Understanding the Cause of Electric Charge in Electrons and Quarks.

Colin James BSc BA MInstP [1]

[1] Independent researcher. 54 Scott Close, TAUNTON, Somerset, TA2 6UN, UK.
E-mail: colinjamesphysics@yahoo.co.uk

Abstract.

I suggest that the electron is an electron neutrino with a unique frequency (≈ 2.47 x $10^{20}s^{-1}$). The unique frequency is identified by the vacuum's virtual photons and the electron is contained by elastic collisions in an approximately circular orbit (hence the diffuse nature of the electron).

The containment redistributes the vacuum energy by redirecting one handedness of virtual photons outwards. The loss of homogeneity in the vacuum is counteracted by an inflow of oppositely handed virtual photons. The outward and inward flows account for electric charge.

The electron's spin (h/4π) is the spin of its orbit relative to a moving observer. The diameter of the free electron's containment orbit equals the reduced Compton wavelength and its circumference is half the Compton wavelength.

A similar structure within hadrons shows the 2:1 charge ratio for quarks.

A search for intermittent e^{2-}, e^{3-} … and e^{2+}, e^{3+} … with masses $\sqrt{2}m_e$, $\sqrt{3}m_e$ … may provide support for the theory.

1. Introduction.

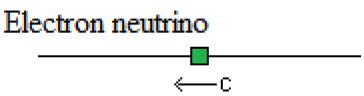
This paper attempts to understand how electric charge arises.

2. Hypothesis - electron/electron neutrino.

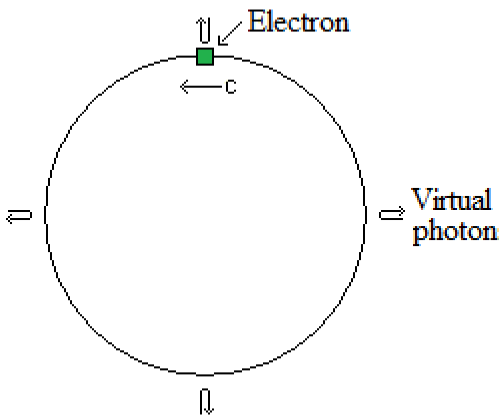
2.1. Hypothesis.

Assume that the electron and the electron neutrino are the same particle differing only in frequency.

The electron neutrino is a free, speed of light, half-spin particle.
Figure 1.



According to this paper the electron is also a speed of light, half-spin particle but rather than being free it is localised through containment by the vacuum.
Figure 2.



2.2. Summary of consequences.
The electron and its neutrino are both half-spin (h/4π), speed of light particles. The unique frequency ($\approx 2.47 \times 10^{20} s^{-1}$) of the electron is what distinguishes it from the electron neutrino.

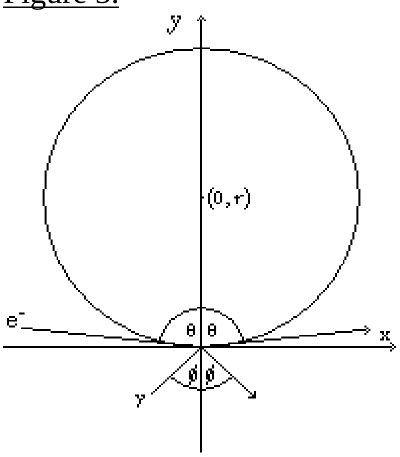
A free electron is confined by the vacuum in an approximately circular orbit of radius $\approx 1.93 \times 10^{-13}$m (causing the diffuse nature of the electron). The electron and its orbit both have spin h/4π. The containment of the electron produces a redistribution of the vacuum energy and this is the cause of electric charge. The electron spin (left-handed or right-handed) is the spin of its orbit relative to a moving observer. If there is no relative motion between electron and observer the spin is ambiguous.

3. Consequences.

3.1. Electron confinement.
As the electron may be stationary it must be confined by the vacuum. Elastic collisions with virtual photons keep it in an approximately circular orbit. The vacuum selects the electron and contains it because of its unique frequency.

The magnitude of the spin of a free electron and the spin of its orbit are both h/4π and the confinement orbit of a free electron may be termed a free electron orbital.

Figure 3.



Energy, angular momentum and magnitude of linear momentum may all be conserved separately in the elastic collisions between an electron and a virtual photon in the vacuum.

Using Figure 3, the x-components of momentum of electron and photon are unchanged. The y-components are reversed but the magnitudes of each are constant.

As the only change in electron and photon momentum during the collision is radial, angular momentum is conserved.

3.2. Forces.
The vacuum's virtual photons provide the centripetal force that keeps the electron contained and the electron's centrifugal force redirects the vacuum's energy to produce the electrostatic force.

