The mechanics of electrostatic attraction and repulsion, a conceptual analysis.

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Significance

A mechanical model for electrostatic attraction and repulsion is proposed.

Abstract

Conceptual analysis finds Coulomb attraction and repulsion between integer charged particles from interactions with spin=2 photon-pairs. Primordial pairs transform to electrostatic pairs to form homogeneous (+E) or (-E) photon fields around particles of charge. Asymmetric fields create conditions for repulsion of same charged particles, or attraction of opposite charges. The Coulomb force effect is achieved through momentum transfer from photons to particles, giving the appearance of a force.

Keywords

Coulomb attraction and repulsion, primordial and electrostatic photon pairs, electric field

Summary

In the introduction a revision is given of some previous attempts to describe the real-word functioning of Coulomb interactions – electrostatic attraction and repulsion. A brief introduction of photon pairs is offered.

In section 1 the state vectors of primordial photon pairs are proposed.

Section 2 proposes the mechanism of photon pair decoupling, being discrete photon-particle interactions and initially not affected by 'mass'. Inflowing primordial (spin=2) photon pairs transform when encountering a unit of charge. Newly transformed photon pairs form outflowing homogenous neutrally polarised (spin=0) electrostatic fields around particles of charge. The fields are not 'static' though and would respond relativistic to changes in position, velocity or acceleration of particles.

Sections 3,4 and 5 propose a model of momentum transfer interactions between photons and particles of charge and that lead to a 'push-type' solution for Coulomb attraction and repulsion.

Introduction

For charged fundamental particles, no mechanistic model has been successful in explaining electrostatic interactions. Proposing a model that attains an equal value of strength for both attractive and repulsive fields or forces has been problematic.

Some learning materials teach that arrowed lines can represent electric fields flowing out of positive particles and into negative particles. See [Figure 1]. In this analogy positive charges are the sources of electric fields and negative charges are the sinks.

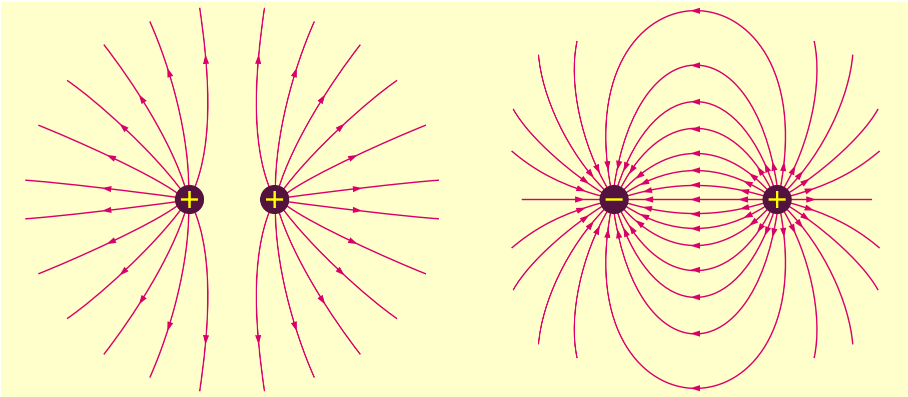

Figure 1: Electric Field Lines (By Andrew Jarvis - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=79523935)

This helps with an intuition for repulsion for +/+ interactions and attraction for +/- interactions. However, this method fails for -/- since this should have represented a double attraction. The mathematical argument that '-1 x -1 = +1' is weak if (-) is also to be seen as a sink.

Another graphic representation of repulsion shows two humans, each standing in their own small boat, passing a ball back and forth, resulting in the boats drifting apart due to transfer of momentum each time the ball is thrown or caught.

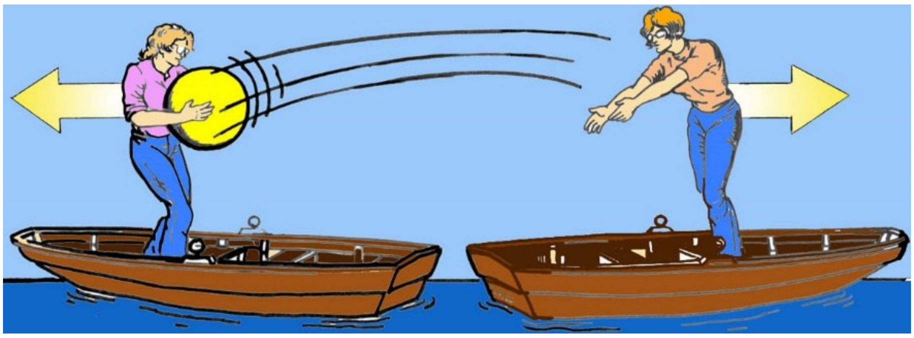

Figure 2: Repulsion Analogy (Image credit Daniel Claes)

[Figure 2] gives a good analogy of repulsion, however if these same humans hoped to apply an 'attractive force' in a different scenario, this model could only work if they have a steady supply of balls to throw in the opposite direction from each other.

With the boomerang analogy in [Figure 3] the supply of materials need not be unlimited because throwing the boomerang in this manner will result in inward momentum when the boomerang is thrown and when it is caught. However, since interactions between charged particles must happen at the speed of light, the longer path of the boomerang analogy would violate the laws of causality.

