A toolkit for improving the understanding of relationships between physical parameters based on adjusted SI units and a new Planck unit framework

Abstract

This paper presents new ways of understanding the relationships between parameters. The novel insights and predictions include: A self-contained and consistent new Planck unit set of maximal sized parameters from which all observed values can be compared and easily combined in equations. A self-contained and consistent new Planck unit set of electron-charge based parameters, some of which are directly observable in experiments. The interpretation of the gravitational constant G as a dimensionless ratio and its relegation from gravitational to permeability use and the elimination of the need to test the equivalence of gravitational and inertial masses. That all parameters can be displayed in terms of only h and c for the Planck maximal parameter set and in terms of only h, c and α for the electron-charge based set (other than permeability and permittivity which have G content), and which was previously considered impossible. There exists a new hypothetical dimensional analysis that can be used to describe parameter dimensions and to uncover any law of nature or any universal constants. That all electron charge based Planck parameters can be described solely in terms of ratios of the R_k and K_j and so will benefit from the precision of measurement of these two parameters. That the experimentally observed value of R_k implies either that the velocity of a current within certain electromagnetic materials could be in excess of light speed, the patterns produced by subluminal physical objects have a maximum velocity of $2\pi c/\alpha$ or that such a velocity is required in order to pass through those material. That most electromagnetic parameters can be reinterpreted in terms of mechanical parameters. By adjusting currently misaligned SI units to be self-consistent and consistent with DAPU units, greater clarity will ensue. This is a toolkit for providing a better understanding of the fundamentals of physics.

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Background

The discovery that the von Klitzing constant R_k [1] and the Josephson constant K_j [2] could be measured directly, although they are composed of Planck and near-Planck sized parameters h and q_e, has improved the precision of measurement of h and some SI electromagnetic units [3]. It is unfortunate that the misalignment of SI units between mechanical and electromagnetic parameters has not been addressed before. This paper looks at how the SI system should be adjusted to be self-consistent and consistent with the most fundamental set of Planck units that are hypothetically possible. It then reinterprets the meaning of, and relationships between, those fundamental parameters and predicts the possibility of a maximum faster than light speed for either physical objects, patterns created by subluminal physical objects or the minimum velocity required to cross certain materials.

Methodology

The paper starts by defining the most fundamental set of Planck units that are hypothetically possible, and then a second linked set based around the maximum values that are actually observed – the difference being that the former is built on a hypothetical Planck charge Q_*, defined later, and the latter on the electron charge q_e.

As part of the process in defining the new Planck units, it is shown that the gravitational constant G is only a dimensionless ratio, and can be subsumed within the new mass and distance units. What emerges from the q_e set are values in the new fundamental units for R_k and K_j. These two constants are members of the set of q_e units, as should be expected, although K_j appears inversely and twice the anticipated size.

The dimensional analysis used to subsume G is employed to show that R_k can be considered as equivalent to a velocity, and that many of the electromagnetic parameters can similarly be considered equivalent to mechanical parameters. This invites a reinterpretation of not just R_k and K_j, but of all electromagnetic parameters.

By using the new fundamental units as a framework, it is shown what adjustments are required to some of the electromagnetic SI units, so that the units are both self-consistent and consistent with the fundamental framework. This reintroduces $\sqrt{G}$ as a replacement for permeability, which is also shown to be dimensionless.

The measured value of R_k is shown to equate to a speed greater than light speed. Although it is not clear whether this increased maximum velocity applies to either physical objects, the media through which the physical objects travel or patterns created by subluminal physical objects, this can be experimentally tested.

The final output is to display all the Q_* parameter set as ratios of only h and c, and all the q_e parameter set as ratios of only h, c and $d = \sqrt{\alpha/2\pi}$. This highlights how the parameters are linked and shows that the laws of nature would be constructed in the same way regardless of the relative sizes of h, c and α.

The dimensional analysis enables new laws to be constructed and new constants of nature to be uncovered, although it is not clear that there are any of the latter needed since h and c are all that are required to generate all the Q_* fundamental parameter set.

Examples are given of simplifications of existing formulae using the new framework, one of which is new to physics.

Significance

The usefulness of the paper is partly in providing a toolkit for looking at the relationships between fundamental parameters and for displaying equations stripped of their usual SI based constants and ratios so that the underlying physics can be better understood.

Although to an extent this is already done [4], the new units introduced mean that there need no longer be odd conversion factors needed when considering electromagnetic and mechanical units together. And further that many electromagnetic parameters can be replaced by mechanical parameters.

A prediction is made on the maximum faster than light velocity that can be obtained. The observed value of R_k implies that there is a limit above light speed, probably in terms of electromagnetic field pattern motion, and that limit can be tested in the laboratory.

The most fundamental set of units possible is produced and the set of SI units compared to it, with two adjustments proposed to ensure the self-consistency of SI units and of their consistency with the fundamental units framework. Also shown is how increased precision in the accuracy of other parameters can be constructed out of ratios of R_k and K_j. The gravitational constant G is eliminated from gravitational equations, confirming the equivalence of inertial and gravitational mass in a novel manner – there being only the former remaining. $\sqrt{G}$ is reintroduced to make the second adjustment to SI units and is thereafter a measure of the permeability or interaction within materials, rather than between masses.

So the paper covers some fundamental ground, changing interpretations of many electromagnetic parameters, eliminating G for gravity but reintroducing it for permeability, suggesting that there may be an observable maximum faster than light speed for electromagnetic patterns and indicating how SI units may be improved in consistency and precision.

Objectives

This paper sets out with a number of objectives in showing what insights this paper provides. These may initially seem disparate, but are actually fundamentally intertwined. The objectives listed were not necessarily objectives of the work undertaken, but were uncovered or used as part of its consideration.

The starting point is a discussion of units and the lack of consistency between current SI units and Planck units. It is shown below that the current set of SI units does not have a consistent relationship with the most fundamental set of Planck units, described as Double-adjusted Planck units (DAPU units), and is not internally self-consistent.

By showing the changes needed to SI units in order to gain consistency, it becomes possible to better understand the relationships between parameters such as mass, length, charge, magnetic flux, resistance and time and to achieve the following objectives:

1 The elimination of the gravitational constant G in gravitational formulae. G is shown simply to be a dimensionless ratio, but its elimination requires that it be subsumed within the mass and distance parameters, rather than just the mass parameter as has been tried previously [5]. This also shows that the question of the equivalence of gravitational and inertial mass is irrelevant. However, $\sqrt{G}$ is usefully reintroduced in place of permeability u_* as one of the adjustments needed within current SI units in order to provide consistency with DAPU units.

2 The definition of a set of self-consistent Planck units at the largest possible values using the hypothetical Planck size charge Q_* (the DAPU units) in terms of only Planck's constant h and light speed c. This has been considered impossible previously [6].

