FUNDAMENTAL TRUTH AND UNITS OF PHYSICS

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Are systems of units equally valid in so far as learning about the operation of the universe? The answer is: Not necessarily. There are two reasons why different systems will have differing degrees of usefulness. One reason is that each system of units is inherently dependent upon the theory within which it is derived. If important fundamentals of the theory change, then, some units may also need to change. All systems of units can be expected to perform well within the purview of the theory within which they are derived. However, they will not work equally well outside of those confines. They will not each extend successfully into new theory. They will not be equally suited for use in deriving a unified theory. The second reason is that the method by which a constant of proportionality is defined determines its extent of usefulness.

The following example demonstrates both of these limitations. During the derivation of my theory, an equation appeared that promises to link disparate parts of theory into a single unified theory. It is:

$$h = keC$$

Where:

$$h = Planck's\ Constant = 6.625x10^{-34}\ (joules \cdot sec)$$

$$k = Boltzmann's\ Constant = 1.38x10^{-23}\ \left(\frac{joules}{molecule \cdot {}^{\circ}Kelvin}\right)$$

$$e = electron\ charge = 1.602x10^{-19}\ coulombs$$

$$C = speed\ of\ light = 2.998x10^{8}\ \frac{meters}{sec}$$

Clearly the units for this unlikely equation do not match. The inability of the *mks* system to show meaning for this equation will help to demonstrate the theoretical limitations of systems of units. This contradiction in units cannot mask the remarkable fact that the arithmetic values form equality. The equation holds very closely for the empirical values of these properties as determined in the mks system of units. However, it will not work in a system of units where proportionality constants in electromagnetic theory are set equal to unity. The different approaches cause the difference in results.

Proportionality constants are generally derived by the use of two methods. One approach determines constants of proportionality by empirical means. This method has the ability to separate out values of fundamental physical properties. The second approach, for the purpose of convenience and mathematical simplicity, sets some proportionality constants equal to unity. This second method works against revealing new physical truths.

For the anomalous equation given above, it makes a great difference in how the value of electric charge is determined. Electric charge needs to be determined by direct reference to empirical evidence. It should not be determined by the use of methods that place a priority on convenience in calculation. The direct reference approach is used in the mks system.

Newton's equation for force is a simple example by which to demonstrate the limitations of theoretical systems of units. The equation is:

$$f = ma$$

There are two operations represented in the equation. One is the arithmetic manipulation of equal quantities. The other is the transformation, as in transform equation, of units of measurement. These units in the mks system are newtons, kilograms, meters and seconds. For example:

$$6\, newtons = 2\, kilograms\, \frac{3\, meters}{sec^2}$$

This equation says 6 newtons of force equal 2 kilograms of mass times a change of velocity of 3 meters per second squared. The arithmetic operation is the multiplication of magnitudes. However, the equation is written to represent a fundamental physical property called force. It includes theoretical interpretation.

The existence of distance and time is empirical knowledge. Length and duration of time are things we experience directly. However, the other two units in the equation represent theoretical interpretations. We know there is a cause called force, but the nature of force is unknown. We also know that objects exhibit different degrees of resistance to force. This resistance to force is assigned the name *mass*. The nature of mass is also unknown. Everything offered to explain either of them is theoretical conjecture. This conjecture includes the units of measurement assigned to each of them.

The only units directly based upon empirical knowledge are distance and time. All empirical data comes in measures of distance and time. We are safe to assign unique units to distance and time. There is no directly observable physical method of finding a dependency between distance and time. Units of distance and time are not combinable. In other words, there is no way to divide units of seconds into units of meters. They are naturally incompatible. They are fundamentally different properties of the universe. Theoretical interpretations such as space-time are not applicable here. We cannot handle and examine either space or time.

This problem of disunity between space and time does not represent disunity in our analysis of the operation of the universe. Our study of the universe concerns only physical entities and physical events. What we examine is the motion of objects. We measure their motion with respect to the motion of other objects. We say an object moved a certain distance with respect to a unit of time, but the unit of time is not directly representative of real time. It always means with respect to a tick of a clock or some other repetitive action that involves physical movement.

We use physical change to measure durations of other physical changes. We do not have to prove a physical or material existence for time in order to include change in our interpretations of the universe. The point is that even though we carry seconds along in our mathematical equations, we are not trying to work with time as if we know its nature. We are instead working with *change as exhibited by objects*. We know directly the empirical value of change. Change of velocity of objects is the essence of the material interpretation of the universe.

In the equation $f = ma$, the use of acceleration does not introduce fundamental disunity. However, the introduction of unique units for force and mass does introduce theoretical disunity. Every idea that reaches beyond our knowledge of relative measurements of distance and time, by means of observing objects, is theoretical. For this reason, when unique units are assigned to either force or resistance to force, they are representative of theoretical guesses.

