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The Proton's Electric Charge at the Atomic Nucleus Depends to the Rotational Motion of a Corresponding Electron in the Atom

Abdelfatah Ettarky

Cadi Ayyad University, 40000, Marrakech, Morocco
Corresponding Author E-mail: *abdelfatahettarky2[at]gmail.com*

Abstract: ***The Charged Atomic Entanglement (CAE)is established naturally between each electron-proton specific pair in the atom. This concept of entanglement was introduced in our previous research about a new physical theory of twin anti- symmetric universes which is based on a very important theoretical prediction realized in our first research paper, that concern the existence of the Disappearance - Appearance phenomenon (DAP), which is a law of nature responsible on the electronic transitions in the atoms. In this third research paper we are going to find that the CAE lead us to a new concept of the electric charge relating to the electrical charged particles in the atoms. This article is a continuation to our two previous research works***

Keywords: DAP, CAE, MAIE, Atomic physics, Quantum entanglement, electronic transitions, Anti-Symmetric Universes

1. Introduction

The quantum entanglement [1] is very complicated concept in quantum mechanics theory. The Charged Atomic Entanglement (CAE) [2] is a directly consequence of the DAP law [3] which represents a law of nature organizes the atomic electronic transitions. This kind of entanglement is established naturally between each specific electron-proton pair in the atom (and each specific positron-antiproton pair in the anti-atom). These two atomic charged particles in the atoms, share between them their quantum states. Particularly in the hydrogen atom, we can seeing how the description of the electron physical reality with quantum mechanics, depends to the proton physical reality and for this reason we describe only the electron motion in this atom by considering this atom as a system of two particles : electron, proton. In general, the electrical neutrality of the atom implies the equality between the electron's electric charge and the electric charge of its corresponding proton at the nucleus. We mean that at any time, the entangled pair electron-proton in an atom, is electrically neutral. The electrical charge of a particle, as its mass, It is a relativistic invariant [4]. The electrical charge of a particle (as the electron) do not depend to its state of motion. But now, we know very well that each electron - proton pair are entangled between them in the atom through the CAE. This fact lead us to the introduction of another concept of the electrical charge of the electrons in the atoms, where the proton electrical charge and the electron rotation velocity are linked via a mathematical formula representing the CAE between the two particles.

In the first paragraph we introduce a brief reminder on the notion of the electrical charge in physics. Then the second paragraph will be consecrated to this new concept of the particle electrical charge that we are talking for. Such as the equality between the electrical charges absolute values of the proton and its entangled electron in the atom, implies a mathematical formulate translate the CAE between them.

2. A Brief Reminder about the Electric Charge Notion

The electric charge of a particle, as its mass, it is a physical property of matter that causes it to experience a force when placed in an electromagnetic field [5]. Electric charge can be positive or negative (commonly carried by protons and electrons respectively, by convention). Like charges repel each other and unlike charges attract each other. An object with no net charge is referred to as electrically neutral. Early knowledge of how charged substances interact is now called classical electrodynamics, and is still accurate for problems that do not require consideration of quantum effects. Electric charge is a conserved property; the net charge of an isolated system, the quantity of positive charge minus the amount of negative charge, cannot change. Electric charge is carried by subatomic particles. In ordinary matter, negative charge is carried by electrons, and positive charge is carried by the protons in the nuclei of atoms. If there are more electrons than protons in a piece of matter, it will have a negative charge, if there are fewer it will have a positive charge, and if there are equal numbers it will be neutral. Charge is quantized; it comes in integer multiples of individual small units called the elementary charge, $e = 1.602\ 10^{-19} C$ which is the smallest charge that can exist freely. Particles called quarks [6] have smaller charges, multiples of 1/3 e, but they are found only combined in particles that have a charge that is an integer multiple of *e*. In the Standard Model, charge is an absolutely conserved quantum number. The proton has a charge of $+e$, and the electron has a charge of e. Electric charges produce electric fields. A moving charge also produces a magnetic field. The interaction of electric charges with an electromagnetic field (a combination of an electric and a magnetic field) is the source of the electromagnetic (or *Lorentz*) force [7] which is one of the four fundamental interactions in physics. The study of photon-mediated interactions among charged particles is called quantum electrodynamics (QED) [8].

The SI derived unit of electric charge is the coulomb (C) named after French physicist *Charles-Augustin de Coulomb*. In electrical engineering it is also common to use the ampere-hour (Ah). In physics and chemistry it is common to use the elementary charge (e) as a unit. Chemistry also uses the *Faraday* constant, which is the charge of one mole of elementary charges.

3. The New Concept of the Particle Electric Charge

Special relativity theory [9] and Quantum electrodynamics (QED) theory consider the particle electric charge as a concept different to the particle mass, such as the particle mass depends to its velocity but this fact is not true for the electric charge.

However, the CAE [2] between electrons and protons in the atoms, makes the electron electric charge depends to its movement in the atom. The electron in the atom, has an electric charge absolute value greater than e, and this value depends to the electron velocity at certain atomic level.