3 The use of DAPU units to define a self-consistent set of parameters using the observed value of electron charge q_e or e in SI units and q_{e*} in DAPU units, in terms of only h, c and a constant d which is based on the fine structure constant α.

4 To show that there exists a hypothetical dimensionality that can be used to describe parameters and to uncover any law of nature or any universal constants.

5 That the von Klitzing constant R_k and Josephson constants K_j are two of the electromagnetic DAPU parameters that emerge from the set of parameters based on the electron charge and that they can be reinterpreted in mechanical terms as equivalent to a velocity and inverse-mass respectively.

6 That all of the q_{e*} parameter set can be described solely in terms of ratios of R_k and K_j and so will benefit from the precision of measurement of these two parameters.

7 That the experimentally observed value of R_k implies either a velocity of physical objects, or patterns created by subluminal physical objects, within electromagnetic materials that is in excess of light speed or that such a speed is required to pass through maximal media..

8 That many electromagnetic parameters can be reinterpreted in terms of mechanical parameters.

9 That using DAPU parameters simplifies equations used in physics, can lead to better understanding and enables reinterpretations of existing expressions.

This paper is emphatically not an exercise in numerology. Although, by necessity, it manipulates numbers and relationships to produce self-consistent values for all the parameters considered in terms of the adjusted SI units, that is not the objective. What this paper provides is a toolkit for investigating the deeper relationships between parameters, which are currently hidden by their partially-aligned SI values and less than optimal Planck units.

Units

The paper by Mohr et al. [7] explains the current state in which SI units are being bought more into the quantum measurement realm. The excellent paper by M. J. Duff, L. B. Okun and G. Veneziano [8] includes a broad and varied introduction to the problems of fundamental units and also covers their relationship with SI units. The issue is not new. To paraphrase Dr Okun [6] - *The use of fundamental units h and c in SI has introduced greater accuracy in some of the units, but some electromagnetic units are based on pre-relativistic classical electrodynamics and so their measurement is not as accurate as other units. The use of permeability and permittivity spoils the perfection of the special relativistic spirit and, whilst this is useful for engineers, it results in the four physical parameters D, H and E, B having four different dimensions.* It is only by starting at the most basic and simple physical maximal sized set of Planck type units - and maintaining the integrity of the relationships within that set by not stretching the parameter space unequally - that it is possible to see that the electromagnetic and mechanical parameters are misaligned and that the current value of permeability results in a further misalignment. A new form of dimensional analysis underpins this and allows both mechanical and electromagnetic parameters to be treated on an identical basis. A simile for the current situation is that of a marionette suspended from a wooden framework by strings attached to various body parts and manipulated from above by a puppeteer. The strings may be attached to the right places, but some of their lengths are wrong and so the marionette can dance - but only after a fashion. Correcting the string lengths will allow a fuller appreciation of the puppeteer's skills.

The Foundations

The most basic two formulae for defining a Planck unit system are the force equation $F = GM^2/L^2 = Q^2c^2/L^2$ and the angular momentum equation $h = McL$. The normal usage of the latter is to define a Planck mass M_p and Planck Length L_p such that $\hbar = M_p c L_p$ and $M_p = \sqrt{\hbar c/G}$. Unfortunately this introduces the 2π factor in many equations, where it serves only to confuse.

The preferred definition to be used here as a starting point is to define the system without the 2π factor. There are two stages to the change, the first is the adjusted Planck unit (APU) and the second the double-adjusted Planck unit (DAPU). Initially the APU mass M_o and APU length L_o are related by $h = M_o c L_o$ and M_o is defined to be $M_o = \sqrt{hc/G}$.

However, to achieve the right relationship between M and L in parameter space, as described below, requires looking at the force equation at the same time. Rearranging to give $FL^2 = GM^2 = (Qc)^2$ provides the simple relationship that the APU mass M_o and APU charge Q_o are related such that $M_o\sqrt{G} = Q_o c$.

Since the latter equation does not include L_o it is not immediately apparent that compared with the Planck parameters M_p and L_p there is a need to adjust both by the factor $\sqrt{G}$ in addition to the $\sqrt{2\pi}$ factor, so that $h = M_o c L_o = 2\pi(M_p\sqrt{2\pi G})c(L_p/\sqrt{2\pi G})$ if the latter factor is distributed in the same way as $\sqrt{G}$. This stretches parameter space equally along the mass and length parameters, rather than just the mass parameter as is usually done [9].

Now the second stage of the change can be made into DAPU units. The DAPU mass M_* is defined to be $M_* = M_o\sqrt{G} = Q_o c = Q_* c$ where Q_* is the DAPU charge.

Following the angular momentum equation, M_* and DAPU length L_* are related by $h = M_* c L_*$ with $L_* = L_o/\sqrt{G}$.

The result is the foundation of a DAPU parameter set and units based on $h = M_* c L_*$ and

$$F_* = M_*^2/L_*^2 = Q_*^2c^2/L_*^2$$

as set out in the initial objective and without G. The dimensionality of G will be shown to be zero later. This is the most basic set of Planck parameters that can be devised because only the two universal constants h and c are used, and this is the minimum number of constants required to establish relationships between the parameters.

The subsuming of G within the mass and distance units also eliminates the difference between gravitational and inertial masses, since there is no longer any gravitational mass. This is not equivalent to making $G = 1$, as will be shown below, because the effect of subsuming G into M_* and L_* is to stretch current parameter space into the more symmetric DAPU parameters space, which does not occur when simply setting $G = 1$.

The base parameter space consists of M, L, c, h and Q. Since Q can be related to M and c only, the minimum parameter space is just M, L, c and h. Because h and c are the two basic universal constants, to maintain the topology and symmetry of the base parameter space requires that the other two parameters M and L are stretched proportionately together. Provided Q is treated in the same way as M, it will stay symmetric. Any non-symmetric stretching results in an asymmetric set of parameters and will require the use of factors such as d in the relationships between the stretched parameters.

SI units and DAPU

The above two relationships hold in the new DAPU system in DAPU units, but unfortunately in SI units there is the first misalignment that becomes apparent. To align the charge and mass side of the equation in SI units requires that the base unit size Planck charge is decreased by the factor $\sqrt{10^{-7}}$ relative to the mass side since $GM_o^2/L_o^2 = Q_o^2c^2(10^{-7})/L_o^2$ in SI units. To identify this difference, each equation in future may, where it might otherwise confuse, be identified either as being in DAPU or SI units, so that $Q_* = M_*/c(DAPU) = M_*\sqrt{10^7}/c(SI)$.

It is useful for display purposes, as will be used liberally later, to define a factor $d = \sqrt{\alpha/2\pi}$ that represents the ratio $d = q_{e*}/Q_*$, where q_{e*} is the DAPU size of the electronic charge.

