Conversion Factors for Physical Property Measurements In Different Rest Frames Using a Revised Version of Relativity Theory Based on the Uniform Scaling Method

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Abstract

The history of the development of the Uniform Scaling Method is reviewed. It has its beginning with the Law of Causality and Newton's First Law of Kinetics (Law of Inertia). On this basis it can be concluded that the rates of clocks do not change spontaneously, i.e. without the application of some external force. Since the ratio Q of the rates of any two such (inertial) clocks must therefore itself be a constant, it follows that whenever they are used to measure a specific time difference between two events, their respective results must always be in the same ratio: $\Delta t' = \Delta t/Q$. This relationship is referred to as Newtonian Simultaneity since it guarantees that if one of the clocks finds that the events occurred simultaneously ($\Delta t'=0$), the other must do so as well ($\Delta t=0$). A useful way to interpret Q is as a conversion factor between the different units of time employed in the two rest frames. If we assume that the value of the speed of light is the same in both rest frames, it follows that they must agree on the unit of speed, i.e. the conversion factor in this case is unity (Q^0). It therefore follows that the unit of distance must be exactly the same as for time, namely also Q. This claim of the Uniform Scaling Method is thus seen to be in direct contradiction to the length contraction tenet of Einstein's theory of relativity introduced in 1905. Experiments with accelerated electrons carried out by Bucherer in 1909 indicate that their inertial mass increase in direct proportion to $\gamma(v) = (1-v^2c^{-2})^{-0.5}$ (v is the speed of the electrons and c = 299792458 ms^{-1} is the speed of light in free space), the same ratio as observed for the periods of atomic lines by

Ives and Stilwell in 1938. Consistency therefore requires that the conversion factor for inertial mass is the same (Q) as for time.

Since inertial mass, time and distance are the three fundamental quantities on which all other physical properties are defined (mks system), it follows that the conversion factor for any other property must be an integral multiple of Q. An analogous set of definitions can also be justified for the corresponding conversion factors in the same two rest frames caused by gravitational effects. In this case the conversion factors are always integral multiples of the quantity S, which therefore plays as analogous role as Q in kinetic scaling. Since experiments with circumnavigating atomic clocks carried out in 1971 by Hafele and Keating found that the two types of effects are completely independent of one another, it is therefore useful to define a product Z of the corresponding Q and S factors for each physical property, including those that are used to define the results of electromagnetic measurements. These total conversion factors are stored in Tables 1 and 2 of the manuscript. They are shown to guarantee that if a physical law is valid in one of the rest frames, it will also hold in the other. This relationship allows for an Addendum to Galileo's Relativity Principle: The laws of physics are the same in all inertial rest frames, but the units in which their results are expressed can differ from one rest frame to another.

Keywords: Law of Causality, Clock-rate Corollary to Newton's First Law of Motion, Conversion Factors, Galileo's Relativity Principle (RP)

I. Introduction

The Uniform Scaling Method[1-3] is a product of a corollary of Newton's First Law of Motion (Law of Inertia)[1-3] which states that the speed and direction of a freely moving object (inertial system) will remain constant indefinitely so long as it is not subjected to an unbalanced external force. It is therefore wholly consistent with the Law of Causality; the latter holds that no interaction takes place spontaneously, but rather requires the introduction of such an external force in order for it to occur. The above corollary (Clock-rate Corollary or CRC) simply applies the Law of Causality to the rates of clocks.[2] It states that the rate of an inertial clock will remain constant indefinitely.

The connection between the CRC and Uniform Scaling is quite straightforward. It only requires recognition of the obvious fact that the ratio of the rates of any two inertial clocks must itself be a constant. What this means in practice is that when the value of a given elapsed time is measured by these clocks, the two results (Δt and $\Delta t'$) must always occur in the same ratio (Q), i.e.

$$\Delta t' = \Delta t/Q.$$

The latter equation has been assigned the name Newtonian Simultaneity.[4] This designation emphasizes that it requires that any pair of events which are found to occur simultaneously in one rest frame ($\Delta t'=0$) must also occur simultaneously ($\Delta t=0$) in any other rest frame. This consequence is perfectly consistent with the view of Newton and coworkers of the absolute simultaneity of all events throughout the entire universe. At the same time, it rules out the possibility of "relativistic non-simultaneity" espoused by Einstein[5] in his version of relativity theory published in 1905.

A useful way to interpret Newtonian Simultaneity is that it implies that each of the two observers employs a different unit of time in which to express their respective results; for example, if the unit of time in one rest frame is 1 s, the corresponding value in the other is Q s. Inherent in this interpretation is belief in the *objectivity* of measurement. In other words, the two observers are evaluating the same experimental result in any given case, but that their recorded results differ simply because they are each *inversely proportional to the respective unit they employ.*

II. Conversion Factors Between Accelerated Rest Frames

The question that arises after the above considerations regarding comparisons of measured times in different rest frames is whether analogous relationships can be found for other physical properties. A good place to start is with measurements of the speed of light in free space. Physicists have claimed for more than several centuries that the numerical value of the speed of light is the same in all rest frames. What this means is that the unit of velocity must be the same in all rest frames, whereupon one deduces that the corresponding conversion factor is always unity, in contrast to what has been concluded above for time differences.