It is useful, in the beginning stages of developing theory, to assign temporary units wherever our understanding is blocked by lack of knowledge. Temporary units have given rise to a great deal of useful theory. However, this human imposed theoretical disunity must be recognized for its artificiality with the intent of correcting it as soon as our knowledge permits. Theory is not the basis upon which we should rely to discover the true nature of the universe. Theory is inherently artificial. Yet theory, especially at the fundamental level, has been inappropriately allowed to acquire the status of fundamental truth.

The way in which this begins is with the early theoretical interpretations of force and resistance to force. Their interpretations are the beginning of theory. This introduction of theory at the beginning forms a questionable basis for additional theoretical analysis. It has become so enmeshed into higher-level theory that the interpretations of these two fundamental properties cannot be changed without changing almost everything else. The great usefulness of higher-level theory makes it seem that the fundamentals must be correct. We must remember the very weak basis upon which their theoretical definitions were formed.

While it is apparent that neither force nor resistance to force can be equivalent to acceleration, it is not known that they cannot be expressed in terms of units of distance and time. We do not know that this is the case, because, we do not know the natures of force and resistance to force. It would be far more preferable to learn to express them in a manner consistent with their empirical measurements. After all, that is the extent of what we know about them. However, it has been the practice for a long time that, in order to proceed with theory, it is necessary to arbitrarily assign unique units to both force and resistance to force.

While this step is useful for allowing theory to move off of a dead spot, it is risky to depend upon it for the development of higher-level theoretical interpretations. It is not representative of real knowledge about the fundamental nature of the universe. We do not know what force is or what resistance to force is; therefore, we do not have empirically based units that arise naturally from empirical measurements. Instead, the assignment of units such as kilograms and newtons has introduced theoretical incompatibility between force, resistance to force and acceleration. In other words, newtons are not the same thing as kilograms times meters per second squared.

The problem with this approach is that the equation sets up numerical equivalency between two otherwise incompatible interpretations of the operation of the universe. The equation becomes a transform equation between types of units. This transformation process is not completely arbitrary. There is consistency designed into systems of units. The definitions of units are made consistent by virtue of defining some of the units as being dependent upon others. For $f = ma$

the units of meters, seconds and kilograms are unique, i.e. indefinable, but the units of newtons are defined in terms of the other three.

Another choice in the formation of $f = ma$ is: Force is defined without the use of a constant of proportionality. If there were such a constant the equation would take the form $f = kma$. The appearance of constants of proportionality is common in higher-level theory. However, there is often a presumption of arbitrariness about such constants. For matters of mathematical convenience, it is sometimes the practice to define equations in such a way as to eliminate the need for such a constant. Its value is set equal to the number one. It is the practice to not show it in the equation.

There does not appear to be any empirical information that would cast doubt on the merit of this practice for Newton's equation. However, in some systems of units this practice is applied to higher-level theoretical equations such as Coulomb's Law. I have chosen to use the mks system of units because there is a constant of proportionality. It will be shown that it plays an important role beyond establishing proportionality. Expressing Coulomb's Law, for two equally charged particles, in the mks system:

$$f = k\,\frac{qq}{r^2}$$

The constant k is found by experiment to be:

$$k = 8.987x10^9\ \frac{newton \cdot meters^2}{coulomb^2}$$

This constant must be found experimentally because: The units of force f, charge q and distance r in the mks system are defined independently of Coulomb's Law.

Electric charge in the mks system is defined as: One coulomb is the quantity of charge passing through a section of a conductor in which there is a constant current of one ampere. In other words, the definition of electric charge is referenced to the definition of current. The unit of current, the ampere, is defined as: That constant current when present in each of two parallel conductors of infinite length and one meter apart in empty space causes each conductor to experience a force, per unit length of the conductor, of exactly:

$$\frac{f}{l} = 2x10^{-7}\ \left(\frac{newtons}{meter}\right)$$

The point is that current is referenced to the fundamental properties of force and distance, while electric charge is, in turn, referenced to current. It is important to recognize that current is defined in terms of an empirical measurement involving force and distance. This act references the measurement of current to two true fundamental properties. There are just four fundamental properties. They are force, resistance to force, distance and time. Even though the numerical choices in the definitions of measurement of those four properties are arbitrarily chosen, the relationships that are developed are firmly based upon fundamental patterns established by empirical evidence. When these properties are relied upon for further derivations, then fundamental truth moves its way into higher-level theory.

The value of force used to measure current also cannot be arbitrary. It has a value that is required by the definitions of electric permittivity and magnetic permeability. These two are other constants of proportionality from electromagnetic theory. Magnetic permeability is assigned the value:

$$\mu = 4\pi x 10^{-7}\ \frac{newtons}{meter}$$

This move takes on the appearance of being an arbitrary assignment; however, it is not arbitrary. It is a value that uniquely fills in a missing value that satisfies the wave equation. The general form of the wave equation is:

$$\frac{d^2P}{dt^2} = v^2\ \frac{d^2P}{dx^2}$$

This relation holds for all mediums be they gaseous, liquid or solid. The velocity of the wave is v. There are specific forms of this equation for an electromagnetic wave. They are:

$$\frac{d^2H}{dt^2} = \frac{1}{\mu\varepsilon}\ \frac{d^2H}{dx^2}$$

Where, H is the magnetic field component. For the electric field the equation is:

$$\frac{d^2E}{dt^2} = \frac{1}{\mu\varepsilon}\ \frac{d^2E}{dx^2}$$

Where, E is the electric field component.

The wave velocity is:

$$\frac{1}{\mu\varepsilon} = C^2$$

In the mks system, the reciprocal of the qualities of μ and ε must, therefore, equal the square of the speed of light. The electrical permittivity ε is found by experiment. The value of magnetic permeability μ is then not arbitrary. The value of μ must satisfactorily substitute into the equation:

$$C = \left(\frac{1}{\pi\varepsilon}\right)^{\frac{1}{2}}$$

This value of electrical permittivity must also work properly in:

$$\frac{f}{l} = \frac{\mu_0}{4\pi}\ \frac{2\, i_1 i_2}{d}$$

Where i_1 and i_2 are the currents in each of the conductors and d is the distance between them. The currents are both set equal to one ampere of current and the distance between is set at one meter. Substituting these values into the equation along with the defined value of μ_0 yields the value:

$$\frac{f}{l} = 2x10^{-7}\ \frac{newtons}{meter}$$

Therefore, this value of force per unit length is required in the definition of one ampere of current.

Because of the direct empirical support for all other terms in Coulomb's equation, the proportionality constant must represent the fundamental physical relationship responsible for quantifying electrical force. What is the physical significance of the proportionality constant? In order to answer this question, it must be established that all extraneous quantities are separated out from the constant of proportionality. In other words, other physical meanings, that are not intrinsically a part of the new empirical truth, must be removed.

In the case of Coulomb's Law, it is usually written showing an inverse proportionality of force with the square of distance. Actually it is inversely proportional to the area of the surface of a sphere with radius r. The formula for the area of the surface of a sphere is:

$$s = 4\pi r^2$$

Taking this into account, Coulomb's Law can be written as:

$$f = k_f\ \frac{qq}{4\pi r^2}$$

Where, k_f is the pure proportionality constant. As stated previously, if the other terms in the equation are independently defined based upon empirical measurements, then, this proportionality constant can be anticipated to represent the new empirical physical property that makes Coulomb's Law unique. It does not matter that the arithmetic values are relative. It does not matter that some of the units may be artificial. What is essential is that the proportionality constant be separate from each of these other properties. It then becomes possible to identify this new property. Within the framework of my theory, it is found to be:

$$k_f = v_s v_c$$

Where v_s is the speed of sound and v_c is the speed of light in the specific medium. This relationship is approximate for a gas and accurate for solids.

There is physical truth in the act of combining μ and ε. What might also be anticipated is that these values may reveal additional truths. Such other truths could involve different combinations of these values. One new combination to be tried is to divide these values instead of multiplying them. In the derivation of my theory, I have found physical meaning for this combination. It is:

$$\frac{\mu}{\varepsilon} = v_s^2$$

Where v_s is the speed of sound of the medium through which the wave is traveling. This relation holds well for solids and less well for gases. In a vacuum it may seem that it should not hold at all. However, sound waves are not constructed out of a unique physical substance. They are a representation of the interaction of material particles that are not by themselves *sound*. The interactions of particles would not end in a vacuum even if there was such a region of space. The point is that there is fundamental truth revealed by this relation and it reaches beyond our concept of what is sound.

Some systems of units are defined so that the proportionality constant is equal to the numerical value of one. An historical example of such a system is the cgs system of units. In this system, force is expressed in dynes, distance in centimeters, and the unit of electric charge is chosen of such magnitude that the proportionality constant in Coulomb’s Law is equal to unity. When this occurs, where does the fundamental physical meaning of the equation make its appearance?

The answer is: It is entangled with the definition of electric charge. In this system of units electric charge is not strictly representative of the empirical basis of electric charge. It is the empirical electric charge multiplied by a value that would have been the proportionality constant. That is where the constant, and its meaning, has become enclosed.

True fundamental constants, including constants of proportionality, can help lead us to unity of theory. That is what is indicated by the anomaly equation presented earlier. It is very unlikely to form equality for no good reason. It is quite likely it is pointing the way to new unity. However, it also demonstrates that the mks system of units is not useful for deriving such a theory. The units do not match. This results from the inclusion of theoretical units. These are units that have been invented to represent fundamental uniqueness for properties whose natures may not be unique or even physical.

Within the confines of standard theory, this anomalous equation would indicate obvious error. Outside the confines of standard theory, it indicates scientific progress. When the units of physics are made universal, then the new units of this equation will match. In my theory, the units for the equation do match. The equation was derived during the development of a unified general theory. The theory uses a new system of units. Maybe it is a universal system. I feel it is showing the method by which a universal system may be pursued. The equation is indicating that universal unity for theoretical physics will require both new theory and new units.