The second SI misalignment appears when comparing electromagnetic and mechanical SI units that have material content requiring permeability or permittivity. The use of permeability u_* as $4\pi \times 10^{-7}$ causes the factor $4\pi \times 10^{-7}/\sqrt{G} = 6.501$ to appear in some parameters when compared with what their DAPU based value should be. This arises from some parameters whose SI units may mix electromagnetic and mechanical parameters within their definition, such as the Farad. So the second SI re-alignment is to define u_* to be equal to $\sqrt{G}$ rather than the usual $4\pi \times 10^{-7}$, which relegates G from gravitational to permeability use, so that it represents a measure of the strength of interactions within materials not between masses.

The result is that the proposed new adjusted-SI units (NSI) which should be used are either the same as the normal SI units or are different to normal SI units by a power of either the $\sqrt{10^{-7}}$ factor, the 6.501 factor or a combination of both. Wherever there is a factor q_{e*} used, the same power of $\sqrt{10^{-7}}$ is used. Where there is no q_{e*} or u_* factor, the NSI and SI values are the same. Where the current SI unit is adjusted by a power of the $\sqrt{10^{-7}}$ factor, the parameter has a cedilla above it. So the SI unit Watts, W becomes $\tilde{W}$ in NSI where $\tilde{W} = \sqrt{10^{-7}}W$. Because most of the parameter examples used here do not have any specific material dependence, as would be the case for the magnetic field H, there is no use of permeability u_* or permittivity ε_* within most of the parameter examples given. For the examples used here, there are no complications of additional 6.501 usage or identification of double adjusted SI units, other than in the permittivity ε_* and capacitance C_*, where the SI unit the Farad F is adjusted by that factor to be $F^{\#}$ in NSI with $F^{\#} = F/6.501$.

So the adjustment of SI units to make them self-consistent across both mechanical and electromagnetic parameters, and to ensure that they have the same overall shape in parameter space as the underlying DAPU units allows the direct comparison of all parameters in either DAPU or NSI units, with the only difference being the actual number value in each set of units. For the Q_* set of parameters, in DAPU the maximal values are always 1. For the q_{e*} set of parameters, the maximal values are always powers of d. For both these sets, the NSI values are shown in Tables 1 and 2.

The merging of G with the mass and distance parameters, and the adjustment of SI units across the charge and mass sides of the force equation also shows that the strength of mass and charge potential actions, via gravity and charge fields, is intrincially identical. The reason why they seem to be so different is because of those changes that have to be made in order to show that they are identical, the use of the ratios G, $\sqrt{10^{-7}}$ and 6.501. So the actual difference that is seen in the 'strength' of charge action versus gravity is due to the relative size of the electron charge versus the electron mass, in the electron. But the inherent strength of their underlying actions is identical.

Dimensionality of G

The subsuming of G with the APU mass M_o to produce the DAPU mass M_*, and the APU length L_o to produce the DAPU length L_*, would seem to ignore the units of G, effectively treating G as unity and without units. But this is not the case. The units of G are $m^3kg^{-1}s^{-2}$. A consideration of the standard laws of nature and the fundamental constants through a new form of dimensional analysis shows that if each parameter is assigned an appropriate dimensionality, every fundamental constant, other than c, will have a total dimensionality of zero. The dimensionalities of the main SI, NSI, APU or DAPU parameters in terms of a hypothetical dimension Y that emerge from the consideration are:

Mass $M_* = Y^{+1}$ Velocity $c = Y^{+2}$ Length $L_* = Y^{-3}$ Charge $Q_* = Y^{-1}$ Time $T_* = Y^{-5}$ Energy $E_* = Y^{+5}$

and of course

$h = Y^0$ and $G = Y^0$

The units of G are $\mathsf{m}^3kg^{-1}s^{-2} = Y^{-9}Y^{-1}Y^{+10} = Y^0$ dimensionality and h has units $kgm^2s^{-1} = Y^{+1}Y^{-6}Y^{+5} = Y^0$ dimensionality.

So the units of both h and G are actually irrelevant because they represent fundamental constants with zero dimensionality. Thus adjusting the APU mass to the DAPU mass, and APU length to DAPU length, involves only multiplying or dividing by $\sqrt{G}$ as a dimensionless number, and does not affect the dimensionality of the units of mass or length, other than changing the sizes of the base Planck mass and distance units. This stretches the current parameter space into the more symmetric DAPU parameter space, which is different to treating G as equal to 1, which does not affect the current parameter space topology at all.

The same dimensional analysis can be done for permeability $u_* = NA^{-2} = kg\mathsf{m}^{-1}s^{-2}(\sqrt{kg\mathsf{m}}s^{-1})^{-2} = Y^0$ which shows that the replacement of u_* by $\sqrt{G}$ does not affect the units used because they are both dimensionless.

This hypothetical dimensionality tool can be used to produce any law of nature by creating equations where the dimensionalities are equal on both sides. One example would be $F = Ma$, where force is Y^8 and is equal to the product of mass Y^1 and acceleration Y^7, so that both sides have Y^8 dimensionality. Another example would be the product of volume and viscosity which produces Y^0 on one side and would represent a new constant of nature on the other. To produce a constant of nature, aside from c, the minimum that is required is that it has Y^0 dimensionality.

However, producing laws of nature through the dimensional analysis does not provide the exact relationship between the non-maximal parameters, because these depend on the specific context in which the parameters are being considered. An example would be the kinetic energy of a particle in motion $E_{ke} = (\gamma_v - 1)mc^2 \simeq \frac{1}{2}mv_e^2$ compared with the rest mass energy of the same particle $E_{rm} = mc^2$. Dimensionally these exhibit the same relationships between mass, energy and velocity but they describe different specific aspects of that relationship.

Values of the Q_* set of parameters

Table 1 provides a list of the main Q_* parameter set and their NSI values at their maximal Planck sizes. The column headed 'NSI units' means that where the current electromagnetic SI units appear they have been adjusted by a power of the factor $\sqrt{10^7}$ mentioned earlier and their use is denoted by a cedilla above the unit or $F^{\#}$ describes the SI unit F adjusted by the 6.501 factor. Note that the factor d does not appear in Table 1 because these values are all based on the DAPU charge Q_*.