It is clear, however, that changing the unit of time must result in a corresponding change in the speed of light, or for that matter, a change in the relative speed of any two objects. How can one make these two conclusions compatible with one another? There is a simple answer once one takes into account that speed is by definition a ratio of the distance traveled by the object/light to the corresponding elapsed time, namely the conversion factor for distance/length of objects must be exactly the same as for times (Q). Accordingly, when one converts the measured time ($\Delta t'$) and distance ($\Delta l'$) in one rest frame, it is simply necessary to multiply each of these values with Q, i.e. $\Delta t = Q\, \Delta t'$ and $\Delta l = Q\, \Delta l'$ to obtain the corresponding values in the other rest frame. This procedure leads automatically to the desired relation between the two measured values of the speed/velocity v of the object, namely $\Delta l/\Delta t = \Delta l'/\Delta t' = v$.

It is important to see the contrast between Einstein's original theory[5] and Universal Scaling. He recognized correctly that kinetic acceleration of the inertial clock is the direct cause of the change in the above time differences. This effect is referred to as *time dilation*. He assumed that the effect was symmetric,[6] however, whereas the Law of Causality and the CRC clearly indicate that it is asymmetric. He also claimed that two clocks can both be running slower than the other *at the same time*. Experiments with atomic clocks carried on board airplanes[7,8] have shown instead that it is always possible to distinguish which of two clocks is running slower/faster, in verification of the Newtonian Simultaneity relation. These results also show that Einstein's claim[5] of the relativistic non-simultaneity of any two events is untenable.[2]

Einstein's justification of both claims is the Lorentz transformation (LT).[5] On the same basis, it was claimed that the length of an object would be decreased upon acceleration (FitzGerald-Lorentz length contraction or FLC). It is easy to show that length contraction and time dilation are inconsistent with the other claim of the LT that the speed of light is unaffected by acceleration.[9] This would mean, for example, that an observer in a different rest frame would find that his value of the distance traveled by a light pulse is smaller at the same time that his corresponding elapsed time value would be greater. Since speed is defined as a ratio of the above two quantities, it is clear that both observers cannot agree on the value they obtain as the speed of light in this experiment, again proving that the LT and Einstein's theory are unphysical. On the other hand, Uniform Scaling claims that the ratio of the values of the measurements of distance and elapsed time is the same in both rest frames, in agreement with its prediction for the lack of any difference in their light speed value predictions.

Despite the problems with the LT and Einstein's theory, Lewis and Tolman[10] were able to combine it with the conservation of linear momentum principle to come up with what turned out to be a successful prediction regarding the effect of acceleration on the inertial mass of electrons. They concluded that the mass of the electrons increases with their speed v in direct proportion to $\gamma (v) = (1-v^2c^{-2})^{-0.5}$ ($c = 299792458\ ms^{-1}$ is the speed of light in free space). Bucherer[11] verified this prediction in 1909 by passing electrons through crossed electric and magnetic fields. On this basis it was shown that inertial mass has the same dependence on speed as the periods of atomic lines predicted in Einstein's theory.[5] The latter prediction was verified in 1938 by Ives and Stilwell.[12] More recently, it has been shown[13] that the successful prediction of Lewis and Tolman[10] is actually based on a faulty application of logic. This is an example of a case in which an accurate prediction can be obtained on the basis of a false premise.

In the context of Uniform Scaling, the main result of the above considerations is that inertial mass varies in direct proportion to elapsed times. Therefore, the conversion factor for inertial mass is also equal to Q, i.e. the same as for time and distance. It is also important to see that inertial mass, time and distance are *fundament*al properties. All other physical properties are simple products of these three quantities. Therefore, it can be concluded that the conversion factor for any property is an integral multiple of Q. For example, the unit of energy is equal to $1.0\ kgm^2/s^2$, as can be seen from the $E=mc^2$ relation. As a result, the conversion factor for energy is computed to have a value of $Q(Q^2)/(Q^2)=Q$. The conversion factor for speed has been obtained above as unity; this follows from the definition of speed as the ratio of distance to time, i.e. as Q/Q. As another example, consider the conversion factor for angular momentum; it has the dimensions of kgm^2/s, so its conversion factor is $Q(Q^2)/Q = Q^2$. The dimension of Planck's constant h is the same as for angular momentum in general, so its conversion factor is also Q^2. This result fits in perfectly with Planck's Law ($E=h\nu$),[14] where ν is the reciprocal of the time period and therefore has a conversion factor of Q^{-1}; therefore, scaling of this expression leads to a value of Q on the left-hand side and $Q^2/Q= Q$ on the right-hand side, which proves that Planck's Law is valid in both rest frames.

