Charge Conversion Constant

So far, it has been shown that adopting the assumption that the universe is only spacetime gives new insights into particles and forces. However, if the single building block of everything in the universe is the energetic spacetime field, then the implication is that all of the effects associated with electrical charge, electric fields, etc. should also be able to be explained using only the properties of spacetime. This is a severe test of the starting assumption.

To obtain an insight into the electrical properties of nature, we will express the electrical potential $\mathbb{V}$ (the voltage relative to neutrality) and the electric field $\mathbb{E}$ in dimensionless Planck units because Planck units are fundamentally based on the properties of spacetime. In both cases we will assume Planck charge q_p. Therefore: $\mathbb{V}_E \equiv q_p / 4\pi\varepsilon_o r$ and $\mathbb{E}_E \equiv q_p / 4\pi\varepsilon_o r^2$. Converting these to dimensionless Planck units (underlined) we divide by Planck voltage $\mathbb{V}_p = \sqrt{c^4/4\pi\varepsilon_o G} \approx 10^{27}\,\text{V}$ and Planck electric field $\mathbb{E}_p = \sqrt{c^7/4\pi\varepsilon_o \hbar G^2}$.

$$\underline{\mathbb{V}}_E = \frac{\mathbb{V}_E}{\mathbb{V}_p} = \frac{\sqrt{4\pi\varepsilon_o\hbar c}}{4\pi\varepsilon_o r}\sqrt{\frac{4\pi\varepsilon_o G}{c^4}} = \sqrt{\frac{\hbar G}{c^3}}\frac{1}{r} = \frac{L_p}{r} \qquad (24)$$

$$\underline{\mathbb{E}}_E = \frac{\mathbb{E}_E}{\mathbb{E}_p} = \frac{\sqrt{4\pi\varepsilon_o\hbar c}}{4\pi\varepsilon_o r^2}\sqrt{\frac{4\pi\varepsilon_o\hbar G^2}{c^7}} = \frac{\hbar G}{c^3 r^2} = \frac{L_p^2}{r^2} \qquad (25)$$

What is the physical interpretation of $\underline{\mathbb{V}}_E = L_p/r$ and $\underline{\mathbb{E}}_E = L_p^2/r^2$? First, an electrical charge only affects the spatial properties of spacetime because there is no time term in Eq. (24, 25). Second, only the radial spatial dimension is affected. Third, the dimensionless ratio L_p/r is proposed to represent the slope of a spatial strain in spacetime. We also know that an electric field is non-reciprocal. A polarized distortion of spacetime is required since there is a difference when we proceed from + to – compared to the opposite direction. Spacetime must exhibit different properties proceeding in opposite directions.

The proposed spacetime based model of an electric field is a polarized (non-reciprocal) distortion of space such that the one-way distance (time of flight) between a positive and negative charge would be slightly different proceeding from + to – compared to the reverse direction. It is not known which direction is shorter. However, the round trip distance should be unchanged. Even though there are some unknowns, we can calculate the magnitude of the effect. To quantify the effect on spacetime produced by a charge, we will define a proposed new constant, designated eta (η). This constant converts units of electrical charge (coulomb) into a polarized strain of space with dimensions of length. This relationship can be extracted from Eq. (24). The validity of this conversion factor will be determined by testing. From Eq. (24) we have:

$$\mathbb{V}_E = \frac{q_p}{4\pi\varepsilon_o r} = \frac{L_p \mathbb{V}_p}{r}$$

$$q_p = \frac{L_p \mathbb{V}_p 4\pi\varepsilon_o r}{r} = L_p\sqrt{\frac{4\pi\varepsilon_o c^4}{G}}$$

$$\eta \equiv \sqrt{\frac{G}{4\pi\varepsilon_o c^4}} = \frac{L_p}{q_p} \approx 8.61\times 10^{-18}\ \text{meter/coulomb} \qquad (26)$$

We will first test the conversion of several constants incorporating electrical charge. These are: elementary charge e, the Coulomb force constant $1/4\pi\varepsilon_o$ ($m^3 kg/s^2 C^2$), the magnetic permeability constant $\mu_o/4\pi$ (kg m/C^2), and the impedance of free space Z_o (kg m/sC^2). To eliminate $1/C^2$ requires multiplying these constants by $1/\eta^2$. We will also use: $\alpha = e^2/4\pi\varepsilon_o \hbar c$

$$e(\eta) = \sqrt{\alpha 4\pi\varepsilon_o\hbar c}\sqrt{\frac{G}{4\pi\varepsilon_o c^4}} = \sqrt{\frac{\alpha\hbar G}{c^3}} = \sqrt{\alpha}L_p \qquad (27)$$

$$\frac{1}{4\pi\varepsilon_o}\left(\frac{1}{\eta^2}\right) = \left(\frac{1}{4\pi\varepsilon_o}\right)\left(\frac{4\pi\varepsilon_o c^4}{G}\right) = \frac{c^4}{G} = F_p \qquad (28)$$

$$\frac{\mu_o}{4\pi}\left(\frac{1}{\eta^2}\right) = \left(\frac{1}{4\pi\varepsilon_o c^2}\right)\left(\frac{4\pi\varepsilon_o c^4}{G}\right) = \frac{c^2}{G} \qquad (29)$$

$$Z_o\left(\frac{1}{\eta^2}\right) = \left(\frac{1}{\varepsilon_o c}\right)\left(\frac{4\pi\varepsilon_o c^4}{G}\right) = 4\pi\frac{c^3}{G} = 4\pi Z_s \qquad (30)$$

