CHAPTER 1 OVERVIEW

1.1 Questions concerning the theoretical basis

It seems that throughout my working career I have been a trouble-shooter. This started when I entered the Navy as an Electrician's Mate working on the power electrical equipment on Navy ships. Troubleshooting was the main job, whether it was finding some electrical malfunction or the presence of saltwater in an electrical box. Later, as a Naval Officer with an Electrical Engineering degree, I was constantly required to ferret out some sort of trouble. This at times would involve missile systems, gun systems, radars, sonar systems, boilers, or other systems. It seemed only natural then to employ this same procedure to investigate what appeared to me as problems in the foundations of physics.

Though I had often asked "Why?" when confronted with some new assumption or adopted postulate, the first really puzzling facet of current physics I encountered was the concept of relativistic kinetic energy from Einstein's Special Theory of Relativity. The puzzling part was that it depended upon the speed of light independent of the mechanism by which this energy might be transferred. To better illustrate what puzzled me, consider the transfer of energy between two charged particles on collision courses. If the particles have near-miss trajectories, then the energy is primarily transferred by the electrical forces between the charges. From the view of retarded potentials, or the concept of a limiting speed of electromagnetic signal transmission, it is rather easy to accept the energy transferred being dependent upon this limiting velocity. But suppose the particles are uncharged and the interaction is strictly a gravitational one. Again the concept of a limiting signal speed would imply that the energy exchanged between the particles depend upon this limiting velocity. But is it the same as the limiting signal velocity for the electromagnetic case? Do gravitational waves travel at the same speed as electromagnetic waves?

Einstein, in the Special Theory of Relativity, adopted the position that the constancy of the speed of light forces a modification of Newton's dynamic law. This modification implies that all forces have the same limiting velocity, namely, the speed of light. There exists an abundance of theoretical and experimental evidence that the speed of light becomes the limiting velocity whenever electromagnetic forces are involved. The point that bothered me was whether other forces, such as gravitational, should also have the same limiting velocity. Though we have had reports of the detection of gravitational waves, we have no experimental determination of the speed of a gravitational wave. Therefore, I object to the viewpoint that the modification to Newton's law should be applied to all forces without some additional justification.

Let me describe an analogy which may not hold in the strictest sense yet may serve to illustrate my point of view. A river, flowing toward the sea, carries energy with it. The speed with which this energy can move from one point to another is the velocity of the river's current. The river produces a force on a boat tied up to a pier on the river. When the boat is set adrift, this force accelerates the boat. However, the maximum velocity to which the river can accelerate the boat is the current velocity; this is the velocity with which the energy of the river can propagate.

From this point of view the speed of light, being the propagation velocity of electromagnetic energy must be the limiting velocity associated with electromagnetic forces. Certainly nature would be much simpler if all forces have the same limiting velocity. Yet without some experimental evidence of the propagation of gravitational energy, I find it difficult to feel comfortable with Einstein's modification of Newton's law justified by electromagnetic experimental evidence and arguments of simplicity.

The fundamental philosophical viewpoint that the force depends upon velocity and vanishes as the velocity approaches the limiting velocity raises another question concerning Einstein's modification of classical mechanics. Under Einstein's modification Hamilton's principle is written with a relativistic mass which depends upon the velocity and a velocity independent force. Does this represent a different philosophy or are both views equivalent? More specifically, are the "real" concepts to be taken as a mass independent of velocity together with a velocity dependent force or should we associate the velocity dependent relativistic mass and velocity independent forces with "real" world? Or does it make any difference which we chose?

At this point I faced the first major decision. If I adopted Einstein's postulates, then it appeared that I would be required to change my intuitive beliefs concerning certain physical phenomena. I found this extremely difficult to do. On the other hand, if I did not embrace these postulates, I would have to replace them with something that would say essentially the same thing in all cases where the Special Theory of Relativity has been found to be very accurate. Not only this but if a new point of view were adopted, then virtually the entire sphere of physics may need to be reviewed in order to ensure that the new point of view did not conflict with currently used theories where they have experimental verification.

1.2 Possible new theoretical approach

History records the advancements in physics which came from the efforts of people new to the field. Therefore my lack of training in physics might be turned into an advantage if I sought to determine a philosophical basis unhampered by the directed philosophy that comes from a study of physics as currently taught. This is in contradistinction with current practices and procedures of academicism where mastery of current theories generally precedes the development of a new one. To deliberately choose this deviation risks accusations of arrogance and naivete. On the other hand such a choice seemed the best way of avoiding the danger of becoming so familiar with current ways of thinking as to make it improbable of giving due attention to other ways.