Table 1: Maximal parameter values in NSI units with electronic charge size Q_*

Parameter (X_*)	Q_*DAPU set's NSI Value	NSI Units	DAPU equivalent	As Constants
Gravitational Constant(G)	*none*	$\mathsf{m}^3kg^{-1}s^{-2}$	*none*	*none*
Permeability(u_*)	$\sqrt{6.67428 \times 10^{-11}}$	NA^{-2}	*none*	$\sqrt{G}$
Angular Momentum(h)	$6.62606896 \times 10^{-34}$	Js	$kg\mathsf{m}^2s^{-1}$	h
Mass(m_*)	$4.45695580 \times 10^{-13}$	kg	kg	$\sqrt{hc}$
Magnetic Flux(ϕ_*)	$4.45695580 \times 10^{-13}$	$\tilde{W}$	$\sqrt{kg\mathsf{m}}\mathsf{m}s^{-1}$	$\sqrt{hc}$
Charge-mass(q_*c)	$4.45695580 \times 10^{-13}$	$\tilde{C}\mathsf{m}s^{-1}$	$\sqrt{kg\mathsf{m}}\mathsf{m}s^{-1}$	$\sqrt{hc}$
Velocity(v_*)	2.99792458×10^{8}	$\mathsf{m}s^{-1}$	$\mathsf{m}s^{-1}$	c
Resistance(R_*)	2.99792458×10^{8}	$\tilde{\Omega}$	$\mathsf{m}s^{-1}$	c
Momentum(m_*v_*)	$1.33616173 \times 10^{-4}$	$kg\mathsf{m}s^{-1}$	$kg\mathsf{m}s^{-1}$	$c\sqrt{hc}$
Current(ι_*)	$8.98755179 \times 10^{16}$	$\tilde{A}$	$\sqrt{kg\mathsf{m}}s^{-1}$	c^2
Action(m_*/r_*)	$8.98755179 \times 10^{16}$	$kg\mathsf{m}^{-1}$	$kg\mathsf{m}^{-1}$	c^2
Angular Frequency(w_*)	$6.04538246 \times 10^{37}$	Hz	s^{-1}	$c^2\sqrt{c/h}$
Frequency(f_*)	$6.04538246 \times 10^{37}$	Hz	s^{-1}	$c^2\sqrt{c/h}$
Energy(E_*)	4.00571211×10^{4}	J	$kg\mathsf{m}^2s^{-2}$	$c^2\sqrt{hc}$
Potential Difference$(\vee_*)$	$2.69440024 \times 10^{25}$	$\tilde{V}$	$\sqrt{kg\mathsf{m}}\mathsf{m}s^{-2}$	c^3
Acceleration(a_*)	$1.81236007 \times 10^{46}$	$\mathsf{m}s^{-2}$	$\mathsf{m}s^{-2}$	$c^3\sqrt{c/h}$

Magnetic Inductance(B_*)	$1.81236007 \times 10^{46}$	$\tilde{A}\mathsf{m}^{-1}$	$\mathsf{m}s^{-2}$	$c^3\sqrt{c/h}$
Force(F_*)	$8.07760871 \times 10^{33}$	N	$kg\mathsf{m}s^{-2}$	c^4
Electric Field(ξ_*)	$5.43331879 \times 10^{54}$	$\tilde{V}\mathsf{m}^{-1}$	$\sqrt{kg\mathsf{m}}\mathsf{m}^{-2}s^{-2}$	$c^4\sqrt{c/h}$
Mass Density(ρ_*)	$3.65466491 \times 10^{75}$	$kg\mathsf{m}^{-3}$	$kg\mathsf{m}^{-3}$	c^5/h
Current Density(J_*)	$3.65466491 \times 10^{75}$	$\tilde{A}\mathsf{m}^{-2}$	$\sqrt{kg\mathsf{m}}\mathsf{m}^{-2}s^{-1}$	c^5/h
Power(P_*)	$2.42160617 \times 10^{42}$	Js^{-1}	$kg\mathsf{m}^2s^{-3}$	c^5
Pressure(p_*)	$3.28464901 \times 10^{92}$	$N\mathsf{m}^{-2}$	$kg\mathsf{m}^{-1}s^{-2}$	c^7/h
Energy Density(ϵ_*)	$3.28464901 \times 10^{92}$	$J\mathsf{m}^{-3}$	$kg\mathsf{m}^{-1}s^{-2}$	c^7/h
Charge(q_*)	$1.48668043 \times 10^{-21}$	$\tilde{C}$	$\sqrt{kg\mathsf{m}}$	$\sqrt{h/c}$
Conductance(ς_*)	$3.33564095 \times 10^{-9}$	$\tilde{\Omega}^{-1}$	$\mathsf{m}^{-1}s$	c^{-1}
Moment(m_*r_*)	$2.21021870 \times 10^{-42}$	$kg\mathsf{m}$	$kg\mathsf{m}$	h/c
Distance(L_*)	$4.95903212 \times 10^{-30}$	m	m	$c^{-1}\sqrt{h/c}$
Inductance$(\mathcal{L}_*)$	$4.95903212 \times 10^{-30}$	$\tilde{H}$	$\sqrt{kg\mathsf{m}}\mathsf{m}^{-1}s^{-1}$	$c^{-1}\sqrt{h/c}$
Permittivity(ε_*)	$1.36193501 \times 10^{-12}$	$F^{\#}\mathsf{m}^{-1}$	$\mathsf{m}^{-2}s^2$	$c^{-2}/\sqrt{G}$
Time(T_*)	$1.65415506 \times 10^{-38}$	s	s	$c^{-2}\sqrt{h/c}$
Area(A_*)	$2.45919996 \times 10^{-59}$	m^2	m^2	h/c^3
Volume(V_*)	$1.21952516 \times 10^{-88}$	m^3	m^3	$h\sqrt{h/c}/c^4$

Values of the q_{e*} set of parameters

In DAPU the value of each parameter in Table 1 is 1. To arrive at the maximal real values that can be found experimentally, the list needs to be adjusted to use q_e instead of Q_* since we do not observe Q_* charges usually. The maximal values in NSI units of some parameters under this limitation are listed in Table 2. Note that the factor d is inversely proportional to the dimensionality of every parameter

Table 2: Maximal parameter values in NSI units using electronic charge size q_{e*}

