The Planck Voltage and Gravitation

Dennis Bluver

June 5, 2019

1 Introduction

In this paper, the implications of the Planck Voltage as a universally constant voltage are explored. In particular, a surprising result is demonstrated, which is that the resulting modified voltage transformation laws demand the existence of a gravitational interaction. Therefore, there is a strong suggestion that gravitation and electrostatics can naturally be unified through the existence of the Planck voltage. This is directly analogous to the way that electricity and magnetism are unified through the constancy of the speed of light. The implications and also limitations of this new framework are explored, highlighting the analogy with special relativity. It is believed that the general method of unification through Planck units outlined in this paper may ultimately be very fruitful for the unification of classical fields.

2 Background

For several decades there has been an interest in extending the special theory of relativity by the introduction of additional universal constants of nature. Typically the Planck units are taken to be these universal constants. A prominent example is doubly-special relativity, wherein the Lorentz transform is modified to accommodate the Planck length as an invariant length under boosts. Other related examples have focused on the existence of a maximal universal acceleration, often taken to be the Planck acceleration.

In the past several years there has been an interest in extending special relativity to accommodate a universally constant voltage, generally taken to be the Planck Voltage. Attempts have been made to formulate new transformations that can accommodate both a constant speed of light and a constant (invariant) voltage. Due to the extremely large magnitude of the Planck Voltage these theories have been difficult to test experimentally. Most of the existing work on this topic focuses on transformations of length and time, while the current paper focuses on transformations of charge and energy. It will be shown that this leads to a simpler and more elegant mathematical framework that more closely resembles special relativity itself.

3 Transformation Laws

In order to successfully extend the special theory of relativity to additional variables, it is only necessary to have two criteria for the variable:

1) That the variable is treated as being 'relative" between observers
2) That the variable has some value that is invariant between obsevers

Electrostatic voltage in electromagnetism is an example that fulfills both criteria. The electrostatic voltage is "relative". It cannot be determined in an absolute way in the same manner that velocity cannot be determined in an absolute way. A system cannot measure a constant voltage if the entire system including all measuring devices is within that region of constant voltage. This is the simple gauge symmetry of electrostatics.

Standard special relativity allows space and time to be altered in different reference frames in order to accommodate an invariant speed of light. From a unit perspective, it therefore seems reasonable that energy and charge must be altered in different reference frames to accommodate a universally invariant voltage. But here the different frames refer to observers with different voltage scales (presumably in regions of different constant voltage) rather than any kind of velocity boost.

Voltage can be represented by $\frac{\Delta U}{\Delta q}$ where ΔU refers to the electrostatic energy of a test charge and Δq refers to the change in the value of a test charge. This is directly analogous to $v = \frac{\Delta x}{\Delta t}$ in special relativity. Therefore, we first begin by writing down the classical formulas relating electrostatic energy to the test charge between observers using different voltage scales:

$$1) U_2 = q_1 \Delta V + U_1$$

$$2) q_2 = q_1$$

Interestingly, these equations have exactly the same mathematical form as the Galilean transformations for space and time:

$$1) x_2 = t_1 v + x_1$$

$$2) t_2 = t_1$$

Here q takes the role of t, and u takes the role of x. We can draw diagrams analogous to space-time diagrams where time is replaced by test charge, space is replaced by internal electrostatic energy, and units are adjusted such that lines with slope of $+1$ or -1 correspond to the Planck Voltage or negative Planck Voltage. One can clearly see that these transformations are not compatible with a universally invariant Planck Voltage just as Galilean transformations are not compatible with the existence of the speed of light as a universal invariant speed.

We must find a set of transformations with certain properties that are analogous to those needed for the Lorentz transformation. Namely:

1) The transformations must be linear such that constant voltages are mapped to constant voltages

2) The transformations must have the same mathematical form for all pairs of observers with different voltages

In addition the transformations need to satisfy the following requirements:

1) Lines representing the Planck Voltage (slope -1 and +1) are mapped to lines still representing the Planck Voltage.

2) $B_{-v} = FB_vF^{-1} = FB{-}vF$

This is exactly the same as in special relativity, except that V now represents voltage, B_v is the transformation between systems at different voltage, and F is a flip of the electrostatic energy from positive to negative.

