot\boldsymbol{m}_x}}^{\text{Distance - Meter}} = \boldsymbol{m}_x\cdot\boldsymbol{c}^2 \text{ Joule} \quad \therefore$$

Electron $\boldsymbol{K}_e = \boldsymbol{m}_e\cdot\boldsymbol{c}^2 = 8.17842557346509\times10^{-14}$ J. $= 510457.221150387$ eV **49**

Negatron $\boldsymbol{K}_n = \boldsymbol{m}_n\cdot\boldsymbol{c}^2 = 2.45352767203953\times10^{-13}$ J. $= 1.53137166345116$ MeV **50**

Proton $\boldsymbol{K}_p = \boldsymbol{m}_p\cdot\boldsymbol{c}^2 = 1.50074109273084\times10^{-10}$ J. $= 936.689000810961$ MeV **51**

where $\boldsymbol{E}_x$ is total energy of particle *x* and $\boldsymbol{K}_x$ is de kinetic energy of particle *x*.

We can observe that the energy calculated in each particle is the maximum given by Einstein's relationship[(2)]. Continuing with the analysis, with expression No. 6 we will calculate the periods of orbit of each particle in the cardinal radius:

Electron $\boldsymbol{t}_e = \dfrac{\boldsymbol{h}}{\boldsymbol{m}_e\cdot\boldsymbol{c}^2} = 8.10188819410215\times10^{-21}$ second **52**

Negatron $\boldsymbol{t}_n = \dfrac{\boldsymbol{h}}{\boldsymbol{m}_n\cdot\boldsymbol{c}^2} = 2.70062939803405\times10^{-21}$ second **53**

Proton $\boldsymbol{t}_p = \dfrac{\boldsymbol{h}}{\boldsymbol{m}_p\cdot\boldsymbol{c}^2} = 4.41519792594123\times10^{-24}$ second **54**

If now we make the product of the total energy in the orbit of cardinal radius per the time that takes each particle in traveling the orbit, we will see just as it is shown in the following expressions that the obtained magnitudes are constant and exactly equal to the constant of Planck[(9)].

Electron $\boldsymbol{E}_e\times\boldsymbol{t}_e = 8.17842557346509\times10^{-14}$ J. $\times 8.10188819410215\times10^{-21}$ s. $= 6.62606896\times10^{-34}$ J.s **55**

Negatron $\boldsymbol{E}_n\times\boldsymbol{t}_n = 2.45352767203953\times10^{-13}$ J. $\times 2.70062939803405\times10^{-21}$ s. $= 6.62606896\times10^{-34}$ J.s **56**

Proton $\boldsymbol{E}_p\times\boldsymbol{t}_p = 1.50074109273084\times10^{-10}$ J. $\times 4.41519792594123\times10^{-24}$ s. $= 6.62606896\times10^{-34}$ J.s **57**

because it is $\boldsymbol{E}_x\times\boldsymbol{t}_x = \boldsymbol{m}_x\cdot\boldsymbol{c}^2\cdot\dfrac{\boldsymbol{h}}{\boldsymbol{m}_x\cdot\boldsymbol{c}^2} = \boldsymbol{h}$ J.s **58**

Note:

I believe that it's time to remove the "fine-structure constant" inside the theoretical physics due to the error made by Niels Bohr[(1)], who assigned the quantum unitary state to the hydrogen-1 atom electron, instead of 136.93825632739532 for $\boldsymbol{Q}_e^{v}$ and 137 exact value for $\boldsymbol{l}_e^{v}$ quantum state of the electron, as I have demonstrated in my previous reports, "*QEDa Theory – The atom and their nucleus*" [(12)] and "*The hydrogen family – Stability and gyromagnetic ratios*" [(13)]. This difference in approximate form was discovered by Arnold Sommerfeld[(10)] in 1916 when he studied the atomic spectral lines of this substance.

Speed of atomic particles and physical constants

Summary

With the present work there are demonstrated the following properties theoretically:

- All the atomic particles always move to the speed of the light.
- All atomic particles in state of rest, rotates at speed of the light in a tiny orbit, denominated cardinal radius orbit because it possess the quantum unitary state, maintaining a magnetic-dynamic absolute equilibrium.
- All electron, proton and negatron in atomic orbit or nuclear orbit, moves in a trajectory in helix form on orbit (spin) to the speed of the light. The movement of the charges determines an electric current, the intensity of this it induces a magnetic torus field in ring form into the spin helix that establishes a magnetic vector that annuls totally the inertial resultant of spin, maintaining a magnetic-dynamic absolute equilibrium, free the nuclear and atomic dynamic-potential equilibrium.
- The constant of Planck(9) result to be exactly equal to the kinetic energy of the particle in rest (in the orbit of cardinal radius - Quantum unitary state) multiplied by the period of orbit of the same one.
- The carried out analysis arises that the magnetic constant is directly proportional to the constant of Planck(9) and inversely proportional to the product of two Pi per the speed of the light and the square of the elementary charge.