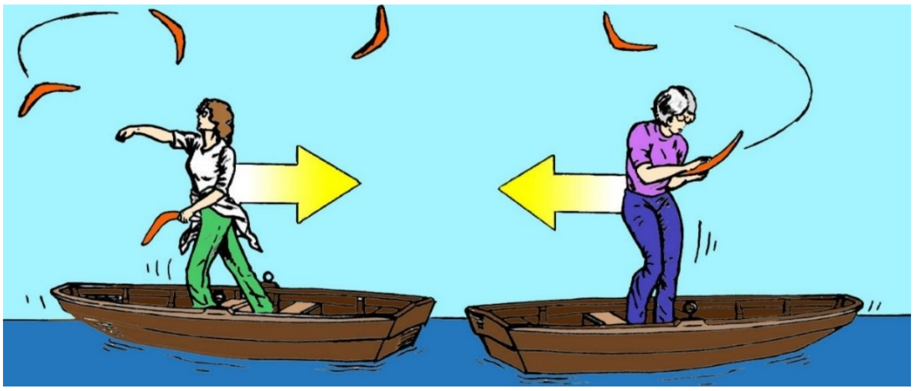

Figure 3: Attraction Analogy with Boomerangs (Image credit Daniel Claes)

Instead of using balls and boomerangs, the effects of charged particles attracting or repelling each other can be achieved between charged particles with photon-pairs as a solution.

In field theories, quantum theories, and by Maxwell's rules[1] – electromagnetic fields are constantly emitted or updated around charged particles. While the gradient of an electrostatic field around a particle may appear static, the entire field is continuously updated from the source outward – at the speed of light. This effect is noticeable if a particle were to be moved relative to another charged particle. Electrodynamic effects ensue and relativistic equations are required to solve for the dynamics of how the fields change. It is evident that electrostatic fields are not 'static'.

Yet here is no 'off switch' for solitary charged particles. Charged particles emit their fields uninterrupted. The source of this energy, and its conversion from primordial vacuum to electrostatic fields, is yet unknown, but proposed in this paper.

This work is based on the concepts of Zero-Point-Fields[2] of Rueda and Haisch, and with specific reference to the paired-photon vacuum[3] of Grahn, Annila and Kolehmainen, A caveat is added that the photon pairs are primordial, remain so paired until interacting with particles, yet each primordial pair must have a very definite energy content, else electrodynamics would have been an unmeasurable science.

As will be shown, a 180° out-of-phase photon-pair has a quantum property spin projection of +2, meaning they travel in the same direction and have similar polarisation, but together they have no net E or B fields to observe. By conventional techniques such a pair would be near-undetectable, since our measuring devices rely on electric (E) or magnetic (B) fields of photons and particles being present. With no E or B reactions to charged particles, e.g. between the multitude of charged particles within complex atoms, such photons may travel unhindered through matter with atoms understood as being 'mostly empty space'. A direct collision with a particle might end the photon pair's travel. Such a collision is expected resulting from a spin-spin interaction, where a particle spin is understood to act like a tiny magnet reacting with the spins of the photon pairs.

Photon fields

Section1: Primordial Photon Pairs

The state vector[1] of an RHC (Right-hand-circularly polarised) photon may be presented as:

$$|R_1\rangle = \frac{1}{\sqrt{2}}(|x\rangle + i|y\rangle) \tag{R}$$

, and for a LHC (Left-hand-circularly polarised) photon

$$|L_1\rangle = \frac{1}{\sqrt{2}}(|x\rangle - i|y\rangle) \tag{L}$$

, where x and y link to the E (electric) and B (magnetic) field vector components, and the distinction between RHC and LHC can be seen in the sign of the imaginary component.

Rewriting (R) and (L) with E and B variables instead of x and y for clarity of concept:

$$|R_1\rangle = \frac{1}{\sqrt{2}}(|E\rangle + i|B\rangle) \tag{1}$$

, as shown conventionally in [Figure 4], with RHC representation as typical E=(+)sin(x) and B=(+)sin(x) waves, seen from the sender's (left) point of view.

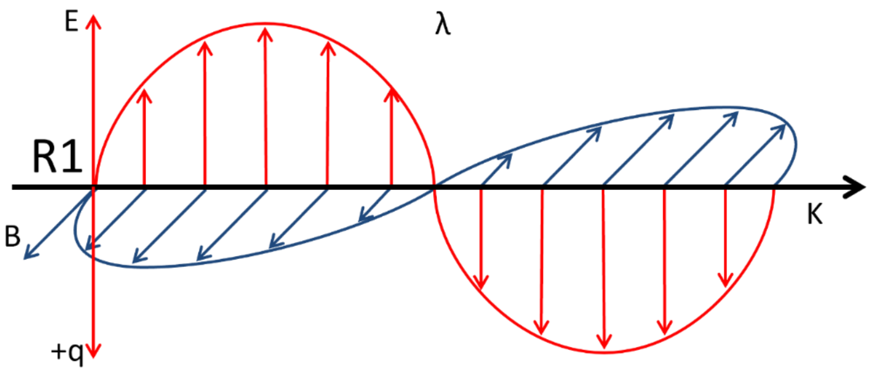

Figure 4: R1 as an RHC photon (wave)