III. Conversion Factors For Gravitational Acceleration

There is an analogous framework for the effects of gravity on physical properties which is based on the parameter S.[15,16] The corresponding conversion factors for the three fundamental properties of inertial mass, time and distance are 1/S. 1/S and 1, respectively. The values for all other properties are based on their composition in terms of these fundamental properties. They are thus integral multiples of S. For example, the conversion factor for energy is obtained as S based on its dimensions of kgm^2s^{-2}, i.e. as $(1/S)1^2(1/S)^{-2}$. Since frequency is the reciprocal of the period of time, its conversion factor is $(S^{-1})^{-1}= S$ as well. To be consistent with Planck's Law, the corresponding factor for h and angular momentum must be unity (S^0). This value follows from its dimensions of kgm^2/s. i.e. as $(S^{-1})1^2/S^{-1}$.

One of the key results of the Hafele-Keating experiments with atomic clocks[7,8] was the finding that the effects of gravity and motion on the clocks could simply be added to one another to predict the actual change in clock rates. This shows unequivocally that the two effects can be treated independently from one another. This was an especially important result because it has often been claimed that gravitational theory cannot simply be painted onto Einstein's version of relativity theory,[5] i.e. that there was an essential mixing of the kinetic and gravitational effects.

The additivity principle is an essential feature of the Global Positioning System (GPS). It is assumed in the "pre-correction" procedure[17] used to ensure that the rates of atomic clocks carried on board orbiting satellites are the same as for those on the Earth's surface. The success of this navigation methodology therefore serves as an everyday verification of this principle. In terms of the Uniform Scaling Method, this means that the total conversion factor Z for a given property is simply a product of the corresponding kinetic and gravitational factors discussed above. These results are shown in Table 1 along with the mks composition for each property.

Table 1. Combined conversion factors Z for a comprehensive list of physical properties

Property	*mks Composition*	*Z*
Energy E	kgm^2s^{-2}	QS

Inertial mass m	kg	QS^{-1}
Time T	s	QS^{-1}
Distance X	m	Q
Frequency ν	s^{-1}	SQ^{-1}
Velocity/speed v	ms^{-1}	S
Angular momentum/h L	kgm^2s^{-1}	Q^2
Acceleration a/g	ms^{-2}	S^2Q^{-1}
Force F	$kgms^{-2}$	S
Torque τ	kgm^2s^{-2}	QS
Rotational Frequency ω	s^{-1}	SQ^{-1}
Gravitational mass μ	kg*	1
Power P	kgm^2s^{-3}	S^2
Gravitational Constant G	m^3s^{-2}	QS^2

There is an intimate connection between the Universal Scaling Method and Galileo's Relativity Principle (RP). The latter states that the laws of physics are the same in all rest frames. All such laws are mathematical equations. In the present context this means above all that the equations are balanced in terms of the units of the three fundamental physical quantities (kg, m and s in the mks system, for example.) The results in Table 1 show that there is a unique conversion factor (Z) for the measured values of each property measured in any pair of rest frames. As a result, the conversion factors themselves must be equal in the two sides. Consider the mass-energy equivalence relation as a prime example. Applying the relevant conversion factors in Table 1 to the values of E', m' and c which satisfy the $E'=m'c^2$ law in one rest frame leads to the corresponding results in the other as E=QS E' and $mc^2 =(Q/S)m'(Sc)^2$. Upon algebraic rearrangement, one therefore obtains $QS\,E' - (Q/S)m'(Sc)^2 = 0 = E-mc^2$. In other words, as long as $E'=m'c^2$, it follows that $E=mc^2$ in the other. Such a cancellation of the Q and S factors is inevitable given the unique relationship between physical properties and conversion factors provided for in the Uniform Scaling Method. The same effect must therefore also occur for any other physical law.

The Uniform Scaling Method therefore makes it possible to addend the RP in the following manner:[18] *The laws of physics are the same in all inertial systems, but the units in which they are expressed vary in a systematic manner from one rest frame to another.*

IV. Experimental Evaluation of the Conversion Factors

It is clearly necessary to know the values of the corresponding Q and S parameters in order to apply the Uniform Scaling Method to a given pair of rest frames. The experiments carried out with atomic clocks by Hafele and Keating[7,8] provide a clear path to accomplishing this objective on a general basis. Their study showed that the elapsed time for a portion of the flight varies in inverse proportion to $\gamma (v) = (1-v^2c^{-2})^{-0.5}$, where v is the speed of the clock relative to the Earth's center of mass (ECM). The corresponding relation for the times Δt' and Δt obtained by two such clocks moving at respective speeds v and v' relative to the ECM is therefore:

$$\Delta t' \gamma (v') = \Delta t \gamma (v).$$

The same relationship can be used quite generally under different circumstances provided the speeds v and v' are measured relative to a particular rest frame in each case. The latter is referred to as the Objective Rest System or ORS.[19] The above equation is therefore referred to as the Universal Time-Dilation Law (UTDL).[20]