We will perform several tests before commenting. From the above $\mu_o = 4\pi c^2/G$, $\varepsilon_o = G/4\pi c^4$ and $Z_o = 4\pi c^3/G$ When we convert: $c = \sqrt{1/\varepsilon_o\mu_o}$ and $Z_o = \sqrt{\mu_o/\varepsilon_o}$ to the equivalent equations substituting the spacetime conversions, the equations are still correct. Also, we will test the conversion by calculating the force between two electrons (charge e) two different ways. Eq. (31) below uses the standard Coulomb law and Eq. (32) uses the spacetime conversions for $1/4\pi\varepsilon_o$ and e. They give the same answer.

$$F_e = \frac{e^2}{4\pi\varepsilon_o r^2} = \frac{\alpha\hbar c}{r^2} \qquad (31)$$

$$F_e = \frac{F_p \alpha L_p^2}{r^2} = \frac{c^4}{G}\frac{\alpha}{r^2}\frac{\hbar G}{c^3} = \frac{\alpha\hbar c}{r^2} \qquad (32)$$

In Eq. (28), it is reasonable that the Coulomb force constant $1/4\pi\varepsilon_o$ should convert to Planck force c^4/G. Planck force is the largest force that spacetime can exert. However, the most important revelation is Eq. (30). The impedance of free space ($Z_o = \mathbb{E}/\mathbb{H}$) converts to c^3/G the impedance of spacetime obtained from GR (ignore 4π). Since Z_o converts to Z_s, this implies that EM radiation experiences the same impedance as gravitational waves which propagate in the medium of spacetime. The implication is that photons also are waves propagating in the medium of the spacetime field. Photons are not packets of energy propagating THROUGH the empty void of spacetime. Photons are waves with quantized angular momentum propagating IN the medium of the spacetime field.

If EM radiation propagates in the medium of spacetime, does this mean that spacetime is the new aether? Spacetime does have energy density and c^3/G impedance that permits waves to propagate at the speed of light but there are also important differences compared to the properties attributed to the aether. First, a photon possesses angular momentum which is quarantined by the superfluid spacetime field. This produces quantization of angular momentum. Photons acquire a particle-like property because quantized angular momentum also affects energy. Absorption results in a collapse of waves so that the entire angular momentum and energy are deposited in a single absorbing unit (atom, molecule, etc.). The superfluid spacetime field causes "wave-particle duality".

A second difference between the aether and the spacetime field is that the aether was presumed to have a frame of reference which should have been detected by the Michelson-Morley experiment. The spacetime field is strongly interacting dipole waves propagating at the speed of light. It is not possible to detect motion relative to this medium. For example, ε_o, μ_o and G are properties of the spacetime field and are unchanged in all frames of reference. Also, suppose that it was possible to do a Michelson-Morley experiment using gravitational waves rather than light. Gravitational waves are undeniably propagating in the medium of spacetime and experience impedance of c^3/G. However, gravitational waves are always propagating at the speed of light, from all frames of reference. A Michelson-Morley experiment using gravitational waves would be unable to detect motion relative to the spacetime field. Similarly, if photons are a quantized wave propagating in the spacetime field, they also would be observed to always propagate at the speed of light. The explanation of this paradox is that particles, fields and forces are also spacetime and compensate (Lorentz transformation) to keep the locally measured speed of light constant.

Next we will attempt to quantify the magnitude of the distortion of spacetime produced by photons to see if it is experimentally measurable. To simplify the calculation and maximize the effect, we will imagine confining photons in the smallest possible volume for a given wavelength. Circularly polarized photons can exist in a cylindrical waveguide that is slightly larger than ½ wavelength in diameter and further confined by two flat mirrors perpendicular to the cylindrical axis and separated by ½ wavelength. This forms the smallest possible vacuum resonant cavity which we will call "maximum confinement". The maximum oscillating electric field strength is at the center of the cavity and the electric field is zero at all the surfaces. Even though the cavity is ½ λ long and ½ λ in diameter with nonuniform electric and magnetic fields, a dimensional analysis plausibility calculation can make the simplifying assumption that the excitation (stressed spacetime) is uniform over a volume of $\lambda\!\!\!^{-3}$, and zero everywhere else. The energy of n photons is $E = n\hbar\omega$ and the energy density in $\lambda\!\!\!^{-3}$ is $U = n\hbar\omega/\lambda\!\!\!^{-3} = n\hbar\omega^4/c^3$. Combine this with Eq. (4):