Having decided to look for a new foundation for physics I was faced with the question of how to begin. I recalled some Ozark hill philosophy I overheard as a youngster. A native Ozarkian was giving directions to a stranger who was trying to find a certain fishing hole. The directions went something like this: "See yonder road going down that holler? Well, go down thar 'bout five mile and you'll come to a fork in the road. Take the right hand fork. Now that's the wrong one but you take it anyways. After you've gone a piece, you'll come to a log across the road. Now you know you're on the wrong road. So go back and take the left hand fork. You can't miss it."

A quick review of physics reveals that there are different branches with different sets of fundamental laws or postulates. Though it is easy to see how the distinction between these branches came about, it was difficult for me to believe that nature shared the same divisions. I felt that all natural phenomena should be explained by a single set of fundamental laws. This belief is somewhat like a grove of redwood trees or bamboo forest. Above the ground each tree appears as a distinct plant. Yet we know that below the ground they may be found to grow from the same root system. Thus, I felt that a more fundamental approach might display the unity in nature and that prior attempts at unification in the search for a unified field theory could be likened to attempts to tie the trees together at the tree top level rather than down at the root level.

Is nature symmetrical in time? Does everything run backward in time as well as forward? Obviously, not every process in nature will run backwards, yet the equations of motion in Newtonian and relativistic mechanics are time symmetrical. I believe in an asymmetrical nature and this belief played a role in the eventual selection of fundamental laws.

How then did I use this philosophy to determine a set of generalized laws on which to base an attempt to construct a new approach to physics?

Before proceeding let me offer a word of caution. During any theorization the philosophy of the theorist plays such an important role that an attempt to understand the theory is aided by a knowledge of this philosophy. Therefore the following includes not only the philosophical basis upon which the theory is based and the mathematical development but also ideas and beliefs which played a part in the various decisions. Because of the individualistic nature of philosophy the following will deviate occasionally from a strict third person presentation, risking a loss of professional appearance, to the clearly personal first person.

Newtonian mechanics fails to describe events involving high velocities, relativistic mechanics fails to describe the atom, and gravitational effects have resisted quantization. If these are viewed as logs and the Ozarkian's directions are followed, then we must retrace our steps and seek another approach rather than attempting to chop up the log and continue to push forward up one of these roads.

The branch of thermodynamics, however, does not appear to have a log somewhere along the way. Here the classical thermodynamic laws are very general, particularly Caratheodory's statement of the second law. Thus the thermodynamic laws appeared to be the fork in the road where a new route might be chosen.

However, in mechanics we talk of equations of motion, field equations, and geometry while in thermodynamics we speak of equations of state and equilibrium. If a generalization of the classical thermodynamic laws is adopted, how might we obtain the equations with which we are familiar in mechanics? More particularly, how could this type of general law yield geometry and a variational principle? The second law of thermodynamics can produce a variational principle through principles such as increasing entropy and minimizing free energy, but can it also produce a geometry?

This seemed to be a crucial point. If the laws could not produce a geometry, then a geometry would have to be assumed, thus necessitating an additional assumption. The belief that a simple fundamental set of laws should lead to the fundamental principles of the different branches of physics made the thought of additional assumptions abhorrent. The notion that the adopted laws should specify the type of geometry that must be used seemed very satisfying. Newton found that the absolute nature of Euclidean geometry brought undesirable features. Einstein, in his General Theory, displayed the benefits that might be gained by going to a more general geometry. He showed that physical phenomena might be displayed as elements determined by certain physical laws. This is essentially the question here. Can a set of laws, which are generalizations of the classical thermodynamic laws, determine the metric elements and hence the geometry?

By appealing to the mathematics of functions of more than one variable we find that a quadratic form becomes involved when a maximum or minimum is sought. Further, this quadratic form generates a natural geometry for that function. In thermodynamics the stability conditions provide a similar quadratic form and therefore the quadratic form which specifies the stability conditions should form a natural geometry for a physical system governed by laws such as the thermodynamic laws.

Thus the foundations of the theory have been outlined, namely the belief that all physical phenomena should be derivable from a single set of physical laws which are generalizations of the classical thermodynamic laws. Such a theory should be capable of describing all the dynamic events in nature. Therefore it seems appropriate to call it the "Dynamic Theory". Obviously, for such a theory to be tenable it must reproduce, or be consistent with, the various fundamental postulates and/or laws currently used in the various branches of physics. Indeed it should do even more. It should also reduce the number of necessary assumptions and provide an unprecedented unification of physics.

Further, there is the possibility that the theory might produce an experimentally verifiable prediction.

