Proton/Electron mass ratio and gravitational constant due to special relativity

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Since relativistic length contraction occurs only in the direction of motion and not in the transverse direction, rotation results in an effect known as Thomas precession. Thomas precession acts as a counter rotation. Because precession increases non-linearly according to the Lorentz factor, rotation minus precession has a maximum value. The maximum value of rotation velocity minus precession velocity is termed the maximum difference velocity and is designated v_m. We showed in previous work that this is the physical basis of charge structure, electromagnetic effects, and the fine structure constant. In this report the proton/electron mass ratio is formulated in terms of v_m, the speed of light, and the electron mass. The proton mass calculated using the formula is well within the standard uncertainty of the CODATA value. The gravitational constant is formulated similarly, and the calculated result is well within the standard uncertainty of the CODATA value. These results build on the framework established in our previous reports.

Proton/Electron Mass Ratio

First, we show the proton/electron mass ratio formulated in terms of v_m, the speed of light, and the electron mass. The speed of light is defined[1] as

$$c \equiv 299792458 \frac{\mathrm{m}}{\mathrm{s}} \tag{1}$$

The relaltivistic rotational difference velocity was derived in our previous report[2] and a graph is provided in Appendix A. The maximum difference velocity is exactly

$$v_m = \left(2^{2/3} - 1\right)^{3/2} c \tag{2}$$

We formulate an equation for the proton-electron mass ratio as

$$\frac{m_p}{m_e} = \frac{m_e}{1\mathrm{kg}} \left(\frac{299792458}{\sqrt{2}} - \frac{\frac{5}{8}\sqrt{3}}{\left(2^{2/3} - 1\right)^{3/2} 299792458^3} \frac{1\mathrm{kg}}{m_e} \right)^4 \tag{3}$$

CODATA reports the mass of the electron[1] as 9.10938356(11)E-31 kg. Using this value on the right side of Eq 3 results in the value of the proton electron mass ratio

$$\frac{m_p}{m_e} = 1836.15267258 \tag{4}$$

Using the CODATA value for electron mass a second time, we arrive at the proton mass

$$m_p = 1.672621897\text{E-}27 \text{ kg} \tag{5}$$

The CODATA value for proton mass[1] is 1.672621898(21)E-27 kg. The calculated value of proton mass in Eq 5 has nine significant digits of correspondence to the CODATA value.

It is obvious upon inspection of Equations 1, 2, and 3 that the proton/electron mass ratio is due to special relativity. Referring to m_e/1kg as the normalized electron mass, we see that both the normalized mass and its inverse appear in Eq 3 . Each of the other terms in Eq 3 is very simple and directly related to the speed of light and special relativity.

The number 299792458 in Eq 3 is not a velocity, but the arbitrarily chosen number associated with the speed of light. The number 299792458 was arbitrarily associated with the speed of light, and could be replaced with another number in the future, but the relationship expressed by Eq 3 is a physical relationship independent of arbitrarily assigned numeric values, so the number represents a maximum and acts as a scaling factor.

The fraction 5/8 in the numerator of the second term in parentheses of Eq 3 has significance at the rotational velocity of $\sqrt{3}/2\ c$ which results in a Lorentz factor of $\gamma = 2$. This is because at rotation velocity $\sqrt{3}/2\ c$, Thomas precession is equal to rotation, resulting in an inertial frame of reference. The MacLaurin series expansion of the Lorentz factor at rotation velocity $\sqrt{3}/2\ c$ shows that 5/8 is the sum of all terms beyond the kinetic energy term. This is described in detail in the section 'Charged Particle to Photon Coupling' in the article *Electromagnetic Effects and Structure of Particles Due to Special Relativity*.

The $\sqrt{2}$ in the denominator of the second term in parentheses of Eq 3 is the ratio of a photon's total angular momentum to its on-axis angular momentum. In general, $\sqrt{2}$ is the magnitude of the vector sum of two unit vectors at right angles to each other. The $\sqrt{3}$ in the numerator of the second term in parentheses of Eq 3 is the ratio of charge total angular momentum to charge per-axis angular momentum. In general, $\sqrt{3}$ is the magnitude of the vector sum of three unit vectors at right angles to each other.

We do not yet have a full understanding of the geometry and interaction of the proton, electron, and space that would completely explain the relationships between the terms of Eq 3. However, the formulation of the proton/electron mass ratio with terms exclusive to special relativity and Thomas precession provides insights, which together with our previous work, should lead to a complete understanding of those relationships.

Fine Structure Constant

The parenthetical quantity in Eq 3 is very similar to the fine structure constant, implying either a dependency between the fine structure constant and proton/electron mass ratio, or a common basis. Eq 6 is a reformulation of the fine structure constant from our previous work[2].

$$\alpha = 2\pi\left(\frac{\sqrt{3}}{\left(2^{2/3}-1\right)^3 299792458^4}\frac{1\text{kg}}{m_e}+\frac{\sqrt{2}\left(2^{2/3}-1\right)^{3/2}}{299792458}\right) \tag{6}$$

This simplifies to

$$\alpha = 0.0072973525664 \tag{7}$$

which exactly matches all eleven significant digits of the CODATA recommended value[1]. We showed in our previous work[3] that the 2π factor in Eq 6 is exactly the angular difference between an inertial frame of reference at the rotation velocity √3/2 *c* and a non rotating laboratory frame of reference[3].

The fine structure constant is part of the electrostatic force equation, and the magnetic force equation as shown in our previous report[2]. Because the forces between charged particles can be formulated in terms of their structure and special relativistic behavior, the base unit Ampere and all its derived units are redundant. They essentially constitute a parallel system of units based on the force between two current carrying conductors spaced 1 meter apart. Additionally, that the proton mass is related to the speed of light, and relativistic Thomas precession, as shown in Eq 3, indicates that the SI units of mass, distance, and velocity are not independent. A consistent system of units requires that the base units have no inter-dependence. They must be mutually orthogonal. Because of this, research into the special relativistic basis of charge structure and interaction, the proton/electron mass ratio, and the gravitational constant require a first principles approach.

Gravitational Acceleration and Force

The gravitational constant can be expressed as

$$G_{sr} \equiv \left(\frac{2\pi\frac{1}{3}\frac{m_e}{1\text{ kg}}\left(2^{2/3}-1\right)^{3/2}299792458}{3\frac{R_e}{1\text{m}}}+\frac{R_e}{1\text{m}}\left(\frac{m_e}{m_p}\right)^{1/2}\right)\frac{\text{m}^3}{\text{kg s}^2} \tag{8}$$

where R_e is the electron radius, derived in our previous work[2]. $R_e \approx$ 1.28663582938E-12 m. Eq 8 reduces to

$$G_{sr} \approx 6.6740417776\text{E-}11 \frac{\text{m}^3}{\text{kg s}^2} \quad (9)$$

CODATA reports the Newtonian constant of gravitation[1] as 6.67408(31)E-11 $m^3/(kg\ s^2)$. The value in Eq 9 is well within the standard uncertainty of the CODATA value.

The parenthetical quantity in Eq 8 is similar to the fine structure constant and proton/electron mass ratio in being unit-less. However, unlike the formulation of the proton/electron mass ratio in Eq 3 and the fine structure constant in Eq 6, a basis for the unit transformation in Eq 8 has not yet been developed. The rational for normalization of electron mass to the kg, and normalization of electron radius to the meter is that physically meaningful bases are being scaled to arbitrary bases.

At first glance, the second term in Eq 8 appears astonishing. It is the normalized value of the proton radius derived in previous work, 3.002626038E-14 m. That the proton radius is in the second term is however consistent with the presence of electron radius in the first term. That the normalized proton radius is a term of the gravitational constant, which results in acceleration multiplied by meters squared, may be startling. However, when we consider that there is a 2π difference in angle between the laboratory frame of reference and the rotational inertial frame of reference at $\sqrt{3}/2c$, it is less so. The 2π difference in angle implies that a circle in one frame has linear characteristics in the other frame, and a linear motion in one frame has characteristics of circular motion in the other frame. There is then a possible relationship via transformation from linear kinetic energy to rotational energy and centripetal acceleration. Once again, the basis of the gravitational constant in special relativity is clear, but we do not yet have a full understanding of the interrelation of all effects. The similarities between Equations 3, 6, and 8 are apparent, and the basis of the terms of each equation is special relativity.

The second term of Eq 8 is related to the structure of the proton, and the first term is directly related to the electron. The second term is roughly 1/2200 the magnitude of the first term. The differing relative magnitudes of the two terms in the gravitational constant may imply that the proton and electron impose gravitational effects with different magnitudes. The first term of Eq 8 may be the effect due to electrons, and the second term may be the effect due to protons, with Eq 8 as a whole applying to a mass with equivalent numbers of electrons and protons. However, the electrostatic force is so much stronger than the gravitational force, that measurements of the gravitational effects of isolated charges is problematic.

CODATA refers to the gravitational constant as the Newtonian gravitational constant[1]. However, the formulation of Eq 8 shows that the basis of gravitation is in special relativity. The correspondence of Eq 8 to the Newtonian formulation implies that it is applicable and relevant, but limited in scope. The precession of Mercury's orbit is not apparently explained by Eq 8. However, the far reaching effects of special relativistic Thomas precession in mass relationships, rotation, angular momentum, and general structure of matter raises the possibility of an as yet undetermined relationship.

The parenthetical quantity in Eq 8 shows that particles with rotating inertial frames of reference have an effect at a distance. The perspective that two particles interact directly through a force

between them is not substantiated when special relativity is considered. Rather, the presence of a single elementary particle is a sufficient condition that any other elementary particle will interact with it through special relativity. The electrostatic force equation from our previous work[2] leads to the same conclusion. We provide here a reformulation of that equation for the magnitude of force between two elementary charged particles separated by distance *r* which supports this perspective.

$$F(r) = \left(\frac{2\pi \dfrac{R_e}{1\text{m}}}{\dfrac{\sqrt{3}}{2}\left(2^{2/3}-1\right)^{3/2} 299792458^2} + 4\pi\sqrt{2}\,\frac{R_e}{1\text{m}}\,\frac{1}{3}\,\frac{m_e}{1\text{kg}}\left(2^{2/3}-1\right)^3 299792458 \right) \frac{\text{kg m}}{\text{r}^2\text{s}^2} \qquad (10)$$

The formulation of Coulomb's law in terms of a square of the elementary charge, implying a direct interaction of charged particles, is not substantiated by Eq 10. Though the effect is identical, the relativistic perspective is one of indirect interaction.

Conclusion

In previous work we formulated equations for the fine structure constant, the proton g factor, the neutron mass, and the deuteron mass. Results of the formulations matched experimentally known values to eleven, seven, eight, and nine significant digits respectively. The terms in each formulation were directly related to the model and the theory based on Thomas precession. The previous formulations are now joined by the proton/electron mass ratio and the gravitational constant with nine and five significant digit correspondences, with the latter limited by the uncertainty of experimental data.

It should be emphasized that elementary particle size as discussed in this report is substantiated in previous reports. Photon wavelength is not directly related to elementary particle dimensions, but to the transition time between rotational velocities. Every change to the state of an elementary particle results in a change to its frame of reference, and this would have to be considered in attempts to measure particle dimensions.

The results presented here and in our previous work show that special relativity, and specifically Thomas precession, has far reaching effects. Charged particle electrostatic interaction, magnetic interaction, atomic nucleus structure, and particle-photon interaction were presented as some of those effects in previous work.

Many fundamental relationships are now formulated in terms of special relativity. The behavior of particles in terms of a special relativistic model had been broadly framed in our previous work. The model becomes more complete with the results presented herein. The model is a physical model that corresponds to experimentally known characteristics of particles and their interactions.

References

1) CODATA Recommended Values of the Fundamental Physical Constants: 2014
J. Phys. Chem. Ref. Data 45, 043102 (2016); doi 10.1063/1.4954402, 7, 57

2) Guynn P. L., viXra [v3] 2017-06-12 15:13:52, 'Electromagnetic Effects and Structure of Particles due to Special Relativity', p.3; p4; p5; p.7; p18

3) Guynn P. L., viXra [v2] 2017-10-07 18:10:32, 'Electrostatic Force and Charge Structure', p.3

Appendix A

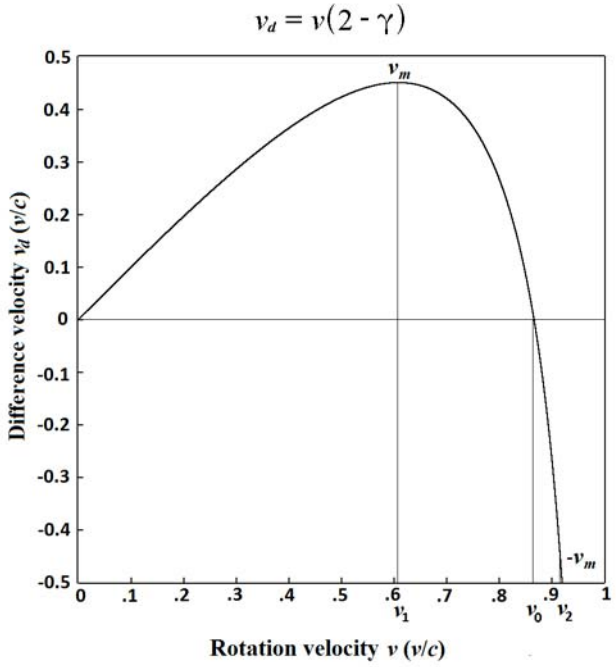

Fig 1. Difference velocity as a function of rotation velocity with maximum difference velocity, v_m, annotated.