$$U = \frac{A^2\omega^2 Z_s}{c} = \frac{n\hbar\omega^4}{c^3}$$

$$A = \sqrt{\left(\frac{n\hbar G}{c^3}\right)\left(\frac{\omega^2}{c^2}\right)} = \frac{\sqrt{n}L_p}{\lambda\!\!\!^{-}} = \frac{\Delta L}{\lambda\!\!\!^{-}}$$

$$\Delta L = \sqrt{n}L_p \qquad (33)$$

The indication is that n coherent circularly polarized photons produce an oscillating length change of $\sqrt{n}L_p$ over a distance of $ƛ$ if we assume a maximum confinement cavity. This is another prediction. To analyze this, suppose that we have a microwave cavity designed to achieve maximum confinement of a reduced wavelength of $ƛ = 0.1$ m. The cavity would be slightly larger than 0.314 m in diameter and the flat reflectors would be separated by 0.314 m. An interferometer with oppositely propagating beams would attempt to detect a polarized path length changed caused by the rotating electric field.

Without attempting to describe the experiment in more detail, it is possible to calculate whether the effect would be large enough to measure. Theoretically it is physically possible to detect length changes larger than Planck length (~10^{-35} m) [3-7]. However, current interferometer technology such as the LIGO experiment can currently detect modulated length changes in the range of 10^{-18} m. Since $L_p \approx 10^{-35}$ m we would have to have $n \approx 10^{34}$ photons in the maximum confinement cavity to achieve a 10^{-18} m effect. ($\sqrt{10^{34}} \times 10^{-35} m \approx 10^{-18} m$). If we assume a microwave cavity tuned for $ƛ = 0.1$ m ($\omega = 3\times10^9$ s^{-1}) the energy of confined microwave photons would have to be about 3×10^9 J. This experiment is beyond current technology.

However, all is not lost. Suppose that we imagine a thought experiment where it is possible to increase the number of the confined photons to any desired level. The spacetime based model of photons predicts that EM radiation should have a maximum intensity limit for a maximum confinement experiment where spacetime is simply not able to transmit a higher intensity. This would occur if the intensity reached the condition which demanded that the spatial displacement of spacetime (ΔL) equaled the reduced wavelength $ƛ$ of the EM radiation causing the effect. In the case of microwave radiation with a reduced wavelength of 0.1 m, this would occur when $\Delta L = ƛ = 0.1$ m. This is demanding 100% modulation of the spacetime volume in the maximum confinement resonant cavity. (ignoring numerical factors near 1).

This theoretical maximum intensity limit will be calculated. The critical number of photons n_c that achieves $\Delta L = ƛ$ is $n_c = E_c ƛ / \hbar c$ where the critical energy is designated E_c.

$$\Delta L = \sqrt{n_c} L_p = \sqrt{\frac{E_c ƛ}{\hbar c}} \sqrt{\frac{\hbar G}{c^3}} \qquad \text{set } ƛ = \Delta L$$

$$\Delta L = \frac{G E_c}{c^4} = \frac{G m_c}{c^2} = R_s \tag{34}$$

Eq. (34) gives the classical Schwarzschild radius $R_s = G m_c / c^2$ of a black hole with energy of E_c. It is not necessary to do an experiment! The prediction that there should be a maximum intensity limit is confirmed by GR because the intensity which achieves 100% modulation of spacetime (achieves $\Delta L = ƛ$) also forms a black hole which blocks further transmission of EM radiation. For example, assuming a reduced wavelength of 0.1 m, it would take about 10^{68} confined photons (~10^{43} J) to achieve $\Delta L = ƛ \approx 0.1$ m. This energy in this radius achieves a black hole with a classical Schwarzschild radius of 0.1 m. For more information about the spacetime based model of a photon, see a related article titled: *Spacetime-Based Model of EM Radiation* [26].

Another hypothetical experiment would use a cubic vacuum capacitor consisting of two flat and parallel plates, each with dimensions DxD and separated by distance D. If the voltage on this capacitor is $\mathbb{V}$, then this voltage in dimensionless Planck units (underlined) would be $\underline{\mathbb{V}} = \mathbb{V}/\mathbb{V}_p$. A time of flight distance measurement across the capacitor would experience a path length difference of ΔL between opposite propagation directions. Using previously stated principles, the polarized strain equation is: $\Delta L = D\underline{\mathbb{V}}$. Since Planck voltage is about 10^{27} volts, even 10^6 volts would be $\Delta L \approx 10^{-21} D$ and unmeasurable.

However, $\Delta L = D\underline{\mathbb{V}}$ also predicts that the properties of spacetime specify a maximum possible voltage. At Planck voltage $\underline{\mathbb{V}} = 1$, therefore the distortion is $\Delta L = D$. This is 100% distortion of the volume within the cubic vacuum capacitor. The spacetime model of charge predicts that it should be impossible to exceed this voltage. A calculation similar to Eq. (34) shows that any size cubic vacuum capacitor would form a black hole with radius of $R_s = D$ when the voltage equals Planck voltage. Therefore this is another prediction of the spacetime-based model which is verifiable.