All of this indicates that the mathematics is exactly the same as in special relativity, and the transformation preserving the Planck Voltage will be exactly the same form as the Lorentz transformation. The difference is that x will be replaced by U, t will be replaced by q, and the speed of light will be replaced by the Planck Voltage V_p.

The full form of the equations in SI units is then as follows:

$$1)q_2 = \frac{q_1}{\sqrt{1-\frac{\Delta V^2}{V_p^2}}} + \frac{\Delta V}{V_p^2}\frac{U_1}{\sqrt{1-\frac{\Delta V^2}{V_p^2}}}$$

$$2)U_2 = \frac{q_1 \Delta V}{\sqrt{1-\frac{\Delta V^2}{V_p^2}}} + \frac{U_1}{\sqrt{1-\frac{\Delta V^2}{V_p^2}}}$$

This has some striking new implications that are directly analogous to those of special relativity. Among these are the following:

1) For two systems with a large voltage difference between the two systems, if system A measures two test charges as being the same value then it is not necessarily true that system B will measure them as having the same value. In other words, what is equal charge to one system will not necessarily appear to be equal charge to another system. This is directly analogous to the relativity of simultaneity in special relativity.

2) There will be "charge dilation" that is directly analogous to time dilation and follows the same form of the equation:

$$\Delta q' = \frac{\Delta q}{\sqrt{1-\frac{\Delta V^2}{V_p^2}}}$$

3) There will be ”internal energy contraction” that is directly analogous to Lorentz contraction in special relativity. Note that the following formula only applies when the charges are identical, in the same way that length contraction technically relates to the position of two ends of a rod at the same time.

$$\Delta U' = \Delta U\sqrt{1 - \frac{\Delta V^2}{V_p^2}}$$

The fact that charges and energies are measured differently for observers at different voltages suggests that they should be unified into a covariant vector under the new set of voltage transformation laws.

4 Covariant Vectors

The invariant interval under this theory will be as follows:

$$(\Delta U_1)^2 - (V_p)^2\Delta(q_1)^2 = \Delta(U_2)^2 - (V_p)^2\Delta(q_2)^2$$

The quantity analogous to 4-position in special relativity will be as follows:

$$U^\mu =< qV_p, U >$$

And this quantity is covariant under the voltage transformation described above. And now we can define an invariant constant we can call K as follows:

$$K = \sqrt{q^2 - \frac{U^2}{V_p^2}}$$

K is a kind of ”proper charge” analogous to ”proper time” in special relativity. Now we can define a new covariant quantity as follows:

$$V^\mu = \frac{dU^\mu}{dK}$$

$$V^\mu =< V_p\frac{dq}{dK}, \frac{dU}{dK} >$$

But we know that

$$dq = \gamma dK, \gamma = \frac{1}{\sqrt{1 - \frac{\Delta V^2}{V_p^2}}}$$

$$dK = \frac{dq}{\gamma}$$

Therefore

$$V^\mu = \gamma < V_p\frac{dq}{dq}, \frac{dU}{dq} >$$

$$V^{\mu} = \gamma < V_p, \frac{dU}{dq} >$$

This is a 2-voltage that is directly analogous to the 4-velocity in special relativity. Another way to state this equation is as follows where V is the usual "Voltage".

$$V^{\mu} = \gamma < V_p, V >$$

We can further define another 2-vector as follows. This we can call the "2-charge", and

$$m^{\mu} = K\gamma < V_p, V >$$

$$m^{\mu} = q < V_p, V >$$

$$m^{\mu} =< qV_p, U >$$

We have not discussed how time and space transform under Voltage transformations. If we assume that there is no immediate effect on time and space directly we can divide by an invariant volume element to obtain the following:

$$\rho^{\mu} =< \rho_{electric-charge} V_p, \rho_{electric-energy} >$$

This is a vector that unifies charge density with energy density. It is directly analogous to the 4-current in special relativity. Under the modified voltage transformation, this vector relates the electric charge density with the electrostatic energy density.