Consequences

As consequence of the carried out analysis, there is not room for the smallest doubt that the mass of the atomic particles doesn't grow in function of the speed, although the speed of the light is reached, in opposition to derived theories of the Lorentz transformations(11).

The return property to the quantum unitary state (orbit of cardinal radius) in all free electron of atomic orbit has notable consequences in the interpretation of the physical phenomena that there is not clearly understood until today.

The electric and dielectrics properties of the substances, the capacitance, resistance and inductance phenomena by accumulation of free electrons in rest in the crystalline interstices, there are clearly explained. This will cause an important advance in the theoretical calculation and in the development of new technologies inside the field of electronic components.

One of the possible applications with more significance that we can achieve, due to the knowledge of all the physical implications of the electrons in rest, is the development of conductors without electric resistance that works with environment temperature, with the wanted longitude and flexibility (flexible superconductor), using molecular nanotubes with unidirectional magnetic canalization.

Another technological application that we can achieve is into the field of computation: the dimension can be decreased and the energy consumption of the devices process and memory can be reduced drastically too, if the architecture of crystalline nets is used with designed interstices in a way that allows the carry out individual and controlled operations to keep and to contain or to exchange free normalized electrons.

Speed of atomic particles and physical constants

Dimensional and constant units

The system of dimensional units that I use is the IS (International System).

I give the inertial mass of particles in function of the inertial mass of electron; therefore, I take as unit the inertial mass of other particles in function of the electron inertial mass.

It's expressed the electric constant and the magnetic constant respecting classic and old expression.

I have calculated derived constants in function of the fundamentals constant. The value obtained for derived constants are 137.036 (the inverse "fine-structure constant") times greater than the present magnitude except permittivity of free space and the impedance of free space that are in inverse form.

I use the values published by NIST – *National Institute of Standards and Technology (CODATA 2006)* [(5)] for the constant of Planck[(9)], the elementary charge and the speed of the light.

Symbol	Fundamental constants		Assigned magnitude	Dimensional units
c	Speed of the light.		299792458.	$\text{Meter} \times \text{second}^{-1}$
h	Planck constant.		$6.62606896 \times 10^{-34}$	$\text{Joule} \times \text{second}$
q	Elementary charge.	$q = \sqrt{\frac{c \cdot h}{2 \cdot \pi \cdot k_e}} = \sqrt{\frac{h}{2 \cdot \pi \cdot c \cdot k_m}}$	$1.602176487 \times 10^{-19}$	Coulomb
m_e	Inertial electron mass.		$9.09972567274628 \times 10^{-31}$	Kilogram

Symbol	Derived constants		Theoretical value	Dimensional units
k_e	Electric constant.	$k_e = \frac{c \cdot h}{2 \cdot \pi \cdot q^2}$	$1.23161814398427 \times 10^{12}$	$\text{Newton} \times \text{meter}^2 \times \text{coulomb}^{-2}$
k_m	Magnetic constant.	$k_m = \frac{h}{2 \cdot \pi \cdot c \cdot q^2}$	$1.37035999694076 \times 10^{-5}$	$\text{Newton} \times \text{second}^2 \times \text{coulomb}^{-2}$
μ_0	Permeability of free space.	$\mu_0 = \frac{2 \cdot h}{c \cdot q^2}$	$1.72204515966497 \times 10^{-4}$	$\text{Weber} \times \text{ampere}^{-1} \times \text{meter}^{-1}$
ε_0	Permittivity of free space.	$\varepsilon_0 = \frac{q^2}{2 \cdot c \cdot h}$	$6.46121299321843 \times 10^{-14}$	$\text{Newton}^{-1} \times \text{meter}^{-2} \times \text{coulomb}^2$
Z_0	Impedance of free space.	$Z_0 = \frac{2 \cdot h}{q^2}$	51625.6151202962	Ohm
m_n	Inertial negatron mass.	$m_n = m_e \times 3.$	$2.72991770182389 \times 10^{-30}$	Kilogram
m_p	Inertial proton mass.	$m_p = m_e \times 1835.$	$1.66979966094894 \times 10^{-27}$	Kilogram

All the calculations of previous section were carried out with the magnitudes of these tables.

Speed of atomic particles and physical constants

Annex 1

In the cardinal radius orbit the speed of the particle is equal to speed of the light and the kinetic energy is maximum and equal to total energy, then this expression is given by Einstein's relationship(2).

$$E_x^{cd} = K_x^{cd} \quad \text{and} \quad \overline{v_x} = c \quad \text{then} \quad E_x^{cd} = m_x \cdot c^2 \qquad 59$$

where E_x^{cd} is total energy of particle x in cardinal radius orbit, K_x^{cd} is the kinetic energy of particle x in cardinal radius orbit, $\overline{v_x}$ is speed of particle x in cardinal radius orbit and c is speed of the light.