3.3. Compton wavelength.
The diameter of the free electron orbital is the reduced Compton wavelength and its circumference is half the Compton wavelength.

From the orbital angular momentum:
$mcr = h/4\pi$
$2r = h/(2\pi mc)$ = reduced Compton wavelength.
$2\pi r = ½ (h/(mc))$ = ½ Compton wavelength.

3.4. Signature spin.
To distinguish between the spin of the free electron orbital and the spin of the particle involved we may call the latter the electron's signature spin. The electron is assumed to have a signature spin that is left-handed (because of its close relation to the electron neutrino) and this does not change.

The positron has a right-handed signature spin and the same unique frequency as the electron.

Because the electron neutrino is not confined by the vacuum its spin is the same as its signature spin (left-handed). It has any frequency other than the electron's or positron's unique frequency. The electron antineutrino has a right-handed spin (which is the same as its signature spin).

3.5. Charge conservation.
If a photon decomposes into a generation 1 lepton pair then the outcome is either an electron/positron or electron neutrino/electron antineutrino pair. In the first case equal amounts of negative and positive charge are created from a photon with the unique frequency that matches the electron and positron unique frequency $\approx 2.47 \times 10^{20} s^{-1}$. In the second case no charge is created.

3.6. Wavelength = orbit circumference.
The wavelength of the electron equals the circumference of the free electron orbital. In this section the subscript $_{el}$ denotes electron.

Using: $\nu_{el}\lambda_{el} = c$; $m_{el}cr_{el} = h/4\pi$; $m_{el}c^2 = ½ h\nu_{el}$ (half the energy of the parent photon from pair production).

$\frac{1}{2} h\nu_{el} = \frac{1}{2} hc/\lambda_{el} = m_{el}c^2$
$\frac{1}{2} hr_{el}/\lambda_{el} = m_{el}cr_{el} = h/4\pi$
$r_{el}/\lambda_{el} = 1/2\pi \Rightarrow 2\pi r_{el} = \lambda_{el}$

3.7. Inertia.
The electron as pictured in this paper (fixed frequency contained 'radiation') has parallels to the electron as suggested in a paper concerning inertia [1]. In it the laws of inertia were shown to be consistent with masses based on phase-locked cavities - resonant cavities filled with monochromatic radiation.

4. Electric charge.

4.1. Redirection of momentum.
Electric charge is deduced to be caused by redistribution of the vacuum energy. Elastic collisions between the electron and virtual photons cause a flow of virtual photon momentum outward from the electron. This may be the cause of repulsion between like charges.

The vacuum attempts to restore homogeneity with a corresponding inward momentum flow - the cause of attraction between unlike charges.

4.2. Matching charge with photon handedness.
Photons are either left-handed or right-handed. Assume that negative charges only interact with one of the two types of photon and positive charges only interact with the other.

4.3. Repulsion.
The electron only reflects (without changing photon handedness) one of the two types of virtual photons (and is deflected only by them). It ignores the other type of virtual photon. A second electron (target) in the presence of an electron (source) responds to the outward momentum flow by being deflected away from the source electron - repulsion between like charges.

4.4. Attraction.
The outward redirection of virtual photon momentum causes a lack of uniformity in the vacuum. Assume that it attempts to restore homogeneity by responding with an inward flow of oppositely handed virtual photons - in effect a time reversal of the outflow. For example, a time reversal of left-handed photons flowing out is equivalent to an inward flow of right-handed photons. A positron (target) in the presence of an electron (source) will ignore the outward flow and be deflected by the inward flow of oppositely handed photons.

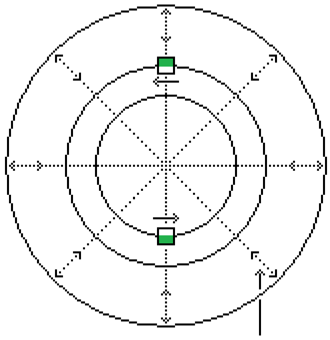
5. Quarks.

Quarks are contained within hadrons. Assume that the quarks are contained by bosons (which in turn are contained within the hadron) in a similar structure to electrons being contained by virtual photons in the vacuum (i.e. held in approximately circular orbits by elastic collisions with bosons).

5.1. Quark/antiquark containment.

Figure 4 suggests a structure for a quark and antiquark contained in orbitals by bosons travelling in radial directions.

Figure 4.



Quark assumptions:
the quarks are in orbit with orbital angular momentum $h/4\pi$; and
the bosons hold the quarks in orbit by elastic collisions; and
the quarks travel at the speed of light.

Containing structure assumptions:
the overall structure that holds the bosons is spherical; and
the containing structure designates the handedness of its boson inhabitants (this ensures that the signature spin of the contained particles is of only one type of handedness. (An equivalent structure containing oppositely handed bosons gives rise to the antihadron).