Although we have been considering the case of a test particle in a voltage, this suggests that we now consider the case where the test particle is itself a source. If we ignore the fact that the energy is electrostatic at the moment we can write the following where subscript q stands for electric charge and subscript e stands for energy.

$$\rho^{\mu} =< \rho_q V_p, \rho_e >$$

Considering that we have an energy density and an electric charge density as part of a common "source" vector, this looks like the beginning of a unification of the electrostatic and classical gravitational fields. Whereas velocity boosts create the "source" of a magnetic field in special relativity, the modified voltage boost creates the "source" of a gravitational field.

The next question is what kind of covariant potential is produced by this source? Following the convention of special relativity, we will define a kind of covariant 2-potential as follows:

$$A^{\mu} =< \frac{V}{V_p}, A >$$

This is directly analogous to the 4-potential in special relativity. Here V refers to the electric potential and A refers to a new kind of potential that we get when transforming to a new voltage frame. We shall see that it should be identified with the negative of the gravitational potential.

It is believed that in the final form of this theory, there will be some "gauge" in which the 2-source will be proportional to the D'Alambertian of the 2-potential, as in the Lorentz gauge of special relativity. Since we are dealing with the time-independent case only we will use the gradient and write the following:

$$-\nabla^2 A^\mu = b\rho^\mu$$

Here b is a constant that must be solved for. It is directly analogous to the vacuum permeability in the special relativistic formulation of electrodynamics. We solve for b by focusing on the first index, writing the following:

$$\frac{-\nabla^2 V}{V_p} = \rho_{charge} V_p b$$

$$-\nabla^2 V = b(V_p)^2 \rho_{charge}$$

From Gauss's law we know that the following must be true:

$$b(V_p)^2 = \frac{1}{\epsilon_0}$$

$$b = \frac{1}{\epsilon_0 V_p^2}$$

$$b = \frac{4\pi G}{c^4}$$

Therefore we can write our full formula as follows, where the newly defined A^μ and ρ^μ are defined above.

$$-\nabla^2 A^\mu = \frac{4\pi G}{c^4}\rho^\mu$$

The second element in the formula is now the following equation:

$$-\nabla^2 A = \frac{4\pi G}{c^4}\rho_{energy}$$

Now we can clearly see that the second index represents the equation for gravitation, and A must simply be the negative of the gravitational potential. The c^4 on the denominator is because units of energy instead of mass are being used for both the source and the test charge. Interestingly, we have recovered the classical formula for gravitation as the second element of the $2 - vector$

equation. It therefore appears that what is an electrostatic interaction in one "voltage frame" is in fact a gravitational interaction in another "voltage frame".

5 Future Directions

Future directions will focus on more fully exploring certain limitations of this theory in its current form. For instance, it is desired to be able to prove the negative sign on the gravitational potential a priori. In addition, the proof so far demonstrated only applies to electrostatic fields and thus only works for particles that have charge or are a composite of charged particles. In its current form it does address gravitational interactions with inherently neutral particles such as the photon. In addition, it is desired to expand this theory beyond electrostatic interactions and classical gravitation to a more complete theory that recovers Maxwell's equations and the Einstein Field Equations. Finally, it is desired to further explore the new idea of relativity of charge and understand how that can be ultimately reconciled with the Planck charge as a universal constant as well.

6 Conclusions

In this paper, the universal invariance of the Planck voltage was explored. It was shown that beginning with electrostatics and postulating the Planck voltage as a universal invariant can lead one to recover the governing equation of classical gravitation. Under the modified transformation law between "voltage frames", it is shown that what is an electrostatic interaction for one observer will appear to be a gravitational interaction for the other and vice versa.

7 References

1) "Doubly Special Relativity: First Results and Key Open Problems". Giovanni Amelino-Camelia. International Journal of Modern Physics D.

2) Introduction to Doubly Special Relativity. J. Kowlaski-Glikman. Planck Scale Effects in Astrophysics and Cosmology. SpringerLink.

3) "On a Relativistic Voltage Limit and Its Implications". Chris Granger. Vixra.org

4) "The Theory of Electrodynamic Space-Time Relativity". Yingtao Yang. SemanticsScholar.org