The parameter Q has been defined in terms of the Newtonian Simultaneity relation: $\Delta t' = \Delta t/Q$, as discussed in the Introduction. Combining this relation with the UTDL therefore leads to the result:

$$Q= \gamma (v')/\gamma (v).$$

It is clear, however, that this definition only holds if the ORS is the same for both clocks. Nevertheless, if there are two clocks with different ORSs, the UTDL can still be used to evaluate Q by employing it separately for each of the clocks and combining the results. For example, it is possible in this manner to evaluate Q for an observer on the Earth's surface for a clock which is orbiting the Moon. The effect of time dilation for a clock stationed on the Moon relative to one located on the Moon's surface needs to be combined with the corresponding effect for the slowing down of the latter clock relative to one located on the Earth's surface. In effect, one has two conversion factors Q_1 and Q_2, the product of which is the total factor Q.

In applying the Uniform Scaling Method, it is necessary to designate which is the rest frame of the object of the measurement and which is the rest frame of the observer. In the above notation the object's properties such as its speed relative to the ORS are shown with a prime (v') while those of the observer are unprimed (v). If the same event is seen from the opposite perspective, the conversion factor must be the reciprocal of that in the original arrangement. This is in keeping with the relationship of the conversion factors in other common situations such as between currency values, i.e. the conversion factor to change dollars into cents is 100, whereas the corresponding factor to convert the amount into dollars is 1/100= 0.01. The above expression for Q satisfies this reciprocal principle automatically, since role reversal leads to a value of $Q' = \gamma(v)/\gamma(v') = 1/Q$. This state of affairs in an essential requirement for considering Q to be a conversion factor in the context of general physical measurements.

The conversion factor used in comparing properties measured at different gravitational potentials is defined in the HK experiments[7,8] to be $S=1 + gh/c^2$, where g is the local acceleration due to gravity defined in the Newtonian theory to be Gm_0/r^2, where G is the Universal Gravitation Constant (6.67×10^{-11} $kg^{*-1}m^3s^{-2}$, h is the distance in m separating the object from the center of the active mass and m_0 is the value of the active gravitational mass in kg* (which scales as 1; see Table 1). The above value for S was first used in Einstein's 1907 paper in which he introduced the Equivalence Principle.[21] This definition for S is used in the HK interpretation of its atomic clock results and is also used in the GPS evaluation of the pre-correction factor for adjusting the rates of atomic clocks prior to launching them into orbit.[17]

There is a more general definition for cases in which the g factor is not uniquely defined, however. It makes use of the factor $A_i=1+Gm_0/c^2r_i$, which plays a similar role as $\gamma(v)$ in determining the value of the kinetic factor Q. Accordingly, $S=A_o/A_p$, where o refers to the observer's rest frame and p is that of the object of the measurement. It reduces to $1+gh/c^2$ in the case where r_o is not greatly different than r_p. The more general version clearly satisfies the aforementioned requirement that the conversion factors for role reversal are the reciprocal of one another. i.e. $S' = A_p/A_o = 1/S$.

Two examples will be considered to demonstrate the application of the conversion factors in Table 1. The first is the equation from Newton's classical gravitational theory, E=mgh. The conversion factor for energy is QS whereas the corresponding factors for mass m, acceleration g and the distance h are Q/S, S^2/Q and Q, respectively, the product of which is also QS. This demonstrates that the observers at the two potentials agree on the validity of this equation. The second example concerns the definition of the parameter $A_i = 1+Gm_0/c^2r_i$ needed to define the value of the key parameter S. The numerator Gm_0 in the fraction on the right-hand side scales as S^2Q, which is the product of unity for the gravitational mass and S^2Q for G. The corresponding denominator is c^2r_i, which also scales as S^2Q (S^2 for c^2 and Q for r_i), the same as for the numerator. Thus the ratio of the two scale factors on the right-hand side is unity, as required in order to ensure that A_i is dimensionless and therefore has the same value for both observers.

V. Extrapolation of the Scale Factors

It is interesting in the context of the above discussion that a key assumption of the Newtonian classical theory is that the speed of light is not finite. It is clear that each of the γ (v) and A_i quantities can only have only unit values in this case, whereupon it is equally obvious that none of the Q and S factors, which play a key role in the Uniform Scaling Methodology, would have other than unit values either, thereby rendering the entire development to be useless as a consequence. It was necessary to achieve a significant level of sophistication before it became possible to demonstrate experimentally that conversion factors not equal to unity actually occur in nature; however, even at the present time it is still true that the corresponding Q and S values do not greatly differ from unity in any practical example.

