Electron from Theory of Dynamic Gravitational Electromagnetism

Shubhen Biswas

G.P.S.H. School, P.O.Alaipur, Pin.-741245(W.B), India
shubhen3@gmail.com

Abstract

In this article the creation of quantized charge and intrinsic magnetic moment of elementary particles especially for electrons has been described with the help of recent Theory of dynamic gravitational electromagnetism (TDGEM). Basically TDGEM gives the measure of induced electric as well as magnetic field for a moving mass particle. Assuming the elementary particle is made of with self bound lump of relativistic photonic masses and treating the dynamic variable of TDGEM as the quantum mechanical observable allowed measuring the quantized charges and spinning magnetic moment, which requires quantization of rotational kinetic energy and these are represented in terms of angular momentum of the elementary particles. The results are very much with the agreement of recent experimental data of electrons and quarks (Leptons). Also the appearance of mass in the expression of the intrinsic magnetic moment of an elementary particle is established as a direct consequence.

Keywords: Charge, Magnetic Moment, Quantization, TDGEM, Electron

1. Introduction

So far we are concern about the elementary particles, the quantized charges and intrinsic magnetic moments are obvious. The TDGEM in a good extent is applicable for electronic spin magnetic moment and the correspondence about the quantization of charges. Basically the TDGEM [1] allows the direct consequence of induced electromagnetic field due to a moving mass particle not having any charges. Now presenting the dynamical variable (here it is momentum of the particle) into operator of quantum mechanical observable the quantization of
charge and intrinsic magnetic moment can be assessed for a particle. Elementary particles like electron, quark up and down annihilate with their antiparticles into radiation energy and also creation of them is possible from very high energetic photons as a consequence of mass energy equivalence. So there is enough scope to think the elementary particles as the lump of relativistic photonic masses (m). The mass associated with the elementary particles is totally relativistic correspondence of photons energy.

The rest mass of photon is zero but it must have relativistic mass corresponding its momentum \( p = \frac{h}{\lambda} \) from theory of Broglie. L.D. [2] regarding its wavelength \( \lambda \)

In the following section the momentum or AM of the bounded relativistic photonic masses will be considered for elementary particle in place of quantization of rotational kinetic energy \( I\omega^2 \).

2. Concept of charge

Now without approximation using TDGEM equation of induced four potentials \( A^\mu \) for a moving mass particle in terms of its gravitational potential \( \phi_r \) at the observation point along the direction \( \cos \psi_r = 1 \) of motion of the mass particle.

\[
A^\mu = (1 - \frac{1}{\gamma^2}) \frac{c}{v} \phi_r U^\mu
\]  

\( U^\mu \) the four velocities of the particle

\[
\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}
\]

Thus induced electric field \( E \) at a distance \( r \) (present position) from the moving mass particle with velocity \( v \), in highly relativistic case will be

\[
E = -\frac{G}{v^2} m \nu \nu
\]  

\( G \) is the gravitational constant

\[
E = -\frac{G}{r^2} \frac{(mv)^2}{m} \hat{r}
\]

Application of Gauss’s divergence theorem to equation (2) gives for a uniformly moving particle, \( (\mathbf{\nabla}, \mathbf{V}) = 0 \).

\[
\frac{\alpha}{e^*} = \oint \mathbf{E} \cdot d\mathbf{s} = \int (\mathbf{\nabla} \cdot \mathbf{E}) d\nu = 0
\]  

Where free space permittivity \( e^* = 8.856 \times 10^{-12} \) F/m
Thus equation (4) shows that a uniformly moving particle cannot have any induced charges \((q)\) associated with it.

Using equation (2.3) allows

\[
E = -\frac{\mathbf{g} p^2}{r^2 m} \hat{r}
\]

Here the momentum, \(p = (mv)\) and mass of the moving particle is, \(m\)

**Fig.1** Induced Electric field through small surface area \(ds\) for a single loop

Application of equation (5) to have the meaningful charges associated with a particle is possible if the particle has the AM orientation in every direction in three dimensional spaces such that it will be constrained in a tiny volume. Here in Fig.1 the contribution of electric field through a small surface at a large distance from a unique loop has been depicted.

\[
\oint E \cdot ds = -4\pi G \frac{p^2}{m}
\]

In this occasion the nonzero divergence of electric field of equation (6) associated with the particle is responsible for charge creation.

The Gauss’s theorem for electrostatics allows equation (6)

\[
\frac{q}{\varepsilon_0} = -4\pi G \frac{p^2}{m}
\]

\[
= -4\pi G \frac{(\Delta r \times p)(\Delta r \times p)}{m \Delta r^2}
\]

\[
= -4\pi G \frac{LL}{m \Delta r^2}
\]

Where angular momentum of the particle is
\[ \mathbf{L} = \Delta \mathbf{r} \times \mathbf{p} = l \mathbf{\omega}, l = m \Delta r^2 \]

Thus the associated charge defined as

\[ q = -4\pi \varepsilon \varepsilon_0 G (l \omega^2) \]  \hspace{1cm} (10)

To give a proposal of charge creation for elementary particles let us to consider particles like the electrons are created due to the self bound relativistic photonic masses in a tiny spherical volume having the AM orientation in every direction in three dimensional spaces such that relativistic photonic masses will be followed in a track as a long thread around a spindle, where a unique loop path must have a single orientation of AM.