Even though we know a +sin(x) curve has positive and negative portions to its curve over a length of 2π, it seems counter-intuitive that the wavefunction of R_1 should enter the negative E and B domain when the state vector for R_1 only has positive E and B components. It would also imply that a -R1 curve only need have a phase difference (in time and space) of π (180°), and if R1 only moves a distance π, it must turn into its evil negative twin. Furthermore, if a train of +sin(x) wavelets were passing an observer, it may appear to be a train of -sin(x) wavelets if the observer chose his moment of observation 180° out-of-phase. It would thus be difficult to understand how a field of +sin(x) wavelets can be distinguished as a +E field surrounding a (+) charged particle. This might seem like a trivial argument, but sin(x) from 0-2π is not the only viable solution for a wavefunction. While a physical form for a photon has not generally been agreed upon, Shan-Liang Liu argues convincingly that a photon length is restricted to a half-wavelength[4] in space and time, which implies that [Figure 4] must already be representative of 2 photons in tandem, R_1 and a phase-following (or leading) $-R_1$. One can now intuitively see how each packet of energy, with any allowed orientation of E and B field, travels through space at velocity 'c' in its original form as it was emitted. Fluctuations, as observed in typical electromagnetic waves, can then be achieved with (+) (-) photons in tandem. In this document it will be shown how trains of photons can form (+) and (-) fields, as might be found around charged particles.

For coupled photon pairs, and with each photon limited to half wavelength wave-functions, R_2 as an RHC (2) photon is envisaged, with its wave-function being 180° out-of-phase of the R_1 photon on both x and y axes, but with same propagation direction:

$$|R_2\rangle \ = \frac{1}{\sqrt{2}}(|E+\pi\rangle + i|B+\pi\rangle) = -\frac{1}{\sqrt{2}}(|E\rangle + i|B\rangle) = \ -|R_1\rangle \tag{2}$$

, as shown in [Figure 5] as a typical wave which already begins to represent a photon train, or a tandem photon pair, although not yet fully representing what Grahn, Annila and Kolehmainen, nor Rueda and Haisch envisaged for their paired vacuum, or zero-point-fields.

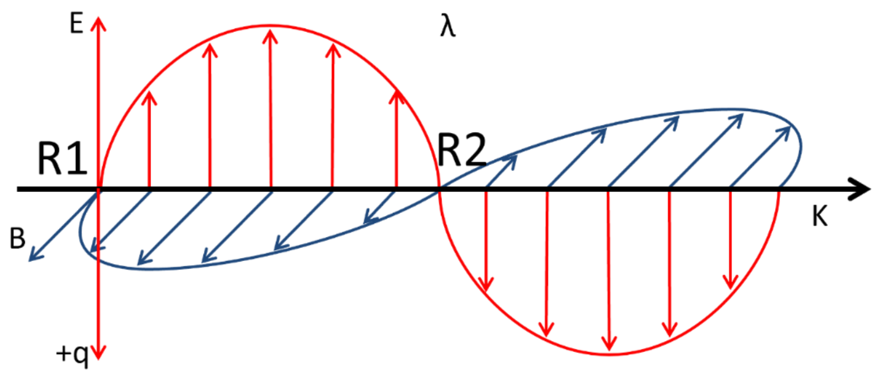

Figure 5: R1(x) + R2(x-π)

Similarly, we define for an LHC photon as shown in [Figure 6]:

$$|L_1\rangle \ = \frac{1}{\sqrt{2}}(|E\rangle - i|B\rangle) \tag{3}$$

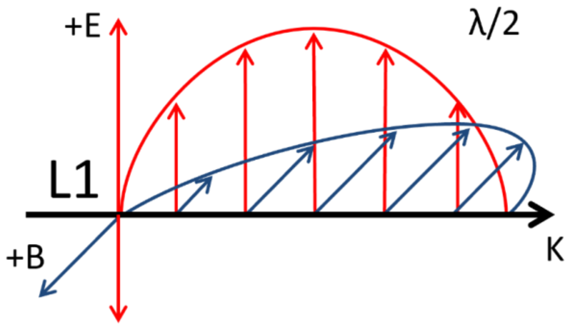

Figure 6: L1 as an LHC photon

, and for $L_2 = -L_1$ as shown in [Figure 7], and shown on its own to begin suggesting that it does not have to always be in tandem with L_1:

$$|L_2\rangle = \frac{1}{\sqrt{2}}(-|E\rangle + i|B\rangle) = -|L_1\rangle \tag{4}$$

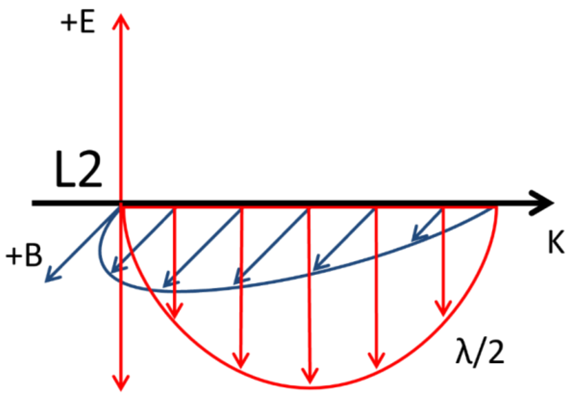

Figure 7: L2 = -L1 as an LHC photon

For the remainder of this document, reference to 'positive photons' would mean the (+E) positive E curves of R_1(RHC) and/or L_1(LHC), and reference to 'negative photons' would mean the (-E) negative E curves of R_2(RHC) and/or L_2(LHC).