Parameter (X_{e*})	q_e DAPU set's NSI Value	NSI Units	DAPU equivalent	As Constants
Permeability(u_{e*})	$\sqrt{6.67428 \times 10^{-11}}$	NA^{-2}	*none*	$\sqrt{G}$
Angular Momentum(h)	$6.62606896 \times 10^{-34}$	Js	$kg\mathsf{m}^2s^{-1}$	h
Mass(m_{e*})	$1.30781284 \times 10^{-11}$	kg	kg	$d^{-1}\sqrt{hc}$
Magnetic Flux(ϕ_{e*})	$1.30781284 \times 10^{-11}$	$\tilde{W}$	$\sqrt{kg\mathsf{m}}\mathsf{m}s^{-1}$	$d^{-1}\sqrt{hc}$
Charge-mass$(q_{e*}c)$	$1.30781284 \times 10^{-11}$	$\tilde{C}\mathsf{m}s^{-1}$	$\sqrt{kg\mathsf{m}}\mathsf{m}s^{-1}$	$d^{-1}\sqrt{hc}$
Velocity(v_{e*})	$2.58128076 \times 10^{11}$	$\mathsf{m}s^{-1}$	$\mathsf{m}s^{-1}$	$d^{-2}c$
Resistance(R_{e*})	$2.58128076 \times 10^{11}$	$\tilde{\Omega}$	$\mathsf{m}s^{-1}$	$d^{-2}c$
Momentum$(m_{e*}v_{e*})$	$3.37583212 \times 10^{00}$	$kg\mathsf{m}s^{-1}$	$kg\mathsf{m}s^{-1}$	$d^{-3}c\sqrt{hc}$
Current(ι_{e*})	$6.66301034 \times 10^{22}$	$\tilde{A}$	$\sqrt{kg\mathsf{m}}s^{-1}$	$d^{-4}c^2$
Action(m_{e*}/r_{e*})	$6.66301034 \times 10^{22}$	$kg\mathsf{m}^{-1}$	$kg\mathsf{m}^{-1}$	$d^{-4}c^2$
Angular Frequency(w_{e*})	$1.31510410 \times 10^{45}$	Hz	s^{-1}	$d^{-5}c^2\sqrt{c/h}$
Frequency(f_{e*})	$1.31510410 \times 10^{45}$	Hz	s^{-1}	$d^{-5}c^2\sqrt{c/h}$
Energy(E_{e*})	$8.71397049 \times 10^{11}$	J	$kg\mathsf{m}^2s^{-2}$	$d^{-5}c^2\sqrt{hc}$
Potential Difference$(\vee_{e*})$	$1.71991004 \times 10^{34}$	$\tilde{V}$	$\sqrt{kg\mathsf{m}}\mathsf{m}s^{-2}$	$d^{-6}c^3$
Acceleration(a_{e*})	$3.39465292 \times 10^{56}$	$\mathsf{m}s^{-2}$	$\mathsf{m}s^{-2}$	$d^{-7}c^3\sqrt{c/h}$
Magnetic Inductance(B_{e*})	$3.39465292 \times 10^{56}$	$\tilde{A}\mathsf{m}^{-1}$	$\mathsf{m}s^{-2}$	$d^{-7}c^3\sqrt{c/h}$
Force(F_{e*})	$4.43957068 \times 10^{45}$	N	$kg\mathsf{m}s^{-2}$	$d^{-8}c^4$
Electric Field(ξ_{e*})	$8.76255225 \times 10^{67}$	$\tilde{V}\mathsf{m}^{-1}$	$\sqrt{kg\mathsf{m}}\mathsf{m}^{-2}s^{-2}$	$d^{-9}c^4\sqrt{c/h}$
Mass Density(ρ_*)	$1.72949881 \times 10^{90}$	$kg\mathsf{m}^{-3}$	$kg\mathsf{m}^{-3}$	$d^{-10}c^5/h$
Current Density(J_{e*})	$1.72949881 \times 10^{90}$	$\tilde{A}\mathsf{m}^{-2}$	$\sqrt{kg\mathsf{m}}\mathsf{m}^{-2}s^{-1}$	$d^{-10}c^5/h$
Power(P_{e*})	$1.14597784 \times 10^{57}$	Js^{-1}	$kg\mathsf{m}^2s^{-3}$	$d^{-10}c^5$

Pressure(p_{e*})	$1.15236684 \times 10^{113}$	$N\mathrm{m}^{-2}$	$kg\mathrm{m}^{-1}s^{-2}$	$d^{-14}c^7/h$
Energy Density(ϵ_{e*})	$1.15236684 \times 10^{113}$	$J\mathrm{m}^{-3}$	$kg\mathrm{m}^{-1}s^{-2}$	$d^{-14}c^7/h$
Charge(q_{e*})	$5.06652691 \times 10^{-23}$	$\tilde{C}$	$\sqrt{kg\mathrm{m}}$	$d\sqrt{h/c}$
Conductance(ς_{e*})	$3.87404585 \times 10^{-12}$	$\tilde{\Omega}^{-1}$	$\mathrm{m}^{-1}s$	d^2c^{-1}
Moment($m_{e*}r_{e*}$)	$2.56696950 \times 10^{-45}$	$kg\mathrm{m}$	$kg\mathrm{m}$	d^2h/c
Distance(L_{e*})	$1.96279576 \times 10^{-34}$	m	m	$d^3c^{-1}\sqrt{h/c}$
Inductance($\mathcal{L}_{e*}$)	$1.96279576 \times 10^{-34}$	$\tilde{H}$	$\sqrt{kg\mathrm{m}}\mathrm{m}^{-1}s^{-1}$	$d^3c^{-1}\sqrt{h/c}$
Permittivity(ε_{e*})	$1.83707675 \times 10^{-18}$	$F^{\#}\mathrm{m}^{-1}$	$\mathrm{m}^{-2}s^2$	$d^4c^{-2}/\sqrt{G}$
Time(T_{e*})	$7.60396075 \times 10^{-46}$	s	s	$d^5c^{-2}\sqrt{h/c}$
Area(A_{e*})	$3.85256718 \times 10^{-68}$	m^2	m^2	d^6h/c^3
Volume(V_{e*})	$7.56180251 \times 10^{-102}$	m^3	m^3	$d^9h\sqrt{h/c}/c^4$
Capacitance(C_{e*})	$2.94580926 \times 10^{-57}$	$F^{\#}$	$\mathrm{m}^{-1}s^2$	$d^7c^{-3}\sqrt{h/c}$

Why this is not numerology

What is important here is that the relationships between the parameters in both tables are easily displayed in terms of only h and c for the Q_* set and in terms of only h, c and d for the q_{e*} set (other than permeability and permittivity which have G content). So each parameter has a simple relationship to each other one. The actual NSI values of these parameters bear out these relationships numerically, but they are only a confirmation of what the fundamental constants already show.

Within the q_{e*} set are two parameters that deserve further consideration, R_k and K_j.

R_k and K_j - members of the q_{e*} parameter set whose values can be measured directly

The maximal value for Resistance R_{e*} is equal to the von Klitzing constant R_k, $R_{e*} = R_k$ (DAPU) and the value of the Magnetic Flux ϕ_{e*} is equal to twice the inverse of the Josephson constant K_j, $\phi_{eo} = (2/K_j)$ (DAPU). Table 3 shows that the NSI values of R_k and K_j are identical to R_{e*} and $2/\phi_{e*}$ when translated into DAPU units. To ensure clarity, new parameters will be defined $R"_k = R_{e*} = R_k$ and $K"_j = 2/\phi_{e*} = K_j$ where $R"_k$ and $K"_j$ denote the DAPU interpretations of R_k and K_j which can be more easily compared with other constants in DAPU units. This will be explored further later.