Thus an elementary particle can be thought of as the lump of the bound relativistic photonic masses \( m \) i.e. of rest mass of the elementary particle which is bounded in the tiny volume with having certain tangential momentum \( p \) at the spherical boundary. Then equation (10) leads quantization of charges from quantization of rotational kinetic energy \( (l \omega^2) \) and is the suitable representation to determine the charge \( (q) \) associated with the elementary particles and antiparticles.

If \( \Delta r \) is the allowed radial dimension for constituent bound photonic masses of the elementary particle then presenting momentum \( p = \hbar / \Delta r \) the charges associated with the elementary particle using(7) will be

\[ q = -4\pi \varepsilon \varepsilon_0 G \left( \frac{\hbar}{\Delta r} \right)^2 \cdot \frac{1}{m} \]  \hspace{1cm} (11)

Here gravitational constant \( G \sim 6.674 \times 10^{-11} \) and plank constant \( \hbar \sim 6.626 \times 10^{-34} J \cdot S \)

The above equation (11) can be achieved more precisely and elegantly with the help of equation (9), just replacing the AM vector \( \mathbf{L} \) to total AM \( \mathbf{J} = \mathbf{L} + \mathbf{S} \), where the quantum mechanical total AM operator \( \hat{\mathbf{J}} \).

Using quantum mechanical AM operator for a localized electron states having non-zero angular momentum such as realization of the Lie algebra of the Poincare group \( [\hat{J}_i, \hat{J}_j] = i\hbar \varepsilon_{ijk} \hat{J}_k \) and \( [\hat{J}_i, \hat{\rho}] = 0 \).

Gives \( \hat{J} \) for the state ket \( |\psi\rangle \)

\[ \hat{J}^2 |\psi\rangle = (J(J + 1)\hbar^2) |\psi\rangle \]

Localized electron states orbital AM, \( L=0 \) and spin AM \( S=1/2 \) then keeping \( J = 1/2 \) for minimum intrinsic or spin angular momentum.
Equation (9) leads the charge \( q \) associated with the elementary particles and antiparticles [5] of mass \( m \), where for stationery state of particle energy \( E = \pm mc^2 \sqrt{1 + \frac{p^2}{m^2c^2}} \) positive energy state for electron and for negative positron.

It is the fact as equation (9) shows that for creation of charge the gravitational constant in a quantized elementary particle play the vital role.

The validity of equation (15) can be judged with the help of the following elementary particles like electron and quarks (Leptons).

The charges are \(|q_d| = \frac{1}{3} e\), \(|q_u| = \frac{2}{3} e\), \(|q_e| = e\) respectively for down quark, up quark and electron [9].

Taking \( m_d \sim 10m_e \) and \( m_u \sim 5m_e \) where,

\[
m_e = 9.1 \times 10^{-31} \text{ K.g.}
\]

\[
e = 1.6 \times 10^{-19} \text{ S.I.}
\]

Equation (47) gives

\[
r_d = r_u \sim 0.11 \times 10^{-19} m.
\]

Although this result is somehow different from experimental data but could be accountable for the tininess of their sizes with this equality of the up and down quark size [6] is established beautifully.

and \( r_e \sim 0.22 \times 10^{-19} m. \)

This calculation for electron radius is as same as the experimentally [3] \( r_e < 10^{-17} cm \), prescribed upper limit of electrons physical radius.
The equation (11) may be valid for any other leptons. In case of hadrons like proton and neutron the charge contribution of their corresponding constituent’s quarks as of the standard model is applicable.

3. The intrinsic magnetic moment

Also for highly relativistic case the magnetic field at the observation point perpendicular to the direction of motion due to a moving mass particle from TDGEM can be given as

$$B = -\frac{Gm(\mathbf{r} \times \mathbf{v})}{r^2} \frac{v}{c} \tag{16}$$

Now using (16) for a moving particle of mass ‘m’ along a tiny loop of radius $\Delta r$, with unique polarization of angular momentum along Z axis as shown in Fig.2 the associated magnetic field at point ‘P’ will be

$$B_z = -\frac{Gm|\mathbf{r} \times \mathbf{v}|}{r^2} \frac{v}{c} \cos \theta \hat{z} \tag{17}$$

Fig.2 Induced Magnetic field at the pole for a unique loop
\[ \delta B_z = -\frac{Gm|\vec{r} \times \vec{v}|}{r^2} c \Delta r \hat{z} \]  

But for a magnetic dipole moment \( \boldsymbol{\mu} \) magnetic field \( \delta \mathbf{B} = \frac{\boldsymbol{\mu}}{4\pi \varepsilon_0 c^2 r^3} \) 