Unlike in [Figure 5], where R_1 and R_2 are represented as following and separated by half-wavelengths, R_1 and R_2 are also bosons and may occupy the same space, but R_2 is the negative of R_1, so adding (1) and (3) in the same space:

$$\Psi_1 = |R_1\rangle + |R_2\rangle = 0 \tag{5}$$

, where R_1+R_2 is no longer to be seen as two photons in tandem, but are both confined within one half-wavelength, as shown in [Figure 8].

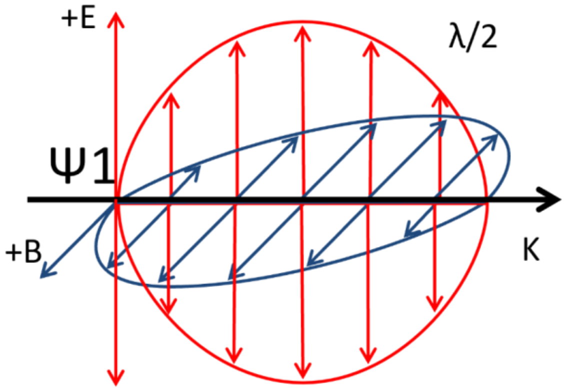

Figure 8: Ψ1 = R1 + R2 = 0

, similarly for the LHC photons:

$$\Psi_2 = |L_1\rangle + |L_2\rangle \ = 0 \tag{6}$$

, which representation of Ψ_2 would also be a match for Ψ_1 in [Figure 8].

The energy density for either R_1 or R_2 equals a non-zero positive value, since the Pointing vector (7) for a photon always has a positive amplitude (ignoring sign change for direction based on a chosen coordinate system which does not change the amplitude, merely the direction of the vector),

$$\bar{S}(|R_i\rangle) \ = \frac{1}{\mu_0}(\bar{E}x\bar{B}) \tag{7}$$

, and always positive for energy (8) of each photon e.g.,

$$\bar{U}(|R_1\rangle = \bar{U}(|R_2\rangle = \ hf \tag{8}$$

Unlike adding the state vectors of R_1 and R_2 to equal zero in (5), energy in (8) does not give a zero result for any f>0. However, from (5) and (6), except for the net spin=±2 values, the photon pairs Ψ_1 and Ψ_2 might appear electromagnetically 'invisible'.

This now represents what Grahn, Annila and Kolehmainen envisage for their paired vacuum, and Rueda and Haisch for their zero-point-fields The results of the HOM[5] experiment may already provide evidence of such invisible photon pairs created in lab conditions.

Because photon pairs Ψ_1 and Ψ_2 have no net electric or magnetic field components, and thus have no visible wavelengths, the triggering of a Compton effect in the vicinity of a charged particle appears improbable. For Ψ_1=R_1+R_2 the net projected spin is +2 and for Ψ_2=L_1+L_2 the net spin is -2. However, spin interactions[6] are short-ranged effects. Thus, if the photon pairs do not interact electrically or magnetically with atomic material, the photon pairs might attain a long mean free path through even the densest atomic matter.

It is proposed that photon pairs Ψ_1 and Ψ_2, as represented in [Figure 8], saturates all of space, of origins yet to be determined, being the vacuum photon pairs of Annila et al and forming an all-pervasive aether to which mass is mostly transparent.

Section2: From primordial photon pairs to electrostatic pairs

The RHC photon pair R_1+R_2 in Ψ_1 consist of equal spin states, resulting in a total projected spin state of +2. The LHC photon pair in L_1+L_2 in Ψ_2, have a total spin state of -2. Both pairs have a net direction +z.

$$S_z(|R_1\rangle + |R_2\rangle) \ = (0,0,2) \tag{9}$$

, and

$$S_z(|L_1\rangle + |L_2\rangle) \ = (0,0,-2) \tag{10}$$

With limited to no probability to interact ‘electromagnetically’ through E or B fields, this renders short-ranged spin-spin interactions between photon pairs and charged particles (spin=½) as the only likely or probable interaction method to decouple or transform the photon pairs Ψ_1 or Ψ_2.

From (8) it is deduced that if a mechanism exists to change a wavefunction from e.g. R_1 to R_2, which equates to changing R_1 to $-R_1$, such a mechanism would require no energy from the transformation since the net energy does not change.