With the postulate of De Broglie(3) we can obtain the correlation of particle inertial mass:

$$\lambda_x^{cd} = \frac{h}{m_x \cdot \overline{v_x}} \quad \therefore \quad m_x = \frac{h}{\lambda_x^{cd} \cdot \overline{v_x}} = \frac{h}{\lambda_x^{cd} \cdot c} \qquad 60$$

where λ_x^{cd} is wave longitude of particle x in cardinal radius orbit.

Even though, being the wave longitude equal to the orbit longitude in cardinal radius orbit is:

$$\lambda_x^{cd} = 2 \cdot \pi \cdot r_x^{cd} \qquad 61$$

where r_x^{cd} is orbit radius of particle x in cardinal orbit.

If we replace in Einstein's relationship(2) the particle inertial mass by the mass relationship of De Broglie(3) is:

$$m_x \cdot c^2 = \frac{h}{\lambda_x^{cd} \cdot c} \cdot c^2 = \frac{h}{\lambda_x^{cd}} \cdot c = \frac{c \cdot h}{2 \cdot \pi \cdot r_x^{cd}} \qquad 62$$

Then solving for the cardinal orbit radius in this last expression we can obtain:

$$\text{Solve for } r_x^{cd} \text{ in } \quad m_x \cdot c^2 = \frac{c \cdot h}{2 \cdot \pi \cdot r_x^{cd}} \quad \text{then} \quad r_x^{cd} = \frac{h}{2 \cdot \pi \cdot c \cdot m_x} \qquad 63$$

The expression No. 63 is what we were looking for and that is exactly equal to expression No. 2 on page 5.

See the excellent work of Prof. Dr. Bo Lehnert(16).

Speed of atomic particles and physical constants

Glossary

Symbol	Definition
m_x	Inertial mass of particle (x).
r_x	Atomic or nuclear orbit radius of particle (x), always smaller or bigger than the cardinal radius.
r_x^{cd}	Cardinal orbit radius of particle (x), when the quantum state of particle is exactly equal to the unit, that it's a physical constant characteristic of each atomic particle.
r_{sx}	Radius of spin helix of particle (x).
P_x	Quantity of step or pass of the spin helix of particle (x).
Q_x^v	Quantum vectorial number calculated with the atomic or nuclear stability expression for the particle (x), when the quantum state of particle is bigger than the cardinal radius.
Q_x^r	Quantum radial number calculated with the atomic or nuclear stability expression for the particle (x), when the quantum state of particle is smaller than the cardinal radius.
l_x^v	Quantum state of the particle (x), the bigger integer most closest where by the value of quantum vectorial number has been calculated.
l_x^r	Quantum state of the particle (x), the smaller integer most closest where by the value of quantum radial number has been calculated.
t_x	Time in traveling an orbit of particle (x).
$\overline{v_x}$	Speed vector of tangential medium of particle (x).
$\overline{v_{sx}}$	Speed vector of the spin helix tangential medium of particle (x).
F_x^i	Inertial resultant to the speed tangential medium of particle (x).
F_{sx}^i	Inertial resultant to the speed for the spin helix tangential medium of particle (x).
f_x	Frequency to pass particle (x) to the nodal points (extreme of the atomic axis where the passage of the atomic particles converges).
I_x	Electric intensity induced by the movement of particle (x).
$\overline{B_x}$	Magnetic vector of particle (x), transverse at the orbit plane for an only spire when particle (x) it is in orbit of cardinal radius. The particle is not in atomic or nuclear orbit.
F_x^m	Magnetic force resultant on particle (x) in orbit of cardinal radius determined by the magnetic vector $\overline{B_x}$.
$\overline{B_{sx}}$	Magnetic vector of particle (x), tangent at orbit of the toroidal magnetic field formed by the spin helix. For all particle that is in atomic or nuclear orbit.
F_{sx}^m	Magnetic force resultant on particle (x) that is in atomic or nuclear orbit caused by the magnetic vector $\overline{B_{sx}}$.
E_x	Total energy resultant of particle (x).
K_x	Kinetic energy resultant of particle (x).

Note:

Right superscript: **cd**: respecting to cardinal orbit, **i**: inertial interaction,
m: magnetic interaction, **e**: electric interaction,
r: quantum state denominator and **v**: quantum state numerator.

Right subscript: **s**: respecting to spin and **x**: any atomic particle, being:
e: electron, **p**: proton and **n**: negatron..

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