One of the advantages of Uniform Scaling is that it allows one to reasonably consider possibilities in which the pertinent conversion factors far exceed unit values. For the A_i value to fall in a suitable range, it would be necessary to access rest frames in which the distance r_i from the pertinent center of mass is far too small for there to be any conceivable expectation of carrying out experiments there.

The situation is different for the γ (v) factors, however. One can imagine a spaceship travelling at close to the speed of light in free space as viewed by an observer located in a stationary position on the Earth's surface. If the speed v is 0.99c, for example, the value of

$Q=\gamma$ (v) is approximately 7.0. On the basis of the results of Table 1, the Earth observer would find that lengths of standard objects located on the spaceship would have 7 times their original value. The spaceship itself would have a volume which is $7^3 = 343$ times greater than when it stood motionless on the launch pad prior to liftoff. Clocks located on the spaceship would now be running at only 1/7 their original rate.

A related example has been reported in earlier work[22] in which details of the blood circulation of a human who is being transported at a high rate of speed was examined. It is found on the basis of Uniform Scaling that the time for one complete passage of the blood would be considerably increased even though the speed of the blood circulation is unchanged relative to its normal value. The reason for this is because, by virtue of the acceleration, the distance that needed to be traversed is greater by the same fraction.

Next consider the situation from the vantage point of an observer on the spaceship. The value of the conversion parameter (see Table 1) relative to the Earth's rest frame is Q=1/7, i.e. the reciprocal of the value in the opposite direction. For him, the time that it takes for the Earth to make a full rotation around its axis is therefore only 24/7 hours = 207 min! The speed of the rotation has nonetheless the normal value, but this is because the circumference of the Earth is also only 1/7 of what is measured in the rest frame of the Earth. In addition, the observer on the spaceship measures the time it takes for the Earth to make a complete circuit in its orbit around the Sun is only 1/7 y = 53 days. In general, it appears to him as though the universe itself has shrunk by the same factor, even though nothing whatsoever has actually changed since he was accelerated to the speed of 0.99c relative to his original launch position on the Earth's surface.

This whole situation has much in common with the fantastical story of "Alice and Wonderland" penned by Lewis Carroll, a professor at Oxford University in England, in 1865.

In the story Alice suddenly finds that she is much taller than the people standing around her.

The fact seemingly anticipated by Carroll is that people can change their dimensions by large amounts, in agreement with what the Uniform Scaling Methodology claims. In reality, people never notice anything unusual in this case, however, because everything around them changes in exactly the same proportion. All we can do is compare lengths with other objects in our environment, so it is always completely impossible for us to see any difference in our own rest frame under this circumstance. The truth is that we are constantly changing our dimensions as we hurtle through space while located on the Erath's surface, but our standard of length appears to be perfectly constant in the process because it is changing in exactly the same ratio.

There are many other surprises for the observer on the spaceship other than differences in his measurement of time and distances. According to the results of Table 1, the acceleration due to gravity on the Earth's surface will be 7 times *greater* than what is measured on the Earth's surface, i.e. ca 70 ms^{-2}. This is because g scales as Q^{-1} just as all acceleration values. The inertial mass m of a given object scales as Q, however, and so the weight, which is a product of the m and g, is measured to be the same in both rest frames. This is consistent with the fact that weight is a type of force and therefore scales as $Q^0=1$.

Atmospheric pressure is a ratio of force to area and therefore is $49=7^2$ times larger, i.e. it scales as $1/Q^2$. The specific gravity of water is equal to the ratio of mass to volume and therefore scales as $Q/Q^3=1/Q^2=49$ as well. Since energy scales as Q, the observer on the spaceship will find that the amount of heat necessary to boil a certain amount of water on the Earth's surface is only 1/7 of its normal value. The corresponding temperature is still 373 ^oK, however, because Boltzmann's constant k scales in the same manner as energy.

VI. Scale Factors for Electromagnetic Properties

Applications of the Uniform Scaling Method outlined above rely on the fact that physical properties can be expressed in units of the three fundamental quantities of inertial mass, distance and elapsed time, for example in the standard mks system. The relevant conversion factors for a given property can therefore be uniquely defined in terms of the kinetic (Q) and gravitational (S) factors for observers in any pair of rest frames.

The situation is not so simple when it comes to the properties describing electromagnetic interactions, however. There one commonly expresses experimental results in units of electric charge (Coulomb) and magnetic field ($Weber/m^2$). The Georgi system of electromagnetic units[23] was introduced in 1901 to ensure that the results of electromagnetic calculations can ultimately be expressed in the mks system of units. It has been pointed out in previous work,[24,25] however, that there is an ambiguity in the definitions of electromagnetic forces which allows one to assign alternative units to properties such as electric charge that fall directly in the mks system. Such an example is found in the definition of the Coulombic force $F = q^2/\varepsilon_0 r^2$, where q is the value of the electric charge in Coulomb and ε_0 is the permittivity of free space, which is given in the unit of Coulomb^2/Nm^2. As a consequence, the q^2/ε_0 ratio must be given in the Nm^2 unit for Fr^2 in the mks system. This leaves open the possibility to assign the unit of electric charge in an infinite number of ways and still satisfy the above constraint, for example, Nm=J. In this case, it is necessary for the unit of N be assigned to ε_0. Such an assignment is quite advantageous for the Uniform Scaling Methodology, since it causes the unit on both sides of the equation for the Coulomb Force to be N. Uniform Scaling can then be carried out in the standard manner on the basis of Table 1. The corresponding unit for q^2 is thus (Nm)^2, which therefore scales as (QS)^2, while that for $\varepsilon_0 r^2$ in the denominator is the same as for Nm^2, namely SQ^2; the ratio is therefore S, the same as the conversion factor for force as required. In other words, if the Coulomb Force relation holds in one of the two rest frames, it must also hold in the other.

Similar assignments can be made for all other electromagnetic properties, as shown in Table 2, which guarantee that all other laws of electromagnetism can be satisfied in both rest frames. For example, consider the Lorentz Force relation F= qE + qvB. The electric field $E = q/\varepsilon_0 r^2$ must be assigned the unit of m^{-1} to be consistent with all previous definitions; the corresponding conversion factor for E is therefore Q^{-1}. At the same time, the unit for the magnetic field B must be s/m^2 in order for qvB to have the unit of force N; the conversion factor for B is thus (QS)$^{-1}$, as shown in Table 2. The mks unit for the magnetic permittivity μ_0 can be deduced from the law of Biot and Savart[26]: $\varepsilon_0 \mu_0 c^2 = 1$. It is seen to be s^2/Nm^2, and therefore the corresponding conversion factor is S^{-3}. This assignment is consistent with the definition of the magnetic intensity H, which has the unit of Amp/m in the Georgi system (Amp=Coul/s). As a result, B= μ_0 H. Therefore, the conversion factor for H is S^3/QS = S^{2}Q^{-1}, which in turn is consistent with the conversion factor for Amp of S^2, i.e. QS/(Q/S). Finally, consider the differential form of Faraday's law of electromagnetic induction: curl E = $-\partial B/\partial t$. The mks unit for curl E is m^{-2}, whereas that for the partial derivative on the other side is (s/m^2)/s, i.e. also m^{-2}; the conversion factor on both sides is therefore Q^{-2}.

Table 2 contains a collection of other results for various electromagnetic quantities. Given are both the Georgi unit and the corresponding mks unit, as well as the conversion factor.

A more comprehensive list of electromagnetic properties is contained in Table D1 of ref. 25.

Table 2. Combined conversion factors Z for various electromagnetic properties

Property	*Georgi units*	*mks units*	*Z*
Electric Charge q	Coulomb	Nm	QS
Permittivity ε_0	Coulomb^2/Nm^2	N	S
Current	Amp	NM/s	S^2
Electric Field E	Coulomb/Nm^2	m^{-1}	Q^{-1}
Permeability μ_0	N/Amp^2	s^2/Nm^2	S^{-3}
Current Density J	Coul/m^{2}s	N/ms	S^2Q^{-2}
Magnetic Field B	Weber/m^2 (Tesla)	s/m^2	$(QS)^{-1}$
Magnetic Intensity H	Amp/m	N/s	S^2Q^{-1}
Potential V/emf	Volt	_	1
Resistance/Impedance	Ohm	s/Nm	S^{-2}
Magnetic Scalar Potential	Amp	Nm/s	S^2
Magnetic Vector Potential	Weber/m	s/m	S^{-1}
Electric Dipole Moment μ	mCoul	Nm^2	Q^2S
Magnetic Dipole Moment M	m^{2}Amp	Nm^3/s	Q^2S^2
Inductance L	Henry	s^2/Nm	QS^{-3}
Magnetization M	Weber	s	QS^{-1}
Admittance Y	Mho	Nm/s	S^2
Reluctance *R*	Amp/Weber	Nm/s^2	S^3Q^{-1}
Conductivity g	Coul/msVolt	N/s	S^2Q^{-1}
Volume Charge Density ρ	Coul/m^3	N/m^2	SQ^{-2}

Surface Charge Density σ	$Coul/m^2$	N/m	SQ^{-1}
Capacitance C	Coul/Volt	Nm	QS
Coeff. of Potential p_{ij}	Volt/Coul	1/Nm	$(QS)^{-1}$
Polarizability a	m^2Coul/Volt	Nm^3	SQ^4

VII. Conclusion

Experimental investigations have shown unequivocally that the rates of clocks decrease when they are accelerated due to an external force. This "time dilation" effect was predicted by Einstein in his landmark 1905 paper on the basis of the Lorentz Transformation. In particular, he claimed that the effect was *symmetric* in character, i.e. that two clocks in motion could both be running slower than one another at the same time. The Hafele-Keating experiments with circumnavigating atomic clocks contradicted the latter claim, however. In addition, it has been shown that the Lorentz Transformation is not internally consistent (Clock Riddle) and is therefore proven to be physically invalid. It claims that the distance travelled in an experiment to measure the speed of light on a moving train can be smaller (length contraction) for an observer located on the station platform while the corresponding elapsed time is greater (time dilation) even though the two observers nonetheless agree on the value of the light speed itself, something which is clearly impossible.