The first requirement that should be placed upon the Dynamic Theory is that it reproduce, or be consistent with, current theories. In order to show that the Dynamic Theory satisfies this requirement, Section A of Chapter 2 states the adopted laws and then sections of the remainder of the book show how appropriate restrictions upon the system do yield the fundamental principles for the various current theories.

Though a theory which has the capability of displaying a unification of physical theories might have significant value based solely upon this capability, it would become more attractive if it could explain phenomena for which no explanation exists or make some new prediction which might lead to an experimental test of the theory. Since restrictions were placed upon the system in order to show how current theories may be obtained, the easiest way to see the expanded coverage of the theory is to relax one or more of the restrictions and consider a more general system. In Chapters 3, 4, 5, 6, and 7 some of the previously imposed restrictions are relaxed and the results are worked out for several types of systems. Chapter 8 presents some experiments which might test the Dynamic Theory.

A theory, such as the Dynamic Theory, immediately poses several problems which are not associated with its validity or applicability. First, there is a new point of view to be dealt with. Initially it would appear to be inconsistent with all past concepts of system energy or relativistic concepts. Yet in the end it is completely consistent with current theories and sheds an entirely new light upon physical phenomena.

Another imposing difficulty with the Dynamic Theory stems from its generality. The scope of the theory includes all physical phenomena while in the past half century the vast amount of scientific knowledge that has been accumulated has demanded specialists. Increasing expansion of mankind's knowledge demands further specialization. Such a progression produces no demand for a generalist. The result is that the greater portion of this theory will be outside the field of many readers.

Closely associated with this problem is another. Throughout science symbols and words are used to denote concepts and quantities. The limited number of available symbols and words together with the expanded scope of scientific knowledge requires duplication. For the specialists this duplication can be somewhat minimized. However, in the case of a general theory touching virtually all areas of specialization the problem becomes very significant. In particular, if a certain symbol or set of words is used, a particular notion or concept may be associated with them by the reader. This association will likely depend upon the reader's specialty and therefore will vary with the reader. Any attempt to choose symbology or word usage aimed at a particular specialty risks increased confusion for readers in other fields. Therefore, the reader is cautioned to keep in mind that conceptualizations and symbology familiar because of its use in one branch of physics may now take on an entirely new meaning.

1.3 A New View of Space-Time-Matter

The history of mankind's attempts to unify electromagnetic and gravitational fields, or interactions, began when man begin to learn of electric and magnetic fields. The first formal theory attempting to unify the two fields of science was presented in 1836[1]. However, no theory has yet been suggested that has gained undeniable experimental verification. Theoretical physicists are still at work trying to find a theory that will ultimately unify the forces of nature. Such is the strength of the belief in the unity of nature.

The theory developed below adopts the premise that a description of physical phenomena should be based upon a simple set of fundamental postulates and that the current physical theories should be found to be subsets of this more general theory by applying restrictive assumptions. The selection of the three following fundamental laws reflect this premise.

Generalized Laws

In looking for a choice of fundamental basis for a theory to unify the various branches of science, consider the following. Newtonian mechanics fails to describe events involving high velocities, relativistic mechanics fails to describe the atom, and gravitational effects have resisted quantization. On the other hand, one finds that thermodynamics is the one branch of science which has always been found to hold. Here one finds the classical thermodynamic laws to be very general, particularly Caratheodory's statement of the Second Law.

In mechanics the basic equations discussed are equations of motion, field equations, and geometry, while in thermodynamics the basic equations are equations of state and equilibrium. If a generalization of the classical thermodynamic laws are adopted as a fundamental basis for a unifying theory, how may the familiar equations from mechanics be obtained? The crucial point is how to obtain geometry and a variational principle from these general laws. Given a geometrical description and a variational principle, established procedures may be used to obtain equations of motion and field equations. Geometry may be obtained from a quadratic form. Therefore, stability conditions should yield a natural geometry based upon laws generalized from the classical thermodynamic laws. Further, in thermodynamics we find two variational principles; one in the maximum entropy principle for isolated systems, the other is the minimum free energy principle for non-isolated systems.

First Law

The First Law is taken as the statement equating the energy exchanged between the system and its surroundings to the change in the system energy plus any work that the system does. The form for expressing this law is

$$\_E = dU - f_j \, d q^j \;;\; (j = 1,\ldots,n). \qquad \textbf{1}$$

In Eqn. (1), *dU* represents the differential change in the system's energy, ðE represents any and all energy exchanged between the system and its surroundings that cannot be expressed by a work term.

