

A New Theory for the Essence and Nature of Electron Charge

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How to cite this paper: Butto, N. (2021) A New Theory for the Essence and Nature of Electron Charge. *Journal of High Energy Physics, Gravitation and Cosmology*, 7, 1190-1201. <https://doi.org/10.4236/jhepgc.2021.73070>

Received: June 19, 2021

Accepted: July 27, 2021

Published: July 30, 2021

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Abstract

Charge is a fundamental physical property of matter that is responsible for its interactions with electromagnetic fields. The real nature and the essence of charge are unknown. In this paper, a new theory is presented to describe the nature and the essence of electric charge is formulated based on the vortex model of the electron which has a finite size and has an irrotational vortex structure. This theory and the vortex model of the electron enables us, for the first time, to describe the origin of bivalency, stability, quantization, equality of the absolute values of the bivalent charges, to derive a simple formulation to calculate the electric charge based on hydrodynamics without the use any constant. The difference between negative and positive charge, is revealed and the charged particles interactions are described. The electric charge is an expression of accelerated spherical mass per area reduced by the stiffness of the vacuum which has the units $\epsilon_0 \text{ ML}^3/\text{T}^2$. The calculated results based on these equations comply accurately with the experimental results.

Keywords

Electric Charge, Irrotational Vortex, Coulomb's Law, Volume Flow Rate, Charge Density

1. Introduction

A few hundred years have passed since the discovery of electricity and electromagnetic fields, a tremendous progress has been achieved in details and applications of the electron theories [1].

However, the nature of the electron has been a mystery confronting physicists of past generations as well as contemporaries [2] [3].

While electrons are useful in the understanding of diverse phenomena, the nature of the electron have never been really understood and the nature of the

electron has been an enigma confronting physicists of past generations as well as contemporaries [2] [3].

In fact, many questions related to the nature of the electron still without answers such as: what is the structure of the electron, what is the origin of the mass of the electron, what is the spin, why must be a positron, why and how does the electron manifest wave properties and how does the electron manifest wave properties? What guides the interaction between two electrons to cause attraction or repel, why do particles with the same charge repel and opposing charges attract, how electron interact with positron at short distances? And finally what is electric charge?

In 1746, the American physicist named Franklin first propounded the idea of positive charges and negative charges.

After finding the quantized character of charge, in 1891 George Stoney proposed the unit “electron” for this fundamental unit of electrical charge. The discovery of the electron in the 1890’s, based on several independent experiments a negative charge e , and mass m were assigned to the electron. A few hundred years have passed since the discovery of electricity and electromagnetic fields, and Maxwell’s equations have been subjected to countless experimentation based on the current definition of electric charge and are definitely correct; however, the nature of an electric charge remains unknown.

Attempts have been made to clarify the nature of the electric charge [4]-[8].

None of these works provides an explicit formula for the exact value and the nature of electric charge based on proven facts.

The main obstacle remains related to the failure to attribute structure to the electron.

Therefore, the unit is today treated as nameless, referred to as elementary charge, fundamental unit of charge, or simply as e . However, almost all physical parameters (constants and variables) have a combination of the dimensions of mass, length, and time.

The dimension of electric charge is $4\pi\epsilon_0 ML^3/T^2$. One can easily decompose ML/T into, e.g., mass (M) and velocity of a particle (L/T), and find a formula for the linear momentum of a particle. This has not been accomplished for electric charge.

Prediction of the anti-electron (positron) by P. Dirac in 1931, which was discovered by C. Anderson in 1932. However, there is no scientific explanation for the origin of difference between properties of electron and positron or really explained the internal mechanism of positive and negative charges.

Although the electric charge seems to be a primary abstract intrinsic property of a particle, nonetheless, the electric charge and electromagnetic field are the physical property of matter, can be directly measured and formulated. Therefore, the relation between electric charge and known physical parameters should be addressed and clarified. This cannot be done until the very nature of the electron mainly its structure is identified, to provide explicit general formulas for the re-

lation between electron attributes and known physical parameters into which all attributes of the electron could be incorporated in a self-consistent way.

The aim of this study is to present a new physical concept to fill this gap and to constitute a physical explanation of the nature and the origin of charge.

This paper provides a new approach to this problem, considering the vacuum as superfluid and the electron as an irrotational vortex of the vacuum. Comprehensive interpretation of electric charge is developed, based on the hydrodynamics a meaningful and explicit description of the nature of the obscure physical parameter of electric charge is found, and an explicit formula that addresses the relation between electric charge and known physical parameters is presented.

This approach allows to express the complicated dimension of the electric charge in M, L and T units ($4\pi\epsilon_0 ML^3/T^2$) and converts it in an observable, measurable, and explicable physical parameter.

2. The Vortex Structure of the Electron

Vacuum density is generally viewed as a fundamental property of the cosmos.

Therefore, the physical vacuum is assumed to be a non-trivial medium filled with quantum mechanical zero-point energy to which one can associate certain energy and density.

In superfluid vacuum theory, the physical vacuum is described as a quantum superfluid and is characterized to behave like a frictionless fluid with density and proposes a mass generation mechanism that may replace or supplement the electroweak Higgs theory. It has been shown that the masses of elementary particles could be a result of interactions with a superfluid vacuum, similar to the gap generation mechanism in superconductors [9] [10].

Although according to quantum mechanics the electron is cloud of probabilities, therefore has no physical structure, many efforts are made to study the shape of the electron. The current model predicts that electrons are slightly aspheric, with a distortion characterized by the electric dipole moment. However, no experiment so far has detected this deviation [11].

Jehle spent a large part of his life developing a theory of the electron and elementary particles based on quantized magnetic flux loops, spinning at the Zitterbewegung frequency [12] [13] [14] [15] [16].

Also, Dirac suggested the existence of the magnetic monopole to describe the charge of the electron [17].

Both these theories rely on a physical relationship between flux and charge. The question of the relation between the electric and magnetic properties is fundamental to electrodynamics. One expects a relationship as moving charge produces magnetic flux.

In previous articles [18], the electron is proposed to be a frictionless vortex with conserved momentum made out of virtual photons that acquire mass when moving in the vortex at the speed of light. The vortex shape electron allowed to resolve the enigmatic wave-particle duality [19].

The vortex shape of the electron and the Hydrogen atom give a full explanation for the origin of fine structure constant [20]. The same model was presented to explain the origin of gravitation force [21] and gravitation constant G [22] indicating the universality of the phenomena.

Thus the proposed idea in this paper is that the electron is an irrotational vortex of frictionless superfluid space with concentric streamlines that was created from the primordial vacuum that converted to Higgs particles during the Big Bang.

The vortex of the electron is made up by massless Higgs particles which acquire mass when they travel around the vortex center. The rate of rotation of the fluid in the irrotational vortex is greatest at the center and decreases progressively with distance from the center until there is no gradient pressure on the boundaries of the vortex where the flow is laminar and the friction is null.

In such a case, the absence of friction would make it impossible to create or destroy the vortex motion.

There are two types of vortices, the first one like the whirlpool, in which the flow goes from the periphery to the center, in such vortex the centripetal forces prevail. This kind of vortex related to the electron. The second kind of vortex is like the tornado where the flow goes from the apex to the periphery, related to the positron in which the centrifugal forces prevails **Figure 1**.

The electric charge density in the core of the electron is less than the vacuum density, while the core density of the positron is major than the vacuum density. Furthermore, the charge density is inversely related to the radius of the vortex.

Therefore, if the vacuum density is ρ and the vortex core density is ρ_0 then the electric charge density would be:

$$q = \rho_0 - \rho / 2 \pi r \rho_0 \quad (1)$$

The charge density is positive if $\rho_0 > \rho$. The charge density is negative if $\rho_0 < \rho$.