It has more recently been pointed out that Newton's First Law of Motion, namely that the speed and direction of an object will not change without the application of some external force, leaves open the possibility of *asymmetric* time dilation. The First Law is clearly consistent with the Law of Causality. A corollary (Clock-rate Corollary) can be deduced on the same basis which maintains that the rates of clocks will not change spontaneously, i.e. also without the application of some external force. This leads to an additional conclusion that the *ratio* Q of the rates of any two such (inertial) clocks must itself be a constant. As a consequence, when the two clocks are used to measure a given elapsed time, their respective values (Δt and $\Delta t'$) will always be in the same proportion as the rates themselves. This proportionality relationship, i. e. $\Delta t' = \Delta t/Q$, is referred to as Newtonian Simultaneity because it forces the conclusion that if one observer determines that two events occurred spontaneously ($\Delta t'=0$), the other must do so as well ($\Delta t = 0$).

A quite useful way to interpret the parameter Q in the Newtonian Simultaneity relation is as conversion factor between experimental timing results obtained in the two rest frames. Another way of framing this is to say that the respective unit of time differs by this factor. It is interesting in this context to see that the speed of light is assumed to have the same value c in all rest frames. This assumption is used in the interpretation of the results of the Ives-Stilwell experiment. This fact raises the obvious question as to how the unit of time can differ in the two rest frames without affecting the value of the speed of light. The simple and unique answer is that the unit of distance must vary in exactly the same manner as the unit of time, i.e. the conversion factor must also be equal to Q in this case. Specifically, the length of an object must increase in the same proportion as elapsed times increase whenever acceleration occurs. This expectation is verified by the fact that the wavelength of light is found to be γ (v) times larger in the laboratory than the value for the light emitted from the accelerated source in its rest frame.. The Uniform Scaling Method therefore assumes accordingly that the conversion factors for time, distance and *relative* speed are Q, Q and $Q^0=1$, respectively.

These choices can be considered in connection with the experimental data obtained by Bucherer in 1909 for variation of the inertial mass of electrons accelerated in crossed electric and magnetic fields. They show that the electronic mass increases in direct proportion to γ (v), the same behavior as observed for the lifetimes of clocks. On this basis, one is led to conclude that the conversion factor for inertial mass is also Q. The conversion factors for all other physical properties can then be determined on the basis of their composition in terms of the three fundamental properties: distance, inertial mass and time. As a consequence, each of these factors is an integral multiple of Q.

An analogous set of conversion factors is available for pairs of rest frames which differ in their position in a gravitational field. The groundwork for this aspect of Universal Scaling was laid by Einstein in 1907 on the basis of his Equivalence Principle. In this case all the factors are integral multiples of the parameter $S= 1+gh/c^2$. It is a product of Einstein's $E=mc^2$ relation and of Newton's classical version of gravitational theory, i.e. E = mgh, where g is the local acceleration due to gravity and h is the distance separating the two rest frames. This value of S is only valid for relatively short separations. The universally applicable definition of S is given in terms of the quantity $A_i = Gm_0/c^2r_i$ (G is the Universal Gravitation Constant, m_0 is the active gravitational mass (such as for the Sun, for example) and r_i is the distance separating the object (such as the Earth) from the center of the active mass. The parameter A_i in this case serves the analogous purpose as γ (v) for kinetic scaling. The value of the generic scaling factor is defined as $S= A_o/A_p$, where o and p refer to the respective rest frames of the observer and the object, respectively. It should be noted that "role reversal" of the two rest frames leads to a reciprocal value of the original factor in both cases, i.e. Q'= γ (v) γ (v') = 1/Q and $S'= A_p/A_o=1/S$, thereby simulating the expected relationships found between conversion factors in everyday applications.

The gravitational scale factors for the fundamental properties of inertial mass, time and distance are 1/S, 1/S and $S^0=1$, respectively. The values for the gravitational scale factors of other properties can be deduced on the basis their composition in terms of the latter fundamental properties, as is the case for the corresponding kinetic conversion factors.

The experiments with atomic clocks on airplanes have shown that the two types of effects are *independent* of one another. Consequently, each of the total conversion factors is simply a product of the corresponding kinetic and gravitational factors. Many examples are given in Tables 1 and 2 and the products are designated by the letter Z therein. These include results for electromagnetic properties; for example, Z=QS for electric charge. Because of the close relationship between the Z conversion factors and the mks composition of each property, it follows that the laws of physics that hold in one rest frame will also be satisfied in the other. This behavior is therefore perfectly consistent with Galileo's Relativity Principle RP), since each law of physics must be balanced in terms of the physical units which it contains.

The overarching assumption of the Uniform Scaling Methodology is that there is a unique relationship between each pair of rest frames in the universe. This relationship is defined in terms of two fundamental parameters (S and Q) which enable one to convert the result for any physical quantity in one of the rest frames to the corresponding value in the other. The underlying basis for this method is the belief in the objectivity of measurement, that is, that everyone obtains the same *absolute* value for any measurement, but that differences in the respective *numerical* values of two observers arise (aside from actual errors in the measurement, of course) from the fact that different units are used to express their respective findings.

References

1. R. J. Buenker, *Relativity Contradictions Unveiled: Kinematics, Gravity and Light Refraction (*Apeiron, Montreal, 2014), pp. 58-60.

2. R. J. Buenker, "Proof That the Lorentz Transformation Is Incompatible with the Law of Causality," *East Africa Scholars J. Eng. Comput. Sci.* **5 (4),** 53-54 (2022).

3. R. J. Buenker, "The Many Flaws of the Lorentz Transformation," *East Africa Scholars J. Eng. Comput. Sci.* **6 (2),**(2023).

4. R. J. Buenker, "Clock-rate Corollary to Newton's Law of Inertia," *East Africa Scholars J. Eng. Comput. Sci.* **4 (10),** 138-142 (2021).

5. A**.** Einstein, "Zur Elektrodynamik bewegter Körper," *Ann. Physik* **322 (10),** 891-921 (1905).

6. R. J. Buenker, "Experimental Refutation of Einstein's Symmetry Principle," *East Africa Scholars J. Eng. Comput. Sci.* **6 (1),** 1-8 (2023).

7. J. C. Hafele and R. E. Keating, "Around-the-world atomic clocks: predicted relativistic time gains," *Science* **177**, 166-168 (1972).

8. J. C. Hafele and R. E. Keating, *Science* **177**, 168-170 (1972).

9. R. J. Buenker, "Incompatibility of FitzGerald-Lorentz Contraction and Time Dilation," *East Africa Scholars J. Eng. Comput. Sci***. 6 (4)**, 48-49 (2023).

10. G. N. Lewis and R. Tolman, *Phil. Mag.* **18**, 510 (1909).

11. A. H. Bucherer, *Phys. Zeit.* 9, 755 (1908).

12. H. I. Ives and G. R. Stilwell, "An experimental study of the rate of a moving clock," J*. Opt. Soc. Am.* **28**, 215-226 (1938); **31**, 369-374 (1941).

13. R. J. Buenker, *Relativity Contradictions Unveiled: Kinematics, Gravity and Light Refraction (*Apeiron, Montreal, 2014), pp. 76-81.

14. M. Planck, "Über das Gesetz der Energieverteilung im Normalspectrum," *Annalen der Physik* 309(3), 553-563 (1901).

15. R. J. Buenker, "Gravitational and kinetic scaling of physical units," *Apeiron* **15***,* 382-413 (2008).

16. R. J. Buenker, *Relativity Contradictions Unveiled: Kinematics, Gravity and Light Refraction (*Apeiron, Montreal, 2014), pp. 113-120.

17. C. M. Will, *Was Einstein Right?: Putting General Relativity to the Test.* 2nd ed. (Basic Books Inc; New York, 1993), p. 272.

18. R. J. Buenker, *Relativity Contradictions Unveiled: Kinematics, Gravity and Light Refraction (*Apeiron, Montreal, 2014), pp. 58-60.

19. R. J. Buenker, "Time dilation and the concept of an objective rest system," *Apeiron* **17**, 99-

125 (2010).

20. R. J. Buenker, *Relativity Contradictions Unveiled: Kinematics, Gravity and Light Refraction (*Apeiron, Montreal, 2014), p. 50.

21. A. Einstein, *Jahrb. Radioakt. u. Elektronik* **4**, 411 (1907).

22. R. J. Buenker, "The giant twin's travels," *Galilean Electrodynamics* ***27,*** 50-53 (2016).

23. J. R. Reitz and F. J. Milford, *Foundations of Electromagnetic Theory* (Addison-Wesley, Reading, Massachusetts, 1960), p. 23.

24. R, J, Buenker, "Expressing the units of electricity and magnetism directly in the mks system," *J. Found. and Applic. Phys.* **2**, 11-16 (2015).

25. R. J. Buenker, *Relativity Contradictions Unveiled: Kinematics, Gravity and Light Refraction (*Apeiron, Montreal, 2014), pp. 207-211.

26. J. R. Reitz and F. J. Milford, *Foundations of Electromagnetic Theory* (Addison-Wesley, Reading, Massachusetts, 1960), p. 152.