Parameters, physical constants and laws of nature

Some of the q_{e*} set of parameters, such as velocity v_{e*}, appear to be larger than their Q_* set versions. As will be shown below, it is possible to interpret R_k as equivalent to a velocity and, if so, this suggests either that faster than light travel by physical objects, or patterns produced by subluminal physical objects, through media may be a possibility or that in order to pass through such maximal media an unachievable speed faster than light is required. Which is the case should should be investigated. This result, where the parameters $X_{e*} > X_*$, will be considered further below.

All the parameters above have been produced using standard relationships and formulae. It is interesting to observe that some parameters on the mechanical side have identical size and dimension partners on the electromagnetic side, for example mass M_* and magnetic flux ϕ_*. One interpretation could be that magnetic flux is the equivalent of the mass in an electromagnetic system, and that resistance R_{e*} is the equivalent of velocity v_{e*}. Dimensional analysis supports this and the appropriateness of this interpretation will be considered later.

To ensure that the above values can be understood properly, the following series of relationships at the Q_* level can be culled from the standard laws and the results computed and confirmed to be correct using their NSI values in Table 1 as:

$$F_* = (M_*/L_*)^2 = (\phi_*/L_*)^2 = (Q_*c/L_*)^2 = M_*a_* = \phi_*B_* = Q_*cB_* = Q_*\xi_* = V_*c = i_*^2 = hc/L_*^2$$

It is also possible to use the same relationships at the q_{e*} level, using the parameter values from Table 2 thus:

$F_{e*} = (M_{e*}/L_{e*})^2 = (\phi_{e*}/L_{e*})^2 = (Q_{e*}c/L_{e*})^2 = M_{e*}a_{e*} = \phi_{e*}B_{e*} = Q_{e*}cB_{e*} = Q_{e*}\xi_{e*} = V_{e*}c = i_{e*}^2 = hc/L_{e*}^2$

Since the values of some electromagnetic parameters are identical to the values of some mechanical parameters, it suggests that mechanical formulae could be used with electromagnetic parameters substituted instead, and vice versa. One example would be the simple $L_{e*} = v_{e*}T = \mathcal{L}_{e*}$ which suggests that in some way electromagnetic inductance is equivalent to a mechanical distance. Were this done in SI units, the mix of mechanical and electromagnetic parameters would not show that the parameters were interchangeable because of the misalignment of those two types of parameter in the SI units system.

The tables show that most electromagnetic parameters can be reinterpreted in terms of mechanical parameters. It requires a complete reinterpretation of what is understood by the terms magnetic inductance (acceleration), magnetic flux (mass), inductance (distance), current density (mass density) and other electromagnetic parameters.

Describing all parameters using only two from the set of parameters

Now it is possible to reinterpret the only two fundamental constants left, aside from the factor d which defines the electron charge-based system that we experience because of the relative size of the charge on the electron q_{e*} versus the DAPU Planck charge Q_*, in term of the two base parameters which have only dimension $Y^{\pm 1}$ which are charge Q_* and mass M_*.

$M_*Q_* = h$

$M_*/Q_* = c$

So the two constants h and c represent the only two possible ratios of the DAPU mass and DAPU charge, each used once. That ought to infer something fundamental about any hypothetical underlying structure of matter, but such consideration is beyond this paper.

Also important is that the same reinterpretation can be done for h and c using R_k and K_j. However, for consistency, the DAPU constants $R"_k$ and $K"_j$ will be used, but the same relationships remain.

$R"_k(K"_j/2)^2 = h$

$R"_k = c/d^2$

The comparison with M_* and Q_* is not identical. $K"_j$ is an inverse magnetic flux and so equivalent to a mass of size $2/K"_j$. However, $R"_k$ is not a charge, but is a resistance or velocity. But by using the same relationship between equivalent mass and charge, with the factor of 2, the value of h can be recovered as:

Equivalent mass x electron charge $= (2/K"_j)q_{e*} = h$

And the same can be achieved with the ratio of equivalent mass to charge to recover the velocity c/d^2 or $R"_k$ as:

Equivalent mass / electron charge $= (2/K"_j)/q_{e*} = h/q_{e*}^2 = h/[d^2Q_*^2] = Q_*^2c/[d^2Q_*^2] = c/d^2 = R"_k$

This shows that if inverse magnetic flux can be considered as equivalent to a mass, then resistance can be considered as equivalent to a velocity.

Parameters as ratios of $R"_k$ and $K"_j/2$

It is possible to generate examples of the usual constants of nature or DAPU parameters, other than G which was subsumed into $M_*$and L_*, using just $R"_k$ and $K"_j/2$ (or with powers of d included for the Q_* set) as follows:

$M_* = d/(K"_j/2)$

$M_{e*} = 1/(K"_j/2) = \phi_{e*}$

$q_{e*} = 1/[R"_k(K"_j/2)]$

$Q_* = 1/[R"_k(K"_j/2)d]$

$L_* = 1/[R"^2_k(K"_j/2)d^3]$

$L_{e*} = 1/[R"^2_k(K"_j/2)]$

$T_* = 1/[R"^3_k(K"_j/2)d^5]$

$h = 1/[R"_k(K"_j/2)^2]$

$E_* = R"^2_k/[(K"_j/2)d^5]$

$c = R"_k d^2$

$\iota_{e*} = R"^2_k$

$\vee_{e*} = R"^3_k$

These relationships can be checked by using the following standard law formulae, in either Q_{e*} or q_{e*} form, and the DAPU values of the parameters in Table 1 or 2:

$\vee_{e*} = \iota_{e*} \times R"_k$ or $B_{e*} = \phi_{e*}/A_{e*}$ or $E_{e*} = m_{e*} \times v^2_{e*}$ or $F_{e*} = p_{e*} \times A_{e*}$ or $q_{e*} = \iota_{e*} \times T_{e*}$ or $E_{e*} \times T_{e*} = h$

Many parameters have been left out of the list for brevity, including those based on materials which require the permeability factor u_* and would mean the inclusion of $\sqrt{G}$ in the formula of constants producing those parameters.

Of particular interest is the value of $\iota_{e*} = R"^2_k$ which suggests that the SI unit of Ampere could be defined using the DAPU value of $R"^2_k$ as its sole reference point.

How to translate between SI and APU/DAPU units

Table 3 shows the relative factors required to translate between DAPU/APU/SI units. The SI values should be multiplied by the the factors in the appropriate column to produce the DAPU or APU values of that parameter.

Table 3: Translating between units

Parameter	DAPU factor X_*	APU factor X_o	SI value of Planck unit	SI Name
h	2π	2π	$1.0545716 \times 10^{-34}$	$\hbar$
M	$\sqrt{2\pi G}$	$\sqrt{2\pi}$	2.1764374×10^{-8}	M_{Planck}
Q	$\sqrt{10^{-7}}$	$\sqrt{10^{-7}}$	$4.7012963 \times 10^{-18}$	Q_{Planck}
q_e	$\sqrt{10^{-7}}$	$\sqrt{10^{-7}}$	$1.6021765 \times 10^{-19}$	e
L	$\sqrt{2\pi/G}$	$\sqrt{2\pi}$	$1.6162525 \times 10^{-35}$	L_{Planck}
G	*none*	1	6.67428×10^{-11}	G
c	1	1	2.99792458×10^{8}	c
R_{e*}	10^{-7}	10^{-7}	$2.581280756 \times 10^{4}$	R_k
$2/\phi_{e*}$	$\sqrt{10^{-7}}$	$\sqrt{10^{-7}}$	$4.835978909 \times 10^{14}$	K_j

Metrology

It may be possible to improve the accuracy of measurement of some of the constants by using the new relationships uncovered between $R"_k$ and $K"_j$. It is not only h that can be made more precisely from ratios of R_k and K_j. There are many more composites of $R"_k$ and $K"_j$ that produce other parameters which may not have been measured to as great an accuracy as R_k and K_j have been. Unfortunately G will not be one such open to improvement unless its square root equivalence to permeability u_*, as defined in the DAPU system of units, is confirmed as appropriate, when it will become the accuracy of measurement of permittivity ε_* that will set the metrology limits for precision of the value of G.

Faster than light speed?

The parameters in Table 2, based on q_{e*}, that have $X_{e*} > X_*$, have sizes greater than their Q_* DAPU set values in Table 1. This leads to parameters like $v_{e*} = c/d^2 = 2\pi c/\alpha$ which is greater than light speed. It is the d factor, the ratio q_{e*}/Q_*, that alters the parameter values in Table 2. Where the parameter has d^{+x} the parameter will be smaller than its Planck parent and where the parameter has d^{-x} it will be larger - the whole q_{e*} parameter space has been stretched out of symmetry when compared with the Q_* parameter space topology, even though the same laws and relationships still apply.

For all physical objects at the maximal values for each q_{e*} parameter possessed, the actual value of d is immaterial. Such objects obey the same laws regardless of the relative size of the electron charge q_{e*} to DAPU charge Q_*. It is only at the lower levels, below maximal values, that the ratio of d to, for example, the masses of the particles will produce varying sizes of physical effect, such as differing electron energy levels in atoms, dependent on the mass of the electron and its orbital velocity.

Whether the maximal values $X_{e*} > X_*$ can actually be attained is a question for experimental verification or rebuttal. That R_k and K_J have been measured to be the sizes that they are [10] makes it certain that some of them can, since $R_k = c/d^2 = 2\pi c/\alpha$. So although equivalent to a velocity, it is not clear if $R_k > c$ means that q_{e*} based physical objects can exceed c in velocity. So there may be limits on the interpretation of 'equivalent to' when two DAPU parameters have identical values and dimensionalities. What is physically possible may depend on whether the parameter under consideration is from the mechanical or electromagnetic part of parameter space and whether physical objects, or patterns caused by them, are at work.

Whilst it is easy enough to see that the inverse of K_j may be interpreted as a form of mass, it may be asked how can a resistance $R_k = c/d^2$ and a velocity c be the same parameter in a different disguise. The initial interpretation may be that the resistance equates to a measure of the velocity required in order successfully to pass through the material producing the resistance. So a zero resistance means that a current of any velocity will pass. At the other end of the scale, this means that either the maximum resistance possible R_k cannot be overcome because nothing can exceed c (the resistance is 'infinite') or that within that material it is possible to travel across, but only if a velocity v/d^2 suitable for that material can be reached.

There have been experimental results [11] which show that patterns produced by subluminal physical objects can travel faster than light, and it may be that the factor c/d^2 represents the maximum velocity limit that these can attain. Experiments along the lines mentioned in the reference article could be undertaken to test the velocity limits of faster than light patterns so that it should be possible to determine which of the two cases, physical object or pattern motion, is actually correct and whether a velocity in excess of c within a material by physical objects is achievable.

The interpretation preferred here is that the factor v/d^2 represents a limitation on the minimum velocity required for electrons to pass across the media. As will be shown below, this velocity is inherent in the media and is distinct from the actual velocity of the current. The two velocities combine together to define the motional charge energy, which is explained later.

Simplifying expressions (1)

An example of the use of simplification enabled by the use of DAPU units would be to compare the standard expression for the principal energy levels of the one-electron atom with the same in DAPU units, where each observed parameter is displayed as a fraction of its maximal DAPU value. It is not suggested that this is the only way to arrive at the simplification, but it shows how thinking in DAPU units enabled simplicity to emerge.

The simplest example of a standard equation for the allowed energy levels, to use as an example, is the Bohr SI equation which provides that

$$E_{n_{mass}} = -1/n^2(k^2me^4/(2\hbar^2)) = -R/n^2$$

where R is the Rydberg constant and the other parameters are as usually described. The factor k has the value $8.988 \times 10^9 N\mathrm{m}^2C^{-2}$ in SI units and can be converted into DAPU units by dividing by $(\sqrt{10^{-7}})^2 = 10^{-7}$ to produce the value $8.988 \times 10^{16} = c^2$. The formula can be manipulated using $F = e^2c^2/r_e^2 = mv_e^2/r_e = \hbar v_e/r_e^2$ so that in DAPU terms this becomes a simpler to understand kinetic energy-like ratio

$$E_{n_{mass}}/E_{*} = -\frac{1}{2}mv_e^2/n^2$$

Whilst the DAPU equation is admittedly not so easy to measure, it does bring out that what is being measured is simply different variations in the kinetic energy of the electron. Had the Bohr example started with the potential energy separated out, then so would the DAPU presentation.

Simplifying expressions (2)

Another simplification providing greater clarity might be based on the expression for the magnetic moment of an orbiting electron, usually described in SI units as

$$\mu_e = eh/2m$$

but which can be recast using the same equations as previously to become

$$n\mu_e/\mu_{e*} = \frac{1}{2}ev_e r_e$$

so that

$$E_{n_{charge}}/E_{e*} = \mu_e c\omega_e/n^2 = \frac{1}{2}[ec]v_e^2/n^2$$

which implies that in the same way that moving mass occurs in units of orbital angular momentum in $n\hbar = mv_e r_e$, so does charge although in units of orbital magnetic momentum as $n\mu_e = \frac{1}{2}ev_e r_e$, using the same form as the $\hbar$ angular momentum equation. And that the form of the equation for energy of motion of charge is comparable with that for the kinetic energy of the mass, but with ec replacing the mass m in the kinetic energy equation.