Taking \((r-z)\) for large distance compare to linear dimension of the loop, the associate magnetic dipole moment for the loop from Fig.2 will be

\[ \boldsymbol{\mu} = -4\pi \varepsilon_0 G m |(\vec{r} \times \vec{v})| \Delta r \hat{z} \]  

\[ = -4\pi \varepsilon_0 G \frac{(m v)^2}{m} c \Delta r \hat{z} \]  

\[ = - \left( 4\pi \varepsilon_0 G \frac{p^2}{m} \right) c \Delta r \hat{z} \]  

\[ = \frac{- \left( 4\pi \varepsilon_0 G \frac{p^2}{m} \right) c}{m v} m v \Delta r \hat{z} \]  

\[ \boldsymbol{\mu} = - \left( 4\pi \varepsilon_0 G \frac{p^2}{m} \right) \Delta \vec{r} \times \vec{v} \left( \frac{c}{v} \right) \]  

\[ = - \left( 4\pi \varepsilon_0 G \frac{p^2}{m} \right) \frac{\Delta r \times \vec{v}}{m} \left( \frac{c}{v} \right) \]  

\[ \boldsymbol{\mu} = - \left( 4\pi \varepsilon_0 G \frac{l^2}{m \Delta r^2} \right) \frac{\mathbf{L}_z}{m} \left( \frac{c}{v} \right) \]  

Here \( \mathbf{L}_z \) is the dynamical variable indicates the angular momentum of the tiny particle.

Let us simulate the equation (26) following sec.2 for the dynamical variable \( \mathbf{L}_z \) as the quantum mechanical observable \( \hat{\mathbf{L}}_z \) and \( \hat{\mathbf{J}}_z |\psi> = \hbar |\psi> \) also \( [\hat{\mathbf{L}}_z, \hat{\mathbf{J}}^2] = 0 \). Then \( \hat{\mathbf{J}}_z \) and \( \hat{\mathbf{J}}^2 \) both of them are simultaneously measureable.

\[ \boldsymbol{\mu} = - \left( 4\pi \varepsilon_0 G \frac{<\psi|\hat{\mathbf{J}}^2|\psi>}{m \Delta r^2} \right) \frac{<\psi|\hat{\mathbf{J}}_z|\psi>}{m} \left( \frac{c}{v} \right) \]  

Now in the preceding section the elementary particle is considered to be as the lump of self bounded photonic masses which follow the quantum mechanical properties. Then the bounded relativistic masses will show the minimum intrinsic or spin angular momentum \( <\psi|\hat{\mathbf{L}}_z|\psi> = \hbar/2 \), which is obvious from Dirac’s formulation [4] for stationary electron like particle in the relativistic quantum mechanics.

\[ \boldsymbol{\mu} = \frac{\hbar c}{2m_{\psi}} \]  

Here \( m_{\psi} \) is dynamical variable attributes the angular momentum of the tiny particle.
The appearance of $c/v$ term in the equation (28) may be dropped out for the ultra relativistic case $v \sim c$

Now for electron’s (q= -e) intrinsic magnetic moment

$$\mu_e = \frac{-e\hbar}{2m_e} \left(1 - \frac{1}{\gamma^2}\right)^{-\frac{1}{2}}$$

(29)

$$\mu_e = \frac{-e\hbar}{2m_e} \left(1 + \frac{1}{2\gamma^2} + \cdots \right)$$

(30)

Ignoring the higher order term of $1/\gamma^2$

$$\mu_s = -\frac{g_e \mu_B S}{\gamma}$$

(31)

$\mu_B = -\frac{e\hbar}{2m_e}$, is the Bohr magnetron and $S = \pm 1/2 \hbar$ is the spin quantum number of electron. The ‘$g$’ factor for electron $g_e$=2 as prescribed by Dirac if we ignore all $1/\gamma^2$ term from equation (29). But experiment shows $g_e$=2.0023193043615 [7].

The so called dimensionless quantity structure factor

$$\alpha = \frac{g_e - 2}{2} = \frac{1}{2\gamma^2} + \cdots$$

(32)

Considering only the first order term with $1/\gamma^2$ in equation (31)

And taking $\alpha^{-1}$=137.035999037 [8], we should infer from (32)

$$v = .998935 \ c$$

This relation shows that velocity of bound photonic masses is almost equal to the velocity of photons in free space. That is $v \sim c$ for the bound masses constituent of the elementary particle as of our requirement in section 2.

**Conclusion**

In this article the equation (9) gives the direct consequence of gravitational constant for charge quantization and the expression is adjudged over for few leptons in regards of present data and may be tested for others. The correction of ‘$g$’ factor can be achieved for the higher order in QED in case of electron. Here from equation (28) the representation of the intrinsic magnetic moment of the elementary particle is given over the quantum correspondence of the TDGEM.
**Acknowledgements.** For writing this article I am grateful to Dr. Abhijit De and Prof. Bikash Chakroborty for their suggestions.

**References**


**Received: August, 2012**