Necessarily, only two types of electric charge exist, positive and negative. Let n be the number of boson Higgs particle in a given volume V . Since $n = \rho_0 V$ and also $n = \rho V$ we get: $V = n/\rho$, $V' = n/\rho_0$, Hence: $(V - V')/V' = -(\rho_0 - \rho)/\rho_0$

If $V' > V$ is dilation, $V' < V$ is contraction

The centripetal force of the electron pulls the surrounding Higgs field into the centre of the electron vortex, hence causing a tension in the surrounding field causing pull force to act on other particles.



Figure 1. The vortex is curling in the plane, expansive (red) or contractive (blue) except in the core center where it is pointing out-of-plane, either up (polarity $p = +$) red or down ($p = -$) blue.

The centripetal forces of the electron and the lines of force made of Higgs particles are shown entering, allows due to attractive force to interact with protons to form different chemical elements and the attraction between two electrons with opposite spins. The positron instead in which the centrifugal forces and the lines of force exerted are always shown leaving the center push the other particles thus cannot interact with matter in a stable manner.

3. The Nature of Electric Charge

One of the fundamental laws of electricity is expressed by coulomb's law which states that the electrical force between two charged objects is directly proportional to the product of the quantity of charge on the objects and inversely proportional to the square of the separation distance between the two objects.

In equation form, Coulomb's law can be stated as

$$F = kQ_1Q_2/r^2, \quad (2)$$

where Q_1 represents the quantity of charge on object 1 (in Coulombs), Q_2 represents the quantity of charge on object 2 (in Coulombs), and r represents the distance of separation between the two objects (in meters). The symbol k is a proportionality constant known as the Coulomb's law constant = $1/4\pi\epsilon_0$. The value of this constant is dependent upon the medium that the charged objects are immersed in.

However, the electric charge nature still mysterious and the reason of such behavior still enigmatic. Furthermore, it is not clear why electrons with different spin they attract despite they have the same charge. The vortex structure model of the electron resolves completely all aspects related to the attributes and the behaviour of the electron including the electric charge.

The field about a charged body is generally represented by lines which are referred to as electrostatic lines of force. The electron as a vortex made up of spiral arms from which stems the fields of force which spread out in the space around the center of the vortex and diminishes in proportion to the square of the distance from the center of the vortex [18].

These lines are real and represent the direction and strength of the field.

Both electron and positron vortices have electromagnetic field, magnetic moment and magnetic dipole.

In the electron vortex, the flow of Higgs particles that moves in spirals downward in the funnel creates a pressure gradient normal to the vortex center and acts along the central axis of vortex spin. It follows moving up around the spiral and returns from the upper side of the central axis generating the magnetic momentum and magnetic dipole. The vertical magnetic pressure gradient is normal to the horizontal electrostatic pressure gradient creating by the vortex and acts along the central axis of spin **Figure 2**.

The acting forces electrostatic and magnetic are now interlinked in self-balancing feedback loops that give great stability to the vortex structure shape of the particle as a whole. These are the two forces that generate movement and create currents. The currents are the avenues of movement made up of

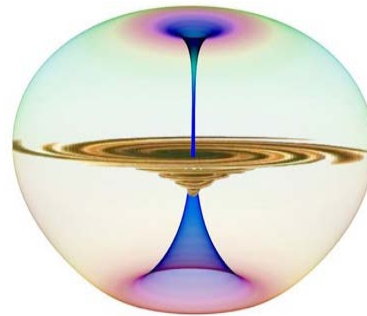


Figure 2. Artistic presentation of the magnetic field around the electron.

Higgs particles, surrounding which are spaces or crevices through which flow currents of lesser density comprising Higgs particles.

The interaction between vortices takes place in three different ways:

- 1) The electrostatic force which is attractive (gravitational) in the electron and repulsive (anti-gravitational) in the positron;
- 2) Magnetic force which is attractive in the opposite polarity, expressed by spin value $-1/2$ or $+1/2$;
- 3) Electrostatic centripetal force which depends on the rotation direction, is attractive if one vortex rotates clockwise rotation and the other counter clockwise rotation.