We consider a hydrogen atom free in the vacuum, and existing in its ground state. According to the *Bohr* model [10] of the hydrogen atom, the radius of the electron in the hydrogen atom is given by $r = r_B n^2$ such that n is a natural number is called the principal quantum number and rB the *Bohr* radius which its value is equal to 0.53Å. We note Q^+_{CAE} the proton electric charge when it is at an atomic nucleus and Q^-_{CAE} the electric charge of the electron when it belongs to an atom. The electron electric charge Q^-_{CAE} changes under the change of the reference. So, to describing this motion, we going to definite two inertial references:

- R_g: The laboratory reference (the reference of the observer)
- R_r: The reference of the electron-proton entangled pair (It is a relativistic reference)

to determinate the dependence of Q^-_{CAE} to the electron velocity, we will do a simplest mathematical calculation based on the following **classical model** :

"*We are going to consider only the corpuscular aspect of the particles. In the first approximation, we will model the electron motion around the proton as a circular motion with the constant radius* $r = r_B = 0.53$ Å, *the period* $T = \frac{2\pi r_B}{v_e}$ *corresponding to the pulsation* $\omega = 2\pi/T$, *such as* $v_e = r_B\omega$ *is the electron velocity has a constant value. Then even the proton at the nucleus makes a rotational motion around itself with the same pulsation* ω and in the same direction of the electron rotational motion".

In accordance to this model, the electron circular motion through the period $1T$ is equivalent to a straight movement of the electron inside a straight wire of metal material (the copper for example), has the length $l = 2\pi r_B$. Thus, we consider a proton crosses, with the same velocity, the distance l parallel to the electron motion inside the copper wire, such that the copper wire and the proton are separated with the distance $d_0 = r_B$. The proton and the copper wire are located in an empty space-time.

The electron in the copper wire, contributes to the intensity of the electrical current, this contribution is equal to the value $I = |Q^-_{CAE}|/ t$, such that $t = 1T$ is the temporal period of the electron and the proton motions. The proton occupies the origin of the Rr (Reference of the electron-proton pair). Then before the beginning of the electron-motion (for example from the left to the right), the Rr is initially at rest in Rg, which means that the electron and the proton velocities are null ($v_e = v_p = 0$).

We suppose that a light ray exits from the proton exactly at the time of the motion beginning, and it spreads vertically upwards the electron. In the electron- proton inertial reference Rr, this light will cross the constant distance of the separation $d_0 = r_B$ between the two particles through an own time $t' = t_0$, which implies that $d_0 = C \times t_0$. An observer located at the laboratory reference Rg will see that the light ray arrives to the electron after a time

$$t = \frac{l}{v_e} = \frac{2\pi r_B}{v_e}$$

then the distance $d = C \times t$ crossed by the light ray is a straight line represents the hypotenuse of a triangle rectangle. By using *Pythagore's* theorem, we going to have the following formula:

$$(C \times t)^2 = (v_e \times t)^2 + (C \times t_0)^2 \qquad (1)$$

So, the solution is:

$$t = \frac{t_0}{\sqrt{1 - \frac{v_e^2}{C^2}}} \qquad (2)$$

Thus, we obtained the famous formula between the two times, derived by *Einstein* in special relativity theory [9] through the Lorentz transformation.

The electron electrical charge during its motion Q^-_{CAE} is proportional to the motion time duration t following this formula $|Q^-_{CAE}| = I \times t$, instead the dependence of Q^-_{CAE} to the velocity v_e could be written as follows:

$$|Q^-_{CAE}| = \frac{I \, x \, t_0}{\sqrt{1 - \frac{v_e^2}{C^2}}} \qquad (3)$$

The quantity - $I \times t_0$ corresponds to the electron electric charge $-e$ when it is at rest ($v_e = 0$).

We have proofed that the electron in the atom, its electric charge depends to its velocity, as follows:

$$Q^-_{CAE} = -\frac{e}{\sqrt{1 - \frac{v_e^2}{C^2}}} \qquad (4)$$

As it is clarified previously, the two charged particles of each electron-proton pair in an atom are entangled

between them via the CAE, that makes this two particles united together as a single particle without electric charge (neutral) because the proton electric charge Q^{+}_{CAE} equals at any time to the absolute value of the $|Q^{-}_{CAE}|$ of the electron electric charge. Thus, the CAE result comes from the fact that for a specific electron-proton entangled pair, the value of the proton electric charge depends to the value of the electron velocity, through its rotational motion around the atomic nucleus. So, we will write the physical law that reflects the CAE in each specific electron-proton pair in the atom, as follows:

$$Q^{+}_{CAE} = \frac{e}{\sqrt{1 - \frac{v_e^2}{C^2}}} \quad (5)$$

Such that $v_e = ||\vec{v}_e||$, and in the spherical coordinates $\vec{v}_e = \vec{v}_e(\theta, \varphi)$.

This formula means also that in an atom, we cannot describing completely the physical reality of an electron independently to its entangled proton at the nucleus.

This result is the same for the entangled positron-antiproton pairs in the anti atoms, such that the antiproton electric charge depends to the positron velocity following the formula (5).

4. Conclusion

The quantum entanglement between each specific electron-proton pair in the atom, has been introduced in our research paper [1] we called it the **Charged Atomic Entanglement (CAE)**. Then as a consequence we found that this entanglement could be represented via a new physical law. Such that the proton at an atomic nucleus, its electrical charge depends to the rotational motion of a corresponding electron.

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