Postulate1:

It is proposed that spin-spin interactions with charged particles cause the primordial spin ±2 photon pairs to transform into spin-0 pairs which in turn manifest as electrostatic fields with no magnetic fields around (static) charged particles. (Particle spin states remain unchanged after the interactions), with the proposed transformation results as:

$$\Psi_3 = |L_1\rangle + |R_1\rangle \ = +\frac{2}{\sqrt{2}}\,|E\rangle \tag{11}$$

, and

$$\Psi_4 = |L_2\rangle + |R_2\rangle \ = -\frac{2}{\sqrt{2}}\,|E\rangle \tag{12}$$

From primordial photon pairs Ψ_1 and Ψ_2 to transition to electrostatic photon pairs Ψ_3 (11) or Ψ_4 (12), transformation mechanisms are proposed as follows:

Transformation T_+:

A charged positive (+) particle will interact with either of photon pairs Ψ_1 and Ψ_2 by interacting with each photon within the pair and:

1. Transform the (-E) photon wavefunction out of the pair to (+E) (e.g. by inverting the photon wave-function)
2. Reflect the (+E) photon (and invert the polarisation).

As shown in [Figure 9], colorised to enhance the T+ transition effect.

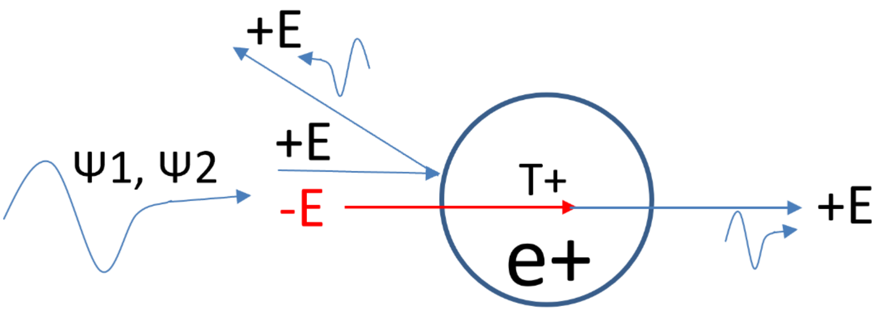

Figure 9: T (+) transformation of photon

Interacting with a (+) particle, within the incoming photon pair Ψ_1, (R_1+R_2), R_1 is reflected:

$$(\boldsymbol{T_+})|\boldsymbol{R_1}\rangle \;=>\; |\boldsymbol{L_1}\rangle \tag{13}$$

, and R_2 is transformed from -E to +E:

$$(\boldsymbol{T_+})|\boldsymbol{R_2}\rangle \;=>\; |\boldsymbol{R_1}\rangle \tag{14}$$

, and within the incoming pair Ψ_2, (L_1+L_2), L_1 is reflected:

$$(\boldsymbol{T_+})|\boldsymbol{L_1}\rangle \;=>\; |\boldsymbol{R_1}\rangle \tag{15}$$

, and L_2 is transformed from -E to +E:

$$(\boldsymbol{T_+})|\boldsymbol{L_2}\rangle \;=>\; |\boldsymbol{L_1}\rangle \tag{16}$$

, resulting in both cases outgoing pairs Ψ_3, (R_1+L_1)

Transformation T_-:

A charged negative (-) particle will interact with either of photon pairs Ψ_1 and Ψ_2 by interacting with each photon within the pair and shown in [Figure 10]:

1. Transform the (+E) photon wavefunction out of the pair to (-E) (e.g. by inverting the photon wave-function)
2. Reflect the (-E) photon (and invert the polarisation).

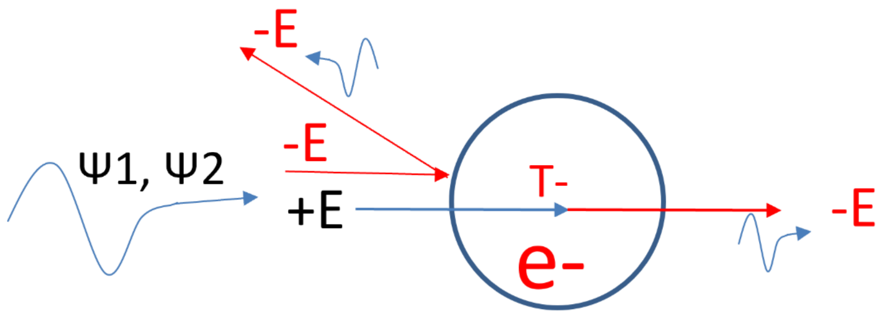

Figure 10: T (-) transformation of photon

Interacting with a (-) particle, within the photon pair Ψ_1, (R_1+R_2), R_2 is reflected:

$$(\boldsymbol{T_-})|\boldsymbol{R_2}\rangle \;=>\; |\boldsymbol{L_2}\rangle \qquad \textbf{(17)}$$

, and R_1 is transformed from +E to -E:

$$(\boldsymbol{T_-})|\boldsymbol{R_1}\rangle \;=>\; |\boldsymbol{R_2}\rangle \qquad \textbf{(18)}$$

, and within pair Ψ_2, (L_1+L_2), L_2 is reflected:

$$(\boldsymbol{T_-})|\boldsymbol{L_2}\rangle \;=>\; |\boldsymbol{R_2}\rangle \qquad \textbf{(19)}$$

, and L_1 is transformed from +E to -E:

$$(\boldsymbol{T_-})|\boldsymbol{L_1}\rangle \;=>\; |\boldsymbol{L_2}\rangle \qquad \textbf{(20)}$$

, resulting in both cases outgoing pairs Ψ_4, (R_2+L_2)

End Postulate1.