There is no restriction in this law concerning the number of independent variables. The dimensionality depends only upon the applicable, independent work terms. However, in this presentation it is beneficial to initially place some restrictions upon the type and number of allowed work terms. Therefore, a system with only one work term which is the pdv expansion work of thermodynamics will be called a "thermodynamic" system. A system with three mechanical fdx work terms will be called a "mechanical" system.

An important aspect of this law is that, while the energy of the system is a function that is independent of the path, both the energy exchanged with the surroundings and the work done depend upon the path by which the system goes from one state to another. The path dependence of these terms places severe limitations upon the utility of this law and will become important when viewing relativistic and Newtonian mechanics using the new theory.

Second Law

Caratheodory's statement of the Second Law of Thermodynamics is very abstract and does not depend upon the type or number of variables used and, therefore, is already in very general form. The law simply says that there exist states to which the system may not go and then be able to return to its original state. Though Caratheodory formed this statement in terms of neighborhoods, it is known from thermodynamics that it contains the aspects of prohibiting perpetual motion; to be exact, perpetual motion of the second kind. The point is that this law seems intuitively to apply to mechanical systems as well as thermodynamic systems.

The Second Law is stated as:

> In the neighborhood (however close) of any state of a system of any number of independent variables, there exist states that cannot be reached by reversible E-conservative (ðE=0) processes.

Obviously, if attention is restricted to purely thermodynamic systems with only a pdv work term, these laws produce classical thermodynamics. Therefore, the important question is whether or not the laws contain the existing mechanical theories when only mechanical fdx work terms are considered.

In thermodynamics, Caratheodory used his statement of the Second Law to show that the Second Law guarantees the existence of an integrating factor for the First Law. One important feature of such a result is that the integrating factor converts the path dependent First Law into a path independent statement. Two other features resulting from Caratheodory's work have increased significance when applied to a mechanical system. Caratheodory showed, in classical thermodynamics, that the integrating factor is a function of temperature only and that it is independent of the system.

When a mechanical system is considered, the integrating factor can be shown[2] not only to exist but also to be a function of the velocity only and independent of the type of force considered. Since the integrating factor is strictly a function of velocity, an absolute velocity may be defined as in thermodynamics where an absolute zero temperature is defined. Thus, the absolute velocity is defined as that constant velocity at which a system may undergo a process from one solution curve to another without exchanging energy with its surroundings.

Mechanical Entropy

The integrating factor may be used to define a mechanical entropy just as we do for a thermodynamic system. Here the definition becomes

$$dS = \frac{\_E}{f(\dot{q})},$$

where S is the mechanical entropy and the process is a reversible one. Thus, the path independent function obtained by using the mechanical integrating factor is the function defined as the mechanical entropy.

The Second Law may be used, as done in Section 2.4, to show that an isolated mechanical system, which cannot exchange energy with its surroundings, undergoing a spontaneous, or irreversible, process must experience an increase in its mechanical entropy.

Third Law

Just as in thermodynamics, where a Third Law was needed in order to associate the entropy of one system to the entropy of another, so also a Third Law is needed here. The Third Law may be stated:

The entropy of a system, when the integrating factor becomes infinite, is a constant, and this constant may be taken to be zero.

Some of the immediate results of these adopted laws may now be presented. In particular, the definition of the absolute velocity says the integrating factor goes to zero for this unique velocity. The Third Law combines with the Second to say that the absolute velocity may not be obtained in a finite number of steps. Thus, the absolute velocity becomes a unique limiting velocity. Also, the Second Law showed that the integrating factor was independent of the type of force considered. Therefore, the limiting velocity does not depend upon the force and, hence, must be the same regardless of the type of force. Thus, not only must all forces have the same limiting velocity, but since the absolute velocity is unique and the only velocity found in Nature that exhibits this characteristic is the speed of light, then the speed of light must be the absolute velocity. Further, since the definition of the absolute velocity is made for a constant-velocity process, Einstein's assumption concerning the constancy of the speed of light comes directly from the adopted laws (see Section 2.3).

Geometry

In order to find the equations of motion for a mechanical system, the geometry required by the adopted laws must first be determined. Since the mechanical system was considered to have three fdx work terms, the energy of the system becomes a function of four independent variables: three space variables and the mechanical entropy. Thus, the quadratic form obtained from the stability conditions may be expressed in terms of the variables of space and mechanical entropy and is

$$\frac{\partial^2 U}{\partial S^2}(dS)^2 + 2\frac{\partial^2 U}{\partial S \partial q^a}(dS)(dq^a) + \frac{\partial^2 U}{\partial q^a \partial q^b}(dq^a)(dq^b) > 0 \ ; \quad (a, b = 1,2,3). \tag{2}$$

Adopting this quadratic form as the metric of a general system whose thermodynamic variables are held fixed, the metric may be written as

$$(ds)^2 = h_{ij}\, dq^i dq^j \ ; \ (i, j = 0,1,2,3) \tag{3}$$

where the summation convention is used and

$$h_{ij} = \frac{\partial^2 U}{\partial q^i \partial q^j}$$ **5**

where q^0 is the entropy. Thus, the stability conditions provide a metric in the four-dimensional manifold of space-entropy.

The arc length s, in the space-entropy manifold, may be parameterized by choosing

$$ds = \dot{q}^0 dt = cdt, \qquad \mathbf{6}$$

where c is the unique velocity appearing in the integrating factor of the Second Law. The metric may now be written as

$$c^2 (dt)^2 = h_{ij} dq^i dq^j \quad ; \quad (i, j = 0,1,2,3). \qquad (4)$$

But Einstein's relativistic theories are in space-time manifolds. In order to show that the proposed theory contains Einstein's theories, a space-time manifold must come from the adopted laws. This is indeed the case if the mechanical system is restricted by requiring that it be isolated (ðE=0). This restriction establishes the condition necessary for the principle of increasing mechanical entropy which becomes a variational principle

$$d \int \sqrt{(dS)^2} = d \int \sqrt{(dq^0)^2} = 0. \qquad (5)$$

In order to use this variational principle, Eqn. (4) may be expanded, solved for dq^0 and squared to arrive at the quadratic form

$$(dq^0)^2 = \left(\frac{1}{h_{00}}\right)[c^2 (dt)^2 + 2 h_{0a} A dt dq^a - h_{ab} dq^a dq^b], \qquad (6)$$

where

$$A = \frac{h_{0a} \dot{q}^a}{h_{00}} +_{-} \sqrt{\frac{c^2}{h_{00}} - \frac{h_{ab} \dot{q}^a \dot{q}^b}{h_{00}} + \frac{h_{0a} (\dot{q}^a)^2}{h_{00}}}$$

with $\dot{q}^n = dq^n / dt$.11

By defining $x^0 = ct$ and $x^n = q^n$ then Eqn. (6) may be written as

$$(dq^0)^2 = \frac{1}{f}\hat{g}_{ij}\, dx^i\, dx^j \quad ; \quad (i,j = 0,1,2,3)$$

(7)

where f = h_{00}. This metric obviously reduces, in the Euclidean limit of constant coefficients, to the metric of Minkowski's space-time manifold of Special Relativity. Thus, the stability conditions and the principle of increasing entropy combine to require that the equations of motion for an isolated system be the equations of geodesics in a space-time manifold. However, this manifold, whose arc length is the entropy, is related to another space-time manifold by a gauge function so that a discussion of geometry involves two space-time manifolds. Recalling Eqn.(7) we have

$$(dq^0)^2 = \frac{1}{f}\hat{g}_{ij}\, dx^i\, dx^j = \frac{1}{f}(ds)^2 = g_{ij}\, dx^i\, dx^j .$$

(8)

The path independence of the entropy fully specifies the geometry of both manifolds[3]. For the entropy manifold, the geometry is required to be Riemannian with a vector curvature. The other manifold, which may be called the "sigma" manifold, is required to have a Weyl geometry with both a vector curvature and a distance curvature. The distance curvature refers to the changes of the length of a vector under parallel displacements in the sigma manifold and is found to be given by

$$dl = \frac{1}{2}\left(\frac{\partial \log f}{\partial x^i}\right) l = (f_i\, dx^i)l.$$

(9)

The requirement of two manifolds for an isolated system and the fact that the adopted laws fully determine the geometry of each are two of the most significant aspects of the proposed theory. The requirement that there be two manifolds coupled by a gauge function gives rise ultimately to Maxwell's electromagnetic theory as well as quantization. The fact that the laws specify the geometry removes the necessity of assuming a particular geometry and leads to the removal of objections to Weyl's unified field theory of 1918[4] and to London's quantization of Weyl's work in 1927[5]. It is these aspects of the theory which allow the unification of the different branches of physics.

In 1918, the German mathematician Weyl proposed a unified field theory based upon his extension of geometry. However, this theory has not gained acceptance, partly because his theory produced only Einstein's General Theory of Relativity and Maxwell's Electromagnetism. Weyl's theory said nothing in addition to these theories. Another reason Weyl's theory failed to gain acceptance is that Einstein produced an argument that, using Weyl's theory, the spectral lines produced from an atom must be dependent upon the history of the atom, which contradicts experience.

The proposed theory removes both these objections. The first objection is quickly removed by the fact that, from the point of view of this theory, the system has been restricted to be, first, a strictly mechanical system, and secondly, an isolated system. The removal of either of these restrictions allows the theory to discuss events that cannot be addressed by Einstein's General Theory of Relativity or Maxwell's Electromagnetism as will later be shown. The second objection is removed by the fact that the Second Law requires that the entropy and, in addition, the change in entropy to be independent of the path and hence, Einstein's argument of path dependence is nullified. Later it will be shown how the theory arrives at the predictions of phenomena predicted by Einstein's General Theory and Maxwell's Electromagnetic Theory from a different approach in which the geometry is required to be that of Weyl.

SPACE-TIME-MASS

In 1918 Weyl published his book titled "Space-Time-Matter" in which he discussed Einstein's theories and his own unified theory of gravitation and electromagnetism. Yet, within the text, matter did not share the same role as space and time, though an equivalence was implied by the title. Space and time were coordinates in the relativistic manifold while matter was not.

The theory proposed here does for mass what Einstein's Special Theory of Relativity did for time; mass also becomes a coordinate on an equal footing with space and time. Just as relativity created considerable conceptual difficulty, so also can the proposed theory be expected to create conceptual difficulty. However, if the unification provided by the theory is considered as justification for attempting to see what the theory might produce, then a fifth dimension with physical interpretation follows rather quickly.

The first restriction placed upon any system discussed thus far has been that of restricting the system to be either a thermodynamic system, with only a pdv work term, or a mechanical system with three fdx work terms. By removing this restriction, a system must be considered, which may be called a thermo-mechanical system, that experiences four types of work. Thus, the first law includes four work terms and, therefore, involves five dimensions. Since the specific volume is the reciprocal of the mass density, the First Law may also be written in terms of the mass density. For such a system the coordinates become the specific entropy, mass density, and the three space variables.

If five dimensions, which include the mechanical and thermodynamic variables, seem odd consider how thermodynamics is taught. The First Law of Thermodynamics is written on the blackboard, equating the differential heat exchanged between the system and its surroundings with the differential change in the internal energy plus the differential work terms. In the work terms are the three mechanical work terms in addition to the thermodynamic work. It is then pointed out to the students that the right hand side of the equation has five independent variables and it is stated that five equations are needed which relate these variables in order to have a solvable system. Usually the first statement made at this point is that conservation of mass guarantees that the mass density may be written as a function of space and time and, therefore, only four additional equations are needed, which are stated as being the Equation of State and the three mechanical equations of motion, such as Newton's.

But what about the case when mass isn't conserved? Can mass density be written as a function of space and time for this case also? If it may not then the fundamental dimensionality of nature must be five dimensions. Where does this lead? It has already been shown that the stability conditions lead to metrics upon which the Entropy Principle works to provide equations of motion when the metric coefficients are assumed known and field equations for these coefficients when they are not known. Thus, it is necessary only to work out what the implications of the five fundamental dimensions would be, compare them to the existing theories in those regions of physical phenomena where the existing theories are known to work and see if there is some predictable critical experiment that may be conducted to test the new theory.

To begin the investigation of the implications of this five-dimensional system first consider the system to be isolated. The principle of increasing entropy becomes effective and the equations of motion are the equations of geodesics in a five-dimensional manifold of space, time, and mass density.

The First Law for five dimensions may be written as

$$\_\tilde{E} = d\tilde{U} - \frac{P}{l^2} dl - F_a dq^a , \quad (a = 1,2,3) \tag{10}$$

where the tilde denotes specific quantities. The entropy variational principle, as stated in Eqn. (5), becomes

$$d \int \sqrt{(dS)^2} = d \int \sqrt{(g\, dq^0)^2} = d \int g \sqrt{(dq^0)^2} = 0 \tag{11}$$

where now q^0 is the specific entropy.

The system's specific energy is now given in terms of the five variables specific entropy, space, and mass density. The stability condition, and hence the metric, is then stated in terms of these same variables. The stability condition is stated as

$$h_{ii}\,dq^i\,dq^i = \frac{\partial^2 \tilde{U}}{\partial q^i \partial q^i}\,dq^i\,dq^i > 0 \;\; ; \; (i = 0,1,2,3,4)$$

(12)

where $q^4 = \tilde{a}/a_0$. The metric may then be written as Eqn. (3) with the indices running from 0 through 4. Eqn.s (7) and (8) give the five-dimensional geometry when the indices also take on the value 4.

Equations of Motion

The equations of motion are obtained when it is assumed that the coefficients of the metric are given and one looks at the Euler equations giving the variations of the coordinates which satisfy the variational condition. By using the variational principle from Eqn. (11) one finds the force densities to be given by

$$F^i = g\, f^i$$

(13)

with

$$f^i = \frac{du^i}{dq^0} + \begin{pmatrix} i \\ lk \end{pmatrix} u^l u^k$$

where u^i are the components of the five-dimensional velocity vector, the

$$\begin{pmatrix} i \\ lk \end{pmatrix}$$

are the Christoffel symbols, and f^i are the components of the five-dimensional acceleration vector. Obviously, if the mass density is considered to be conserved such that $u^4 = 0$ and the system is near equilibrium so that a flat metric makes a good approximation, then the volume integral of Eqn. (13) becomes the force-mass-acceleration relation of Special Relativity. Therefore, Einstein's Special Theory is obtained within this theory by employing the restrictions of an isolated system near equilibrium, with conservation of mass.

It is interesting to note that the inertial mass density comes from the fact that the stability conditions are given in terms of specific quantities while the Entropy Principle is stated in terms of the entropy. This fact will take on an even more interesting character when we consider the comparison between inertial and gravitating mass.

Another interesting fact is that if the First Law is considered for an isolated system, one obtains

$$\_E = 0 = d\tilde{U} - \frac{p}{g^2} dg - \tilde{F}_a \, dx^a \quad ; \quad (a = 1,2,3)$$

so that

$$d\tilde{U} = \tilde{F}_a \, dx^a \quad ; \quad (a = 1,2,3,4) \tag{14}$$

When the energy integral of Eqn. (14) is evaluated one finds

$$\tilde{U} = g\, c^2 + \frac{1}{2} g\, v^2 + \frac{1}{2}\frac{g}{(a_o)^2}(\dot{g}\ )^2 \tag{15}$$

where $u^4 = /a_0$ is used and it is assumed that the system is near rest. The energy density in Eqn. (15) includes the rest energy term because the integral requires it; not because of a constant of integration as in the Special Theory of Relativity. Further, because the system was considered to be isolated, đE=0, then the appearance of the rest energy term in the expression for the system specific energy brings with it some sublities of interpretation not found in Einstein's Special Theory where energy and mass are equated one-for-one. For instance, the one-to-one correspondence between energy and mass exists only for resting mass when mass is conserved. Also notice that the Special Theory of Relativity energy equivalence may exist only for isolated systems. Also, if we require the usual conservation of mass then dã/dt=0 and Eqn. (15) reduces to the rest energy plus the classical kinetic energy.

Gauge Fields

When the standard variational techniques are used on the metric for the isolated, five-dimensional system, it is found[6] that the gauge function yields a gauge field with ten components as

$$F_{ij} = \begin{pmatrix} 0 & iE_1 & iE_2 & iE_3 & iV_4 \\ -iE_1 & 0 & B_3 & -B_2 & V_1 \\ -iE_2 & -B_3 & 0 & B_1 & V_2 \\ -iE_3 & B_2 & -B_1 & 0 & V_3 \\ -iV_4 & -V_1 & -V_2 & -V_3 & 0 \end{pmatrix} \tag{16}$$

and eight partial differential equations, Eqn. (17),

$$\overline{\Delta}\_\overline{B} = 0$$

$$\frac{1}{c}\frac{\partial \overline{B}}{\partial t} + \overline{\Delta} x \overline{E} = \overline{0}$$

$$\overline{\Delta} x \overline{B} - \frac{1}{c}\frac{\partial \overline{E}}{\partial t} + a_0 \frac{\partial \overline{V}}{\partial g} = \frac{4p\overline{J}}{c}$$

$$\overline{\Delta}\_\overline{E} + a_0\frac{\partial V_4}{\partial g} = 4pr$$

$$\frac{\partial r}{\partial t} + \overline{\Delta}\_\overline{J} + a_0 \frac{\partial J_4}{\partial g} = 0$$

$$\overline{\Delta} x \overline{V} + a_0 \frac{\partial \overline{B}}{\partial g} = 0$$

$$\overline{\Delta} V_4 + \frac{1}{c}\frac{\partial \overline{V}}{\partial t} = a_0 \frac{\partial \overline{E}}{\partial g}$$

$$\overline{\Delta}\_\overline{V} + \frac{1}{c}\frac{\partial V_4}{\partial t} = -\frac{4p}{c}J_4$$

(17)

which replace Maxwell's four equations and the equation of charge continuity.

However, there are four new field components appearing in these eight field equations. When these are assumed to be zero the system of equations collapses back to the Maxwell's equations of electromagnetism. It is no surprise that the collapse of the eight equations produces the Maxwell system; this has been shown by many researchers. The objective becomes one of how are these new field components to be interpreted?

Initial investigations led into the five-dimensional quantum mechanics and to a predicted magnetic moment for neutrally charged particles[7] (discussed later). Current theories ascribe these anomalous magnetic moments to the strong nuclear force. This led to the erroneous interpretation that these new field components must be related to the nuclear forces. This turned out to be wrong when later research was conducted in which a closer look was taken at the concept of fundamental particles.

Fundamental Particle Fields

The concept of fundamental particles might be rather loosely stated as something like "smallest possible" or "cannot be further divided". But one generations' fundamental particles have been divided by the next generation until there now exists a plethora of "fundamental" particles and the search for more continues. But how can the concept of "fundamental particle" be stated with mathematical rigor? If a mathematical statement for this "state" can be put forth, then the logic of mathematics may be used upon the field equations and it should then be possible to determine what fields these "particles" or "states" might have.

Consider the concept of a fundamental particle and look for a mathematical definition for it. First, consider the realm of thermodynamics where the very stable states are isentropic states and, therefore, suppose that the fundamental particles are isentropic states. When one looks at the metric for an isentropic state of an isolated system one finds that the condition which the German physicist London imposed upon Weyl's theory in 1927 is required. Namely, one finds that in order to satisfy the isentropic condition the line integral formed by the gauge potentials and the differentials of the metric variables must be quantized, or since $\eth E=0$, then, from Eqn. (8), $(ds)=(ds)_0$ so that

$$e^{\int f_j dx^j} = 1 \tag{18}$$

which is satisfied only if

$$\int f_j dx^j = 2piN \tag{19}$$

where N is an integer and i is the square root of minus one.

When a line integral is encountered in the class room the students are generally asked to find the value of the line integral given a certain path. Here though, one has a line integral that already has a value. There are then two questions that might be asked. First, if the gauge potentials are given, what are the paths allowed? London's work answered this question[5]. The only paths possible are those given by the solutions to the quantum mechanical equations of motion. Further consequences of this result will be discussed later. The second question that might be asked of the line integral is; what gauge potentials are allowed by the line integral if the value of the integral is independent of the path? This is asking what potentials may be used in the integral which will produce a quantized value for the integral independent of the path considered? This is the same as asking "What fields may a particle have if these fields are to be independent of the path?"

If the value of the integral is to be independent of the path, then Eqn. (19) must be true even when all dx^j are zero but one. Thus, the quantum condition requires that

$$\int f_k dx^k = 2piN, \tag{20}$$

where there is no summation on k. Eqn. (20) must be true for all k, and because one is free to choose the path, the φ_k must reflect the quantization represented by the integer N. Therefore,

$$f_j = N_j \tilde{f}_j \tag{21}$$

where there is no sum on j and the may not be quantized. Thus, Eqn. (21) represents the first response to the question concerning what φ_j are allowed for fundamental particles; the gauge potentials must be quantized.

This is the first known quantization of the gauge potentials for particles which is required by some fundamental condition, such as the isentropic state requirement. Restating; this is the first display of a logical necessity for quantization of electric charge based upon fundamental principles and obtained by restrictive assumptions.

By using the mathematical approach of assuming a solution in the form of a product of functions of independent variables and setting

$$\log f^{\frac{1}{2}} = f_t f_r f_q f_f f_g ,$$

the trial solution was run through the eight field equations of Eqn. (17)[8]. The result produced for the radial function is

$$f_r = \frac{k}{r} e^{-\frac{l}{r}} . \tag{22}$$

Here ë depends upon the particle and the potential displays some familiar attributes of the Maxwellian gauge potential and some that are, at first, surprising. The potential corresponding to the classical electromagnetic potential

$$f_r = \frac{Zk}{r} e^{-\frac{l}{r}} \tag{23}$$

where Z is the quantum number required by the quantum condition, depends only upon the radial distance from the particle, not just the usual 1/r dependence. At first glance one is prompted to state that this is the Yukawa potential. However, the exponent in the Yukawa potential goes as r rather than 1/r. One may also note that this potential has no singularities for any value of the radial distance r. At distances much greater than ë this potential (herein called the Neo-Coulombic potential) has the familiar 1/r form from electrostatics and Newtonian gravitation. When the radial distance equals lambda the potential has its maximum absolute value. Because of the overