The Dimensions of Motion

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Now that the existence of scalar motion has been demonstrated, it will be appropriate to examine the consequences of this existence. Some of the most significant consequences are related to the *dimensions* of this hitherto unrecognized type of motion. The word "dimension" is used in several different senses, but in the sense in which it is applied to space it signifies the number of independent magnitudes that are required for a complete definition of a spatial quantity. It is generally conceded that space is three-dimensional. Thus three independent magnitudes are required for a complete definition of a quantity of space. Throughout the early years of science this was taken as an indication that the *universe* is three-dimensional. Currently, the favored hypothesis is that of a four-dimensional universe, in which the three dimensions of space are joined to one dimension of time.

Strangely enough, there does not appear to have been any critical examination of the question as to the number of dimensions of *motion* that are possible. The scientific community has simply taken it for granted that the limits applicable to motion coincide with those of the spatial reference system. On reviewing this situation it can be seen that this assumption is incorrect. The relation of any one of the three space magnitudes to a quantity of time constitutes a scalar motion. Thus three dimensions of scalar motion are possible. But only one dimension of motion can be accommodated within the conventional spatial reference system. The result of any motion within this reference system can be represented by a vector (a one-dimensional expression), and the resultant of any number of such motions can be represented by the vector sum (likewise one-dimensional). Any motions that exist in the other two dimensions cannot be represented.

Here again we encounter a shortcoming of the reference system. In our examination of the nature of scalar motion we saw that this type of motion cannot be represented in the reference system in its true character. The magnitude and direction attributed to such a motion in the context of the reference system are not specifically defined, but are wholly dependent on the size and position of the object whose location constitutes the reference point. Now we find that there are motions which cannot be represented in the reference system in *any* manner. It is therefore evident that the system of spatial coordinates that we use in conjunction with a clock as a system of reference for physical activity gives us a severely limited, and in some respects inaccurate, view of physical reality. In order to get the true picture we need to examine the whole range of physical activity, not merely that portion of the whole that the reference system is capable of representing.

For instance, gravitation has been identified as a scalar motion, and there is no evidence that it is subject to any kind of a dimensional limitation other than that applying to scalar motion, in general. We must therefore conclude that gravitation *can* act three-dimensionally. Furthermore, it can be seen that gravitation *must* act in all of the dimensions in which it *can* act. This is a necessary consequence of the relation between gravitation and mass. The magnitude of the gravitational force exerted by a material particle or aggregate (a measure of its gravitational motion) is determined by its mass. Thus mass is a measure of the inherent negative scalar motion content of the matter. It follows that motion of any mass m is a motion of a negative scalar motion. To produce such a compound motion, a positive scalar motion v (measured as speed or velocity) must be applied to the mass. The resultant is "mv," now called momentum, but known earlier as "quantity of motion," a term that more clearly expresses the nature of the quantity. In the context of a spatial reference system, the applied motion v has a direction, and is thus a vector quantity, but the direction is imparted by the coupling to the reference system and is not an inherent property of the motion itself. This motion therefore retains its positive scalar status irrespective of the vectorial direction.

In the compound motion mv, the negative gravitational motion acts as a resistance to the positive motion v. The gravitational motion must therefore take place in all three of the available dimensions, as any one of the three may be parallel to the dimension of the reference system, and there would be no effective resistance in any vacant dimension. We may therefore identify the gravitational motion as three-dimensional speed, which we can express as s^3/t^3, where s and t are space and time respectively. The mass (the resistance that this negative gravitational motion offers to the applied positive motion) is then the inverse of this quantity, or t^3/s^3. Since only one dimension of *motion* can be represented in a three-dimensional spatial coordinate system, the gravitational motion in the other two dimensions has no directional effect, but its magnitude applies as a modifier of the magnitude of the motion in the dimension of the reference system.

We now turn to a different kind of "dimension." When physical quantities are resolved into component quantities of a fundamental nature, these component quantities are called dimensions. The currently accepted systems of measurement express the dimensions of *mechanical* quantities in terms of mass, length, and time, together with the dimensions (in the first sense) of these quantities. But now that mass has been identified as a motion, a relation between space and time, all of the quantities of the mechanical system can be expressed in terms of space and time only. For purposes of the present discussion the word "space" will be used instead of "length," to avoid implying that there is a some dimensional difference between space and time. On this basis the "dimensions," or "space-time dimensions" of one-dimensional speed are space divided by time, or s/t. As indicated above, mass has the dimensions t^3/s^3.

The product of mass and speed (or velocity) is $t^3/s^3 \times s/t = t^2/s^2$. This is "quantity of motion," or momentum. The product of mass and the second power of speed is $t^3/s^3 \times s^2/t^2 = t/s$, which is energy. Acceleration, the time rate of change of speed, is $s/t \times 1/t = s/t^2$. Multiplying acceleration by mass, we obtain $t^3/s^3 \times s/t^2 = t/s^2$, which is force, the "quantity of acceleration," we might call it. The dimensions of the other mechanical quantities are simply combinations of these basic dimensions. Pressure, for instance, is force divided by area, $t/s^2 \times 1/s^2 = t/s^4$.

When reduced to space-time terms in accordance with the foregoing identifications, all of the well-established mechanical relations are dimensionally consistent. To illustrate this agreement, we may consider the relations applicable to angular motion, which take a different form from those applying to translational motion, and utilize some different physical quantities. The angular system introduces a purely numerical quantity, the angle of rotation ϑ. The time rate of change of this angle is the angular velocity ω, which has the dimensions $\omega = \vartheta/t = 1/t$. Force is applied in the form of torque, L, which is the product of force and the radius, r. $L = Fr = t/s^2 \times s = t/s$. One other quantity entering into the angular relations is the moment of inertia, symbol I, the product of the mass and the second power of the radius. $I = mr^2 = t^3/s^3 \times s^2 = t^3/s$. The following equations demonstrate the dimensional consistency achieved by this identification of the space-time dimensions:

energy (t/s) = $L\vartheta = t/s \times 1 = t/s$

energy (t/s) = $\frac{1}{2}I\omega^2 = t^3/s \times 1/t^2 = t/s$

power (1/s) = $L\omega = t/s \times 1/t = 1/s$

torque (t/s) = $\frac{1}{2}I\omega 2 = t^3/s \times 1/t^2 = t/s$

The only dimensional discrepancy in the basic equations of the mechanical system is in the gravitational force equation, which is expressed as $F = Gmm'/d^2$, where G is the gravitational constant and d is the distance between the interacting masses. Although this equation is correct mathematically, it cannot qualify as a theoretically established relation. As on physics textbook puts it, this equation "is not a defining equation… and cannot be derived from defining equations. It represents an *observed relationship*." The reason for this inability to arrive at a theoretical explanation of the equation becomes apparent when we examine it from a dimensional standpoint. The dimensions of force in general are those of the product of mass and acceleration. It follows that these must also be the dimensions of any specific force. For instance, the gravitational force acting on an object in the earth's gravitational field is the product of the mass and the "acceleration due to gravity." These same dimensions must likewise apply to the gravitational force in general. When we look at the gravitational equation in this light, it becomes evident that the gravitational constant represents the magnitude of the acceleration at unit values of m' and d, and that these quantities are dimensionless ratios. The dimensionally correct expression of the gravitational equation is then F = ma, where the numerical value of "a" is Gm'/d^2.

The space-time dimensions of the quantities involved in current *electricity* can easily be identified in the same manner as those of the mechanical system. Most of the measurement systems currently in use add an electric quantity to the mass, length and time applicable to the mechanical system, bringing the total number of independent base quantities to four. However, the new information developed in the foregoing paragraphs enables expressing the electrical quantities of this class in terms of space and time only, in the same manner as the mechanical quantities.

Electrical energy (watt-hours) is merely one form of energy in general, and therefore has the energy dimensions, t/s. Power (watts) is energy divided by time, $t/s \times 1/t = 1/s$. Electrical force, or voltage (volts) is equivalent to mechanical force, with the dimensions t/s^2. Electric current (amperes) is power divided by voltage. $I = 1/s \times s^2/t = s/t$. Thus current is dimensionally equal to speed. Electrical quantity (coulombs) is current multiplied by time, and has the dimensions $Q = I\ t = s/t \times t = s$. Resistance (ohms) is voltage divided by current, $R = t/s^2 \times t/s = t^2/s^3$. This is the only one of the basic quantities involved in the electric current phenomenon that has no counterpart in the mechanical system. Its significance can be appreciated when it is noted that the dimensions t^2/s^3 are those of mass per unit time.[1] The dimensions of other electrical quantities can be obtained by combination, as noted in connection with the mechanical quantities.

As can be seen from the foregoing, the quantities involved in the current electricity are dimensionally equivalent to those of the mechanical system. We could, in fact, describe the current phenomena as the mechanical aspects of electricity. The only important difference is that mechanics is largely concerned with the motions of individual units or aggregates, while current electricity deals with continuous phenomena in which the individual units are not separately identified.

The validity of the dimensional assignments in electricity, and the identity of the electrical and mechanical relations, can be verified by reducing the respective equations to the space-time basis. For example, in mechanics the expression for kinetic energy (or work) is $W = ½mv^2$, the dimensions of which are $t^3/s^3 \times s^2/t^2 = t/s$. The corresponding equation for the energy of the electric current is $W = I^2Rt$. As mentioned above, the product Rt is equivalent to mass, while I, the current, has the dimensions of speed, s/t. Thus, like the kinetic energy, the electrical energy is the product of mass and the second power of speed, $W = I^2Rt = s^2/t^2 \times t^2/s^3 \times t = t/s$. Another expression for mechanical energy is force times distance, $W = Fd = t/s^2 \times s = t/s$. Similarly, relations of current electricity are likewise dimensionally consistent, and equivalent to the corresponding mechanical relations, when reduced to

1 $t^3/s^3 \times 1/t = t^2/s^3$

space-time terms.

Identification of the space-time dimensions of electrostatic quantities, those involving *electric charge*, is complicated by the fact that in present-day physical thought electric charge is not distinguished from electrical quantity. As we have seen, electric quantity is dimensionally equivalent to space. On the other hand, we can deduce from the points brought out in the preceding article that electric charge is a one-dimensional analog of mass, and is therefore dimensionally equivalent to energy. This can be verified by consideration of the relations involving electric field intensity, symbol E. In terms of charge, the electric field intensity is given by the expression $E = Q/s^2$. But the field intensity is defined as force per unit distance, and its space-time dimensions are therefore $t/s^2 \times 1/s = t/s^3$. Applying these dimensions to the equation $E = Q/s^2$, we obtain $Q = Es^2 = t/s^3 \times s^2 = t/s$.

As long as the two different quantities that are called by the same name are used separately, their practical application is not affected, but confusion is introduced into the theoretical treatment of the phenomena that are involved. For instance in the relations involving capacitance (symbol C), $Q = t/s$ in the basic equation $C = Q/V = t/s \times s^2/t = s$. The conclusion that capacitance is dimensionally equivalent to space is confirmed observationally, as the capacitance can be calculated from geometrical measurements. However, the usual form of the corresponding energy equation is $W = QV$, reflecting the definition of the volt as one joule per coulomb. In this equation, $Q = W/V = t/s \times s^2/t = s$. Because of the lack of distinction between the two usages of Q the quantity CV, which is equal to Q in the equation $C = Q/V$ is freely substituted for Q in equations of the $W = QV$ type, leading to results such as $W = CV^2$, which are dimensionally incorrect.

Such findings emphasize the point that the ability to reduce all physical relations to their space-time dimensions provides us with a powerful and effective tool for analyzing physical phenomena. Its usefulness is clearly demonstrated when it is applied to an examination of *magnetism*, which has been the least understood of the major areas of physics. The currently accepted formulations of the various magnetic relations are a mixture of correct and incorrect expressions, but by using those that are most firmly based it is possible to identify the space-time dimensions of the primary magnetic quantities. This information then enables correcting existing errors in the statements of other relations, and establishing dimensional consistency over the full range of magnetic phenomena.

In carrying out such a program we find that magnetism is a two-dimensional analog of electricity. The effect of the added dimension is to introduce a factor t/s into the expressions of the relations applicable to the one-dimensional electric system. Thus the magnetic analog of an electric charge, t/s, is a magnetic charge, t^2/s^2. The existence of such a charge is not recognized in present-day magnetic theory, probably because there is no independent magnetically-charged particle, but one of the methods of dealing with permanent magnets makes use of the concept of the "magnetic pole," which is essentially the same thing. The unit *pole strength* in the SI system, the measurement system now most commonly applied to magnetism, is the weber, which is equivalent to a volt-second, and therefore has the dimensions $t/s^2 \times t = t^2/s^2$. The same units and dimensions apply to *magnetic flux*, a quantity that is currently used in most relations that involve magnetic charge, as well as in other applications where flux is the more appropriate term.

Current ideas concerning *magnetic potential*, or magnetic force, are in a state of confusion. Questions as to the relation between electric potential and magnetic potential, the difference, if any, between potential and force, and the meaning of the distinctions that are drawn between various magnetic quantities such as magnetic potential, magnetic vector potential, magnetic scalar potential, and magnetomotive force, have never received definitive answers. Now, however, by analyzing these quantities into their space-time dimensions we are able to provide the answers that have been lacking. We find that force and potential have the same dimensions, and are therefore equivalent quantities. The term “potential” is generally applied to a distributed force, a force field, and the use of a special name in this context is probably justified, but it should be kept in mind that a potential is a force.

On the other hand, a magnetic potential (force) is not dimensionally equivalent to an electrical potential (force), as it is subject to the additional t/s factor that relates the two-dimensional magnetic quantities to the one-dimensional electric quantities. From the dimensions t/s^2 of the electric potential, if follows that the correct dimensions of the magnetic potential are $t/s \times t/s^2 = t^2/s^3$. This agrees with the dimensions of *magnetic vector potential*. In the SI system, the unit of this quantity is the weber per meter, or $t^2/s^2 \times 1/s = t^2/s^3$. The corresponding cgs unit is the gilbert, which also reduces to t^2/s^3.

The same dimensions should apply to *magnetomotive force* (MMF), and to *magnetic potential* where this quantity is distinguished from vector potential. But an error has been introduced into the dimensions attributed to these quantities because the accepted defining relation is an empirical expression that is dimensionally incomplete. Experiments show that the magnetomotive force can be calculated by means of the expression MMF = nI, where n is the number of turns in a coil. Since n is dimensionless, this equation indicates that MMF has the dimensions of electric current. The unit has therefore been taken as the ampere, dimensions s/t. From the discrepancy between these and the correct dimensions we can deduce that the equation MMF= nI, from which the ampere unit is derived, is lacking a quantity with the dimensions $t^2/s^3 \times t/s = t^3/s^4$.

There is enough information available to make it evident that the missing factor with these dimensions is the *permeability*, the magnetic analog of electrical resistance. The permeability of most substances is unity, and omitting has no effect on the *numerical* results of most experimental measurements. This has led to overlooking it in such relations as the one used in deriving the ampere unit for MMF. When we put the permeability (symbol μ) into the empirical equation it becomes MMF = μnI, with the correct dimensions, $t^3/s^4 \times s/t = t^2/s^3$.

The error in the dimensions attributed to MMF carries over into the potential gradient, the *magnetic field intensity*. By definition, this is the magnetic field potential divided by distance, $t^2/s^3 \times 1/s = t^2/s^4$. But the unit in the SI system is the ampere per meter, the dimensions of which are $s/t \times 1/s = 1/t$. In this case, the cgs unit, the oersted, is derived from the dimensionally correct unit of magnetic potential, and therefore has the correct dimensions, t^2/s^4.

The discrepancies in the dimensions of MMF and magnetic field intensity are typical of the confusion that exists in a number of magnetic areas. Much progress has been made toward clarifying these situations in the past few decades, both active, and sometimes acrimonious, controversies still persist with respect to such quantities as magnetic moment and the two vectors usually designated by the letters B and H. In most of these cases, including those specifically mentioned, introduction of the permeability where it is appropriate, or removing it where it is inappropriate, is all that is necessary to clear up the confusion and attain dimensional validity.

Correction of the errors in electric and magnetic theory that have been discussed in the foregoing paragraphs, together with clarification of physical relations in other areas of confusion, enables expressing all electric and magnetic quantities and relations in terms of space and time, thus completing the consolidation of all of the various systems of measurement into one comprehensive and consistent system. An achievement of this kind is, of course, self-verifying, as the possibility that there might be more than one consistent system of dimensional assignments that agree with observations over the entire field of physical activity is negligible.

But straightening out the system of measurement is only a small part of what has been accomplished in this development. More importantly, the positive identification of the space-time dimensions of any physical quantity defines the *basic physical nature* of that quantity. Consequently, any hypothesis with respect to a physical process in which this quantity participates must agree with the dimensional definition. The effect of this constraint on theory construction is illustrated by the findings with respect to the nature of current electricity that were mentioned earlier. Present-day theory views the electric current as a flow of electric charges. But the dimensional analysis shows that charge has the dimensions t/s, whereas the moving entity in the current flow has the dimensions of space, s. It follows that the current is *not* a flow of electric charges.

Furthermore, the identification of the space-time dimensions of the moving entity not only tells us what the current is not, but goes on to reveal just what it *is*. According to present-day theory, the carriers of the charges, which are identified as electrons, move through the spaces between the atoms. The finding that the moving entities have the dimensions of space makes this kind of a flow pattern impossible. An entity with the dimensions of space cannot move through space, as the relation of space to space is not motion. Such an entity must move *through the matter itself*, not through the vacant spaces. This explains why the current is confined within the conductor, even if the conductor is bare. If the carriers of the current were able to move forward through vacant spaces between atoms, they should likewise be able to move laterally through similar spaces, and escape from the conductor. But since the current moves through the matter, the confinement is a necessary consequence.

The electric current is a *movement of space* through matter, a motion that is equivalent, in all but direction, to movement of matter through space. This is a concept that many individuals will find hard to accept. But is should be realized that the moving entities are not quantities of the space with which we are familiar, extension space, we may call it. There are physical quantities that are *dimensionally equivalent* to this space of our ordinary experience, and play the same role in physical activity. One of them, capacitance, has already been mentioned in the preceding discussion. The moving entities are quantities of this kind, not quantities of extension space.

Here, then, is the explanation of the fact that the basic quantities and relations of the electric current phenomena are identical with those of the mechanical system. The movement of space through matter is essentially equivalent to the movement of matter through space, and is described by the same mathematical expressions. Additionally, the identification of the electric charge as a motion explains the association between charges and certain current phenomena that has been accepted as evidence in favor of the “moving charge” theory of the electric current. One observation that has had considerable influence on scientific thought is that an electron moving in open space has the same magnetic properties as an electric current. But we can now see that the observed electron is not merely a charge. It is a particle with an added motion that constitutes the charge. The carrier of the electric current is the same particle *without the charge*. A charge that is stationary in the reference system has *electrostatic* properties. An uncharged electron in motion within a conductor has *magnetic* properties. A charged electron moving in a conductor or in a gravitational field has *both* magnetic and electrostatic properties. It is the motion of physical entities with the dimensions of space that produces the magnetic effect. Whether or not these entities—electrons or their equivalent—are charged is irrelevant from this standpoint.

Another observed phenomenon that has contributed to the acceptance of the “moving charge” theory is the emission of charged electrons from current-carrying conductors under certain conditions. The argument in this instance is that if charged electrons come *out of* a conductor there must have been charged electrons *in* the conductor. The answer to this is that the kind of motion which constitutes the charge is easily imparted to a particle or atom (as anyone who handles one of the modern synthetic fabrics can testify), and this motion is imparted to the electrons in the process of ejection from the conductor. Since the uncharged particle cannot move through space, the acquisition of a charge is one of the requirements for escape.

In addition to providing these alternative explanations for aspects of the electric current phenomena that are consistent with the "moving charge" theory, the new theory of the current that emerges from the scalar motion study also accounts for a number of features of the current flow that are difficult to reconcile with the conventional theory. But the validity of the new theory does not rest on a summation of its accomplishments. The conclusive point is that the identification of the electric current as a motion of space through matter is confirmed by agreement with the dimensions of the participating entities, dimensions that are verified by every physical relation in which the electric current is involved.

The proof of validity can be carried even farther. It is possible to put the whole development of thought in this and the preceding article to a conclusive test. We have found that mass is a three-dimensional scalar motion, and that electric current is a one-dimensional scalar motion through a mass by entities that have the dimensions of space. We have further found that magnetism is a two-dimensional analog of electricity. If these findings are valid, certain consequences necessarily follow that are extremely difficult, perhaps impossible, to explain in any other way. The one-dimensional, oppositely directed flow of the current through the three-dimensional scalar motion of matter neutralizes a portion of the motion in one of the three dimensions, and should leave an observable two-dimensional (magnetic) residue. Similarly, movement of a two-dimensional (magnetic) entity through a mass, or the equivalent of such a motion, should leave a one-dimensional (electric) residue. Inasmuch as these are direct and specific requirements of the theory outlined in the foregoing paragraphs, and are not called for by any other physical theory, their presence or absence is a definitive test of the validity of the theory.

The observations give us an unequivocal answer. The current flow produces a magnetic effect, and this effect is perpendicular to the direction of the current, just as it must be if it is the residue of a three-dimensional motion that remains after motion in the one dimension of the current flow is neutralized. This perpendicular direction of the magnetic effect of the current is a total mystery to present-day physical science, which has no explanation for either the origin of the effect or its direction. But both the origin and the direction are obvious and necessary consequences of our findings with respect to the nature of mass and the electric current.

There is no independent magnetic particle similar to the carrier of the electric current, and no two-dimensional motion of space through matter analogous to the one-dimensional motion of the current is possible, but the same effect can be produced by mechanical movement of mass through a magnetic field, or an equivalent process. As the theory requires, the one-dimensional residue of such motion is observed to be an electric current. This process is *electromagnetic induction*. The magnetic effect of the current is *electromagnetism*.

On first consideration it might seem that the magnitude of the electromagnetic effect is far out of proportion to the amount of gravitational motion that is neutralized by the current. However, this is a result of the large numerical constant, 3×10^{10} in cgs units (represented by the symbol c), that applies to the space-time ratio s/t where conversion from an n-dimensional quantity to an m-dimensional quantity takes place. An example that, by this time is familiar to all, $E=mc^2$, is the conversion of mass (t^3/s^3) to energy (t/s). In that process, where the relation is between a three-dimensional quantity and a one-dimensional quantity, the numerical factor is c^2. In the relation between the three-dimensional mass and the two-dimensional magnetic residue the numerical factor is c, less than c^2 but still a very large number.

Thus, the theory of the electric current developed in the foregoing discussion passes the test of validity in a definite and positive manner. The results that it requires are in full agreement with two observed physical phenomena of a significant nature *that are wholly unexplained* in present-day physical thought. Together with the positively established validity of the corresponding system of space-time dimensions, this test provides a verification of the entire theoretical development described in this article, a proof that meets the most rigid scientific standard.