Thus, a charged (+) particle transforms any of the photon pairs Ψ_1 and Ψ_2 to Ψ_3 (11), equation rewritten:

$$\Psi_3 = |R_1\rangle + |L_1\rangle = +\frac{2}{\sqrt{2}}\,|E\rangle \qquad (11)$$

, which now has a net spin = 0 and a net zero B field, thus forming a net positive electrostatic field flowing out from around the (+) particle, with photon pair E and B fields as shown in [Figure 11].

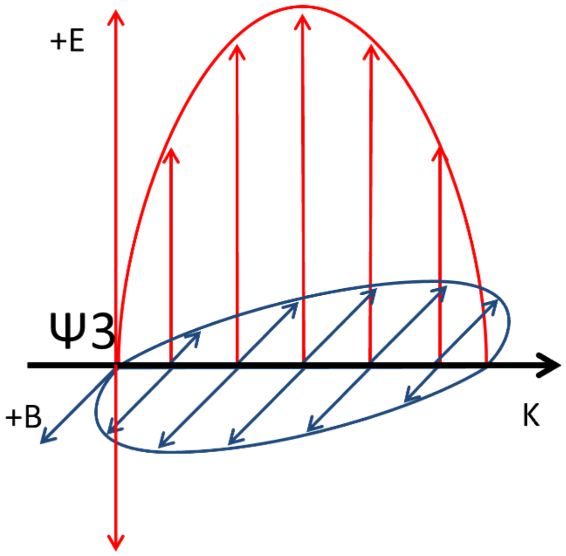

Figure 11: Outflowing photon pairs from a (+) particle have a net +E component

And a charged (-) particle transforms any of the photon pairs Ψ_1 and Ψ_2 to Ψ_4 (12), rewritten:

$$\Psi_4 = |R_2\rangle + |L_2\rangle = -\frac{2}{\sqrt{2}}\,|E\rangle \tag{12}$$

, which now has a net spin = 0 and a net zero B field, thus forming a negative electrostatic field flowing out from around the (-) particle, with photon pair E and B fields as shown in [Figure 12].

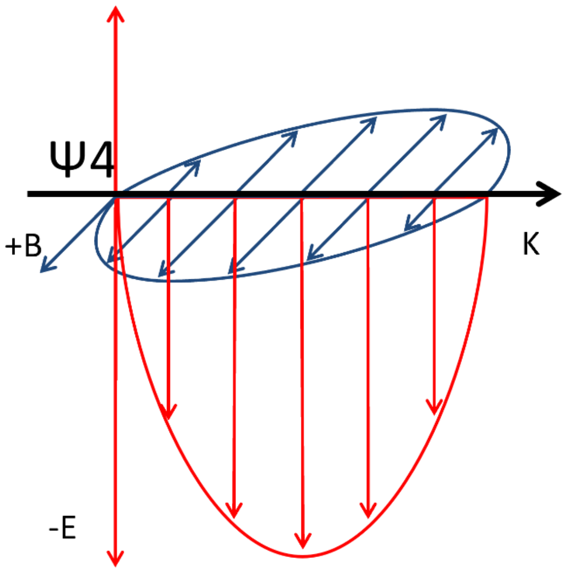

Figure 12: Outflowing photon pairs from a (-) particle have a net -E component

Section3: The Coulomb field equation visualised

Being a conceptual analysis of a model, electrostatic interactions between charged particles will be represented as simplified Coulomb fields and forces.

Charged particles are represented as submerged in an aether of spin=±2 photon pairs Ψ_1 and Ψ_2. As shown in [Figure 13], that in a symmetric photon field there is no net macroscopic force on a single isolated particle. Quantum fluctuations are ignored for now, and representations are limited to a two-dimensional graphic representation of a one-dimension effect, for clarity of concept. A complete solution will necessarily require tensors and will need to include analysis of relative velocities.

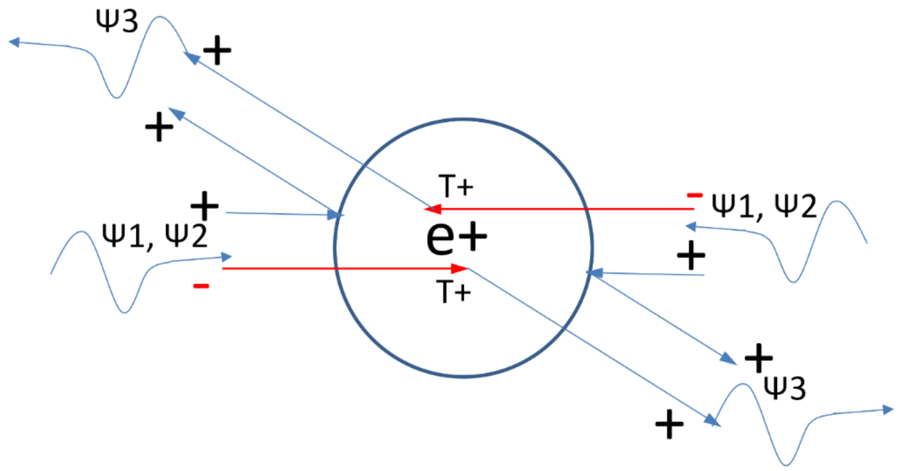

Figure 13: Zero net momentum transfer to a particle in a symmetric aether

Following interactions with the aether, charged particles have a field of 'new' photon pairs flowing outward from the particles. While individual particles are 'infinitely far' removed from each other, they each remain in a symmetric aether (spin=±2 photon pairs Ψ_1 and Ψ_2 incoming and spin=0 photon pairs Ψ_3 and Ψ_4 outgoing for (+) and (-) particles respectively.

From incoming spin=±2 photon pairs, [Figure 13] also shows outgoing pairs Ψ_3 (+/+), creating a positive electric field around a (+) particle.

The well-known Coulomb Field equation for a charged particle Q:

$$E = \frac{kQ}{r^2} \tag{21}$$

, is rewritten as below:

$$E = \frac{1}{4\pi r^2} * \mu_0 c^2 * Q \tag{22}$$

, from which the first component is the effect of a Gaussian sphere, showing intensity of the field would drop as the surface area of the sphere increases with radius 'r'.

The second component shows an interaction in an aether with incoming flux Ψ_1 and/or Ψ_2, with flux intensity of c^2, and an interaction constant of u_0 (permeability of free space) with the particle Q, creating an outgoing flux of photons Ψ_3 (+E) or Ψ_4 (-E).

Photon pairs Ψ_1 and Ψ_2 are decoupled with spin-spin interactions, which is a magnetic effect, hence the appearance of u_0 does not seem out of place.

Maxwell's equations:

$$\nabla \cdot E = \frac{\rho}{\varepsilon_0} = \mu_0 c^2 \rho \tag{23}$$

, and:

$$\nabla \cdot B = 0 \tag{24}$$

, are now understood in context to the above description. Equation (24) shows divergence of a magnetic field around a (static) charged particle is zero, since for the outgoing flux Ψ_3 (+E) or Ψ_4 (-E), the net B components of these photon pairs are zero.

Section4: Electrostatic attraction and repulsion

It is known that an electron will recoil in close vicinity of another electron, in other words, it will be pushed away by the negative electric field created around another electron. Fields do not push against fields, as may have been suggested in [Figure 1]. It is also known that a positron (or proton) will not recoil in vicinity of an electron, in other words, it is not pushed away by the negative electric field, because then there could be no attraction. Ignore for a moment that the two opposites will attract but visualise that the negative and positive fields exist but goes right through an opposite charge with no 'push' effect.

In [Figure 13] it was shown that a particle in a symmetric aether will experience no net force from the field, and a symmetric electrostatic field will form around the particle. However, while the incoming- and outgoing fields are symmetric around a single isolated particle, nearby particles will sense each other's fields as an asymmetry. Photons approach and depart at the speed of light to- and from particles, so that at first appearances it might seem as if the fields 'are always there'. Relativistic effects will certainly apply but are ignored in this concept analysis for electrostatic effects.

Following on from Postulate1, it is crudely extended that, as shown in [Figure 14]:

Postulate2: From within any pair of Ψ1, Ψ2, Ψ3 or Ψ4

1. **A reflected photon will transfer (2x) momentum onto the particle and appear as if it is exerting a momentary pushing force 1F on the particle it interacts with.**
2. **A transformed photon will exert a negligible force 0F on the particle.** ***

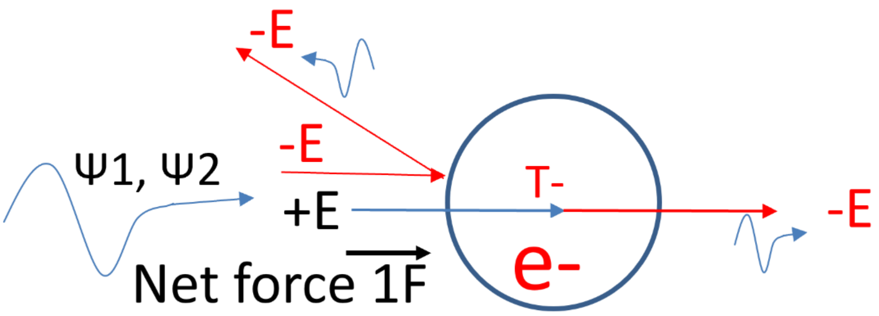

Figure 14: Net force 1F applied by the reflecting photon

End Postulate2

*** According to Mansuripur[7] and Pfeiffer et al[8] a transiting photon (e.g. through glass) only transfers momentum to the particle when entering a particle and retrieves it when exiting the particle. Considering the small size of fundamental particles and the speed of the photon 'c' through the particle, the interaction strength is considered negligible compared to the momentum transferred by the reflected photon.