Boson assumptions:
the bosons all have the same speed and momentum; and
they may act singly, in pairs, in threes and so on; and
they travel radially reflecting off the containing structure and passing back through the centre of the sphere unless reflected by one of the quarks; and
they all have the same handedness (as designated by the containing structure).

5.2. Boson/quark interaction.

Single boson interaction with quarks matches the lower quark frequency. Double boson interaction with quarks matches the higher quark frequency ($\sqrt{2}$ times the lower quark frequency).

Double boson interaction is most likely to occur where the boson density per unit area per unit time is double that where single boson interaction contains the lower frequency quark. This occurs where the spherical area (centred on the centre of the containing structure) has radius $1/\sqrt{2}$ times the radius of the lower frequency quark.

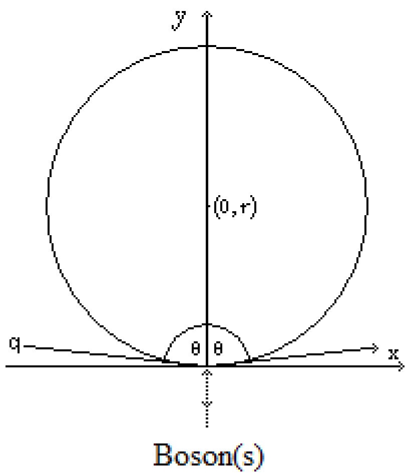
Let the less energetic quark be labelled with 1 and the more energetic quark with 2.

Quark.	Radius of orbital.	Spherical. area.	Frequency.	Charge *.
1	r_1	$4\pi r_1^2$	ν_1	q_1
2	$r_1/\sqrt{2}$	$4\pi r_1^2/2$	$\sqrt{2}\nu_1$	$2q_1$

* Please see the section below entitled: '5.5. Charge and centrifugal force'.

5.3. Conservation of energy and momentum.

Figure 5.



Energy, angular momentum and magnitude of linear momentum may all be conserved separately in the elastic collisions between quarks and bosons.

Using Figure 5, the x-components of momentum of quark and boson(s) are unchanged. The y-components are reversed but the magnitudes of each are constant.

As the only change in quark and boson(s) momentum during the collision is radial, angular momentum is conserved.

5.4. Centrifugal force.

For the quarks: $mcr = h/4\pi$; $mc^2 = ½ h\nu$

The centrifugal force in different terms is:

frequency:	$mc^2/r = h\nu/(2r) = (h\nu/2) \times (4\pi c/h) \times h\nu/(2c^2) = \pi h\nu^2/c$	$\propto \nu^2$
mass:	$mc^2/r = mc^2 \times (4\pi mc)/h = 4\pi m^2c^3/h$	$\propto m^2$
radius:	$mc^2/r = h/(4\pi cr) \times c^2/r = hc/(4\pi r^2)$	$\propto 1/r^2$

5.5. Charge and centrifugal force.

If charge is the ability of a particle to redistribute the vacuum energy then we may identify charge as proportional to the centrifugal force of the contained particle. That is, charge is proportional to (frequency)^2. The quarks may interact with the vacuum's virtual photons directly or through intermediaries such as gluons or other bosons.

5.6. Suggestion.

It has already been suggested in this paper that the electron and its neutrino may be the same particle differing only in frequency.

Could all the generation 1 quarks and leptons be the same particle offering different properties because of variations in signature spin, frequency and the environment they operate in?

5.7. Heavy electrons (e^{2-}, e^{3-} …).

If electrons are contained by the vacuum in a similar way to quarks, then an electron neutrino with $\sqrt{2}$, $\sqrt{3}$ … times the frequency of an electron might be intermittently contained by pairs, triples ... of vacuum virtual photons. The containment would produce a short-lived charge of e^{2-}, e^{3-} … since charge (redistribution of vacuum energy) is proportional to $(\text{frequency})^2$.

The charge would appear to be short-lived because of the lower probability of two, three ... virtual photons operating on the electron neutrino at the same time. The particle would spend some of its time as an electron neutrino and some as a heavy electron. As well as intermittent e^{2-}, e^{3-} … there would be the same number of intermittent antiparticles e^{2+}, e^{3+} … resulting from electron neutrino, electron antineutrino pair production and charge would on average be conserved.

6. Conclusion.

The containment idea suggested in this paper provides a straightforward explanation of why some particles possess electric charge and others do not. Section 5.7. may point to one way of testing it.

Acknowledgements.

The author would like to thank Emma Walsh, Sophie James, David James, Harvey Milne and Lynne Smith for advice and support.

References.

[1] Jennison RC and Drinkwater AJ. 1977. An approach to the understanding of inertia from the physics of the experimental method. J. Phys. A: Math. Gen. **10** No 2 167.