The electron can have a magnetic dipole is oriented in a way that the negative pole is up and the positive pole down. In this case, the projection value said to be $-1/2$, while in the opposite direction said to be $+1/2$. The projection can be changed, but the total spin of $1/2$ related to the spiral arm curl is fixed for all time.

Electron annihilation [23] [24] [25] is the phenomenon that consists in the collision of electrons with positrons. This phenomena, can take place in Thibaud's experiment where free positrons were launched against a metal lamina (tungsten) which is rich in conductive electrons or collision between free electrons and free positrons with low speed.

The two particles disappear and generally energy quanta appear in their place. As per the conservation law of momentum the two quanta have by practise opposite directions with an angle 90 degrees.

Each quantum has the energy of about 0.51 MeV, with frequency and wavelength placed in the spectrum of gamma radiation (gamma rays): $f = 1.2 \times 10^{20}$ Hz; $\lambda = 2.5 \times 10^{-2}$ Angstroms. As per the conservation law of energy, because the intrinsic total energy of both, electron and positron, is 1.02 MeV, the produced quanta has about 1.02 MeV. This process is presented schematically by Feynman diagram **Figure 3**.

Feynman diagram does not explain the interaction mechanism. However, whirlpool structure of both electron and positron and rotation direction give us good mechanical explanation

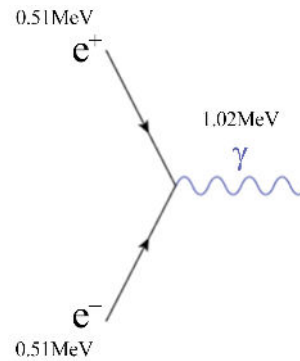


Figure 3. Feynman diagram of the electron-positron collision at low energy.

The interaction between electron and positron takes place in the mouth of the electron and in the apex of the positron which have attractive the force, therefore the positron will be swallowed by the mouth of the electron, however, the collision at low energies causes overlapping opposite rotation direction, destructive wave interference and annulation the rotation of both vortices, the annihilation of the electron and positron, and materialisation of gamma photons **Figure 4**.

Electrons mostly repel each other due to having the same charge. However, electrons with opposite spins not only lack of repulsion but they partially attracted. The vortex model of the electron explains completely this behaviour.

The interaction between two opposite electrons, combines two different forces: the first the opposite attractive electrostatic force of the spiral arm of the vortices **Figure 5**.

Therefore, opposite spin electrons have this attraction, without any Coulomb's repulsion.

The second is the dipole opposite spin and magnetic force, the stream flows mesh, the particles will attract one another **Figure 6**.

When two electrons are in the same rotation direction, the stream flows clash and repel the two electron vortices **Figure 7**.

Furthermore, there is magnetic repulsion between similar magnetic dipole moments. Each is like a tiny metal bar magnet that are directed in the same direction. This is the origin of Pauli exclusion principle.

The description of magnetic pole attraction and repulsion will be discussed separately in other articles that describe the internal structure of the monopole.

4. The Essence of Electron Charge

In hydrodynamics, the rotation of a vortex creates a drag force that attracts the medium to the center of the vortex. This force is directly related to the density of the vacuum, the speed of rotation, and the area according to the equation

$$F = 1/2 \rho c^2 A, \quad (3)$$

where, ρ is the density of the vortex, c is the speed of light and A is the area of the vortex.

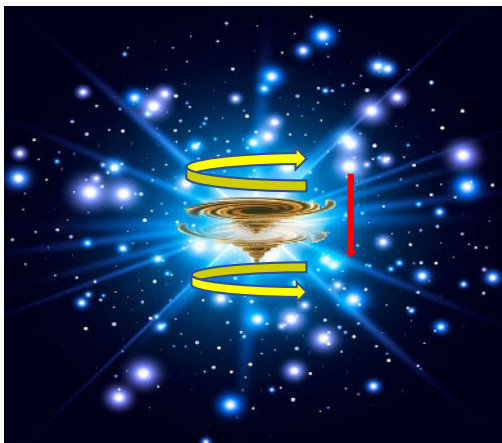


Figure 4. Electron-positron annihilation process caused by the collision between the apex of the positron (upper vortex) which has clockwise rotation and the mouth of the electron (down vortex) which has counter clockwise rotation.