The interactions between two particles in [Figure 15] shows how the symmetry is disturbed,

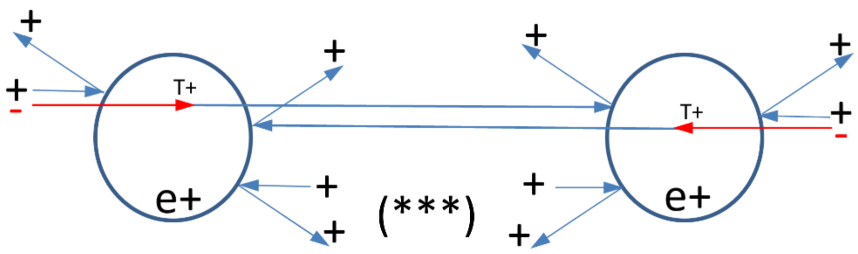

Figure 15: Symmetry is disturbed when particles approach, shown for two (+) particles. (***) From the opposite particle, an asymmetry is observed

Then, reducing complexity by removing any symmetric (net zero) and insignificant force actions from the diagram, and only showing the remaining effects of the newly created asymmetry between particles, electrostatic repulsion is shown in [Figure 16] to be because of photons pushing particles of similar charges apart:

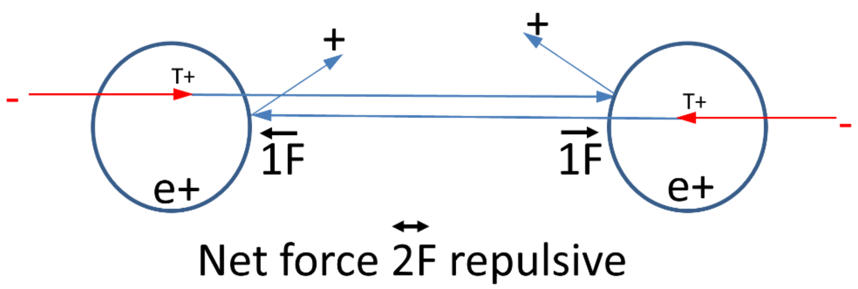

Figure 16: Repulsive Coulomb ‘Force’ for same-charge particles

, and with a similar diagrammatic exercise for two opposite charged particles in [Figure 17].,

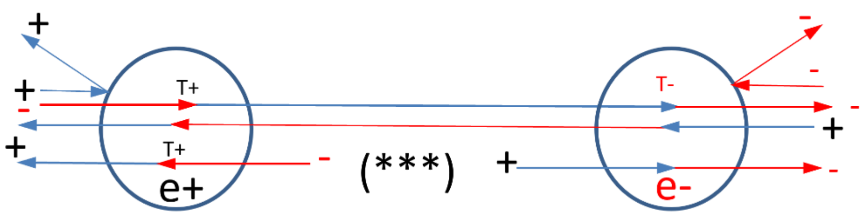

Figure 17: Symmetry is disturbed when two particles approach, shown here for a (+) and (-) particle. (***) From the opposite particle, an asymmetry is observed

An ‘attraction’ force is shown in [Figure 18] (with net zero and insignificant effects removed) because of photons pushing particles of opposite charges toward each other.

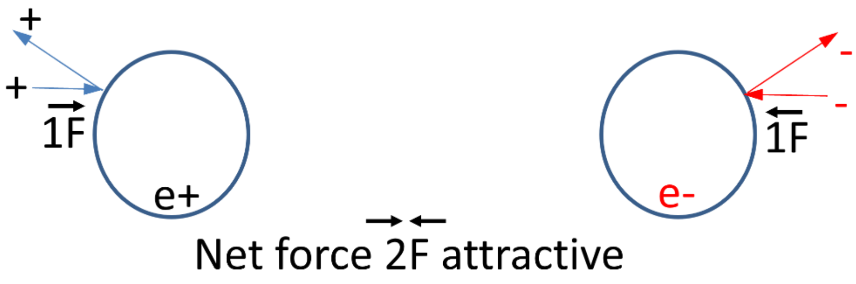

Figure 18: Attractive Coulomb 'Force' for opposite charge particles

Coulomb field and force equations are known and need not be derived here again.

Conclusions

Primordial superimposed photon pairs would exhibit a small cross-section and thus can travel mostly unobstructed through mass.

Primordial aether pairs transform to electrostatic pairs through interaction with charged particles.

Electric fields around charged particles are reliably and repeatably measurable. This motivates for aether photons and pairs to be at a very specific energies, else electromagnetics would have been an unpredictable science.

Charge is a discrete effect due to interaction of primordial aether with individual particle spin only. (By extension mass is also a primordial effect from interactions during decoupling of aether photon pairs, but where particles of equal charge, e.g. e- u-, could then have different masses due to their different magnetic moments.)

Electrostatic attraction **and** repulsion can be visualised with a aether model.

Further studies

Further studies may reveal a mechanical model for magnetic effects, e.g. R_1+L_2 would constitute a pure magnetostatic field. However currently no magnetic monopoles are known to exist.

Fatio and Le Sage models of gravity must be revisited since both the transparency- and energy problems[9-12] now seem resolved. The mechanics of gravity can be achieved by recognising that: **Ψ1, Ψ2 (IN) > Ψ1, Ψ2 (OUT)** for any collection of mass which will result in an inward push.

A relativistic and detailed quantum solution with tensors is required for this simplified model, which will also lead to further understanding of the mechanics of gravity, including quantum gravity.

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