Taking these comparisons further, since the motional energy of charge is so similar in form to that for kinetic energy, being purely related to relative motion, it must be that both are due to the excess relativistic energy above rest mass or rest charge energy. So where $E_{ke} = (\gamma_v - 1)mc^2 \simeq \frac{1}{2}mv_e^2/n^2$ it should also be the case for charge that $E_{qe} = (\gamma_v - 1)[ec]c^2 \simeq \frac{1}{2}[ec]v_e^2/n^2$. Both charge and mass are being treated identically in terms of the relativistic increase in energy due to motion and are displayed in exactly the same form and the factor $\frac{1}{2}$ is only a low energy approximation.

The nature of latter approximation may be tested by measuring the divergence of electron energy levels from exactly $\frac{1}{2}$ in atoms where the velocity of the electrons is very high. The divergence should follow the relativistic factor minus one half, $\delta = (\gamma_v - 1)/v_e^2 - \frac{1}{2}$.

Looking at a law of nature

It is possible to now extend the consideration above and show how a velocity and a resistance can be the same thing, even at the SI level. If the equation for the motional energy of charge above is now simplified by ignoring the principal quantum number, but converting into q_e set units based on the maximum velocity c/d^2, the result is that

$$E_{qe} = (\gamma_v - 1)[ec/d^2]c^2/d^4$$

which can be equated with the energy stored in a capacitor $E_c = \frac{1}{2}e\vee_v$ where $\vee_v$ is the potential difference across the plates. The same argument about relativistic increase in energy can be made here as well, in that the electrons will be in motion, so that the more accurate description should be $E_c = (\gamma_v - 1)e \vee_v c^2/v_e^2$ and both can now be equated to give

$$E_c = (\gamma_v - 1) \vee_v c^2/v_e^2 = (\gamma_v - 1)c^3/d^6 = E_{qe}$$

or

$$\vee_v = [v_e/d^2][v_e c/d^4]$$

It is now necessary to take a step back to consider which velocities are being considered. In the kinetic energy formula there is only one velocity and the motional energy being considered is relative to this velocity. With the motional energy of charge, there are two components. One velocity v_I is how fast the electron is effectively moving on average as part of a current and the other velocity v_R is how fast the electron is able to move at in the material due to the limitations of the material. The two energies are the same, but the frameworks are different. The only way to solve this is to define that v_e^2 in the kinetic energy equation is equal to the product of the two velocities in the charge equation v_R and v_I, so that $v_e^2 = v_R v_I$. This does not say that the velocity of the electron is different to the velocity of the charge, only that the measurement of the velocity in the framework that is chosen decides which parameter is being measured. The result is that the formula for the voltage can now be written as

$$\vee = [v_R/d^2][v_I c/d^4]$$

and the two parts can be identified as the resistance $R_v = v_R/d^2$ and current $I_v = v_I c/d^4$ and the equation as Ohm's Law.

A worked example in both SI and DAPU units will serve to show that the equation is correct. If the circuit is of 240V with a current of 20A passing, the resistance must be 12 Ω. Simply expressed $240 = 20 \star 12(SI)$. The equivalent in DAPU units is a voltage of $1.39542 \times 10^{-32} \vee_{e*}$, a current of $3.0016 \times 10^{-22} i_{e*}$ and a resistance of $4.64886 \times 10^{-11} R_{e*}$. Now $1.39542 \times 10^{-32} = 3.0016 \times 10^{-22} \star 4.64886 \times 10^{-11}(DAPU)$ which again is correct.

Clearly it does not require DAPU units to arrive at these conclusions and the DAPU values here are more complex than the SI ones. But the underlying relationships between voltage, current and resistance are the velocities of the electrons, instantaneously or on average, together with the limitation of velocities inherent in the media, which are clearer in the DAPU format. It serves to show that it is the method of simplification that allows the core of relationships to be understood and easily manipulated. And by using DAPU units for calculation the relationships are direct and do not contain the current misalignments identified within SI units that bring with them the confusion produced by the $\sqrt{10^{-7}}$ and 6.501 factors, although the example given here does not mix mechanical and electromagnetic parameters, so is simple in any case.

Conclusions

This paper presents new ways of understanding the relationships between parameters. The novel insights and predictions include:

1 A self-contained and consistent new Planck unit set of maximal Q_* based parameters from which all observed values can be compared and easily combined in equations.

2 A self-contained and consistent new Planck unit set of electron charge-size based parameters, some of which are directly observable in experiments.

3 The interpretation of the gravitational constant G as a dimensionless ratio and its relegation from gravitational to permeability use, so that it represents a measure of the strength of interactions within materials not between masses,

the strength of charge versus gravity fields is due to the difference in size of the electron charge versus its mass, rather than any inherent difference in the strength of their interactions, and the elimination of the need to test the equivalence of gravitational and inertial masses.

4 That all parameters can be displayed in terms of only h and c for the Q_* parameter set and in terms of only h, c and d for the q_{e*} set (other than permeability and permittivity which have G content), which was previously considered impossible.

5 There exists a new hypothetical dimensionality analysis that can be used to describe parameter dimensions and to uncover any law of nature or any universal constants. All that is required to produce a law of nature is to create an equation where the dimensionalities are equal on both sides. To produce a constant of nature, aside from c, the minimum that is required is that it has Y^0 dimensionality.

6 That most Q_* and q_{e*} parameters can be described solely in terms of ratios of the R_k and K_j (and d for the Q_* set) and so will benefit from the precision of measurement of these two parameters.

7 That the experimentally observed value of R_k implies either that the velocity of a current within certain electromagnetic materials could be in excess of light speed, the patterns produced by subluminal physical objects could have a maximum velocity of c/d^2 or that such a minimum velocity is required in order to pass through those material. This is open to further experimental work to confirm which is the case.

8 That most electromagnetic parameters can be reinterpreted in terms of mechanical parameters. It requires a complete reinterpretation of what is understood by the terms magnetic inductance (acceleration), magnetic flux (mass), inductance (distance), current density (mass density) and other electromagnetic parameters.

9 That the reinterpretation of R_k and $K_j/2$ with their current excellent precision of measurement, should enable increased accuracy in the estimation of the values of other parameters and fundamental constants identified as novel composite functions of $R"_k$ and $K"_j/2$.

10 A universal method of discovering laws of nature that apply regardless of any stretching of parameter space. A unit with $q_e/Q_* \neq \sqrt{\alpha/2\pi}$ would still have the same relationships between parameters although the numerical values of the results would be different.

11 Physics can be better understood when stripped to its bare essentials and without the use of a system of SI units that are currently misaligned across the electromagnetic and mechanical parameters. By adjusting SI units to be self-consistent and consistent with DAPU units, greater clarity will ensue.

12 The two adjustments necessary to align and make SI units self-consistent and also consistent with the simplicity of DAPU units have been proposed.

This is a toolkit for providing a better understanding of the fundamentals of physics.

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