Figure 5. Partial attraction between two opposite spins the one has projection value said to be up with spin $-1/2$ and the other as $+1/2$.

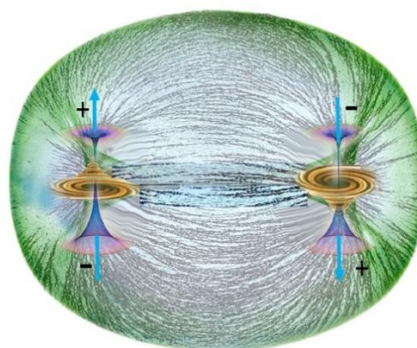


Figure 6. Right $-1/2$ spin electron, left, $+1/2$. The stream flows mesh, the particles will attract one another.

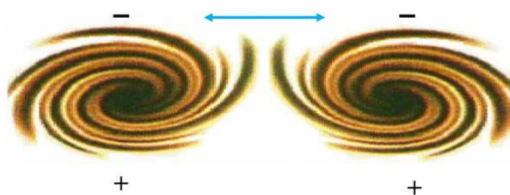


Figure 7. The two-opposite head to head flux leads to electron repulsion.

However, any motion in a curved path represents accelerated motion, and requires a centripetal force directed toward the center of curvature of the path which inversely related to the radius according to the equation

$$F = 1/2 \rho c^2 A/r . \tag{4}$$

Multiplying and dividing the right side of Equation (4) by time t , we obtain

$$F = 1/2 \rho c t A c/r t = 1/2 \rho V c/r t , \tag{5}$$

where ctA is the volume V . However, this force is reduced owing to interactions with the adjacent vacuum. If the density of the vortex is ρ and the rotation speed of the vortex is c , dividing the momentum ρc by the length of the circumference of the vortex $\lambda = 2\pi r$ will give the momentum P_d for a unit of length, thus:

$$P_d = \rho c/\lambda . \tag{6}$$

Therefore, the momentum of the vortex is multiplied for every unit of length by $\rho c/\lambda$ according to the equation

$$F = 1/2 \rho V \rho c^2 /r t \lambda . \tag{7}$$

If $\lambda = 2\pi r$, then

$$F = 1/2 \rho V \rho c^2 /r t 2\pi r = \rho V \rho c^2 /4t\pi r^2 . \tag{8}$$

In hydrodynamics, ρc^2 is the elasticity of the vacuum. In fact, the speed of a particle in an elastic medium can be expressed by the formula

$$c = (E/\rho)^{1/2} , \tag{9}$$

where c , the speed of light, E is the elasticity, and ρ the density of the medium.

Therefore, the elasticity of the vacuum, E , can be written as

$$E = \rho c^2 , \tag{10}$$

which is the inverse of the stiffness of the vacuum and has the same value as the electric permittivity, *i.e.*, $\rho c^2 = \epsilon_0^{-1}$.

This makes sense in terms of dimensions because the elasticity modulus is Newton \times m⁻² whereas the permittivity is Newton⁻¹ \times m⁻² (C²/N m²).

Then, the Equation (6) becomes

$$F = \rho V /4t\pi r^2 \epsilon_0 . \tag{11}$$

The force at a point in a fluid divided by the density is the acceleration of the fluid at that point known in fluid mechanics, as the force density \mathbf{f} [26].

Therefore Equation (11) become

$$F/\rho = \mathbf{f} = (V/t)/4\pi r^2 \epsilon_0 . \tag{12}$$

Force density is the negative gradient of the pressure which has physical dimensions of force per unit volume. The force density is a vector field representing the flux density of the hydrostatic force within the bulk of a fluid.

In fluid dynamics, the volume of a fluid that passes per unit of time, V/t , is the volume flow rate, which is usually represented by the symbol q . Its SI unit is m³/s. therefore force density is expressed as:

$$f = q/4\pi r^2 \varepsilon_0, \quad (13)$$

this is the same formula of the force of electric charge. Therefore, the electric charge is the volume flow rate of vacuum flux from the vacuum to the center of the electron vortex that can be expressed as:

$$q = f4\pi r^2 \varepsilon_0, \quad (14)$$

the q charge equals to Force x Area of the sphere ($4\pi r^2$) which is the cross product between the potential energy and the radial distance of the sphere charge, diminished by the vacuum stiffness ε_0 .

The SI unit of quantity of electric charge is the coulomb, which is equivalent to about $6.242 \times 10^{18} e$ (e is the charge of a proton). Hence, the charge of an electron is approximately -1.602×10^{-19} C. The coulomb is defined as the quantity of charge that has passed through the cross section of an electrical conductor carrying one ampere within one second.

According to *Newton Law* $f = ma$, thus we substitute f in Equation (14) to obtain

$$q = ma4\pi r^2 \varepsilon_0, \quad (15)$$

This is an explicit combination of mass, length and time. If the a is c/t (a) its units are L/T^2 and $4\pi r^2$ units are L^2 the final charge units will be $4\pi \varepsilon_0 ML^3/T^2$. That indicates that the charge is the mass quantity M that pass area L^2 per time T at speed of light L/T diminished by the vacuum stiffness ε_0 .

This equation demonstrates that the electric charge is equivalent to mass change in a particle. This is a momentum equation which is conserved, and the net charge is always conserved, and this is the origin of law of conservation of charge.

In this article, the nature and the essence of a single charged was discussed, the charge interaction and Coulomb Law will be discussed in detail in separate article.

5. Conclusions

Herein, a new theory connects the structure of the electron and presents a new and explicit description of the obscure physical parameter of electric charge. The electron is presented as a frictionless vortex with conserved momentum made out of condensed vacuum.

The electron as a vortex rotates around an axis in such a way, that it possesses an angular momentum, spin and charge. This understanding enables us to apply hydrodynamic laws to derive and calculate the electron attributes including spin and charge.

This model shed light on the difference between electron and positron, comparing them to water whirlpool and tornado. The electron negative charge is related to the attractive force toward the center of the vortex, while the positron has repulsive force from the center to the periphery. The attraction or repulsion between charged particles depends on three different forces:

1) The kind of vortex (whirlpool or tornado type) that determines the charge negative or positive respectively.

2) Clockwise or counter clockwise rotation of the vortex that is related to the spin.

3) The dipole orientation.

The attraction between two oppositely oriented electrons despite they have the same charge is explained by dipole attraction and opposite spin rotation direction.

The centripetal force of the electron vortex that attracts Higgs particles to the center of the vortex which depends on the density of the vacuum, the area and the radius of the vortex is formulated. Taking into consideration the reduced momentum of the vortex, the density force in a giving point in the vortex and the net final momentum in that point is formulated. This is actually the flux density of the hydrostatic force within the bulk of a fluid. The force density equation is an expression of volume flow rate which is equivalent to the electric charge q per unit of area of a sphere $4\pi r^2$ reduced by the stiffness of the vacuum expressed as the constant of permittivity ϵ_0 . This comes to indicate that the charge has a sphere shape. Accordingly, the electric charge is an expression of Force x Area which is the cross product between the potential energy and the radial distance, diminished by the vacuum stiffness ϵ_0 . In other words, it's the accelerated mass per area reduced by the stiffness of the vacuum which has the units $\epsilon_0 ML^3/T^2$. It appears that dimensional analysis is not only a reliable method for assessing the validity of equations, but also it can help to find a meaningful interpretation for a category of unknown physical parameters.

The vortex model of the electron may turn out to have far-reaching consequences, for theoretical physics and to be indeed very useful and even almost essential auxiliaries of reasoning. The essence and nature of the electric charge could make a major breakthrough in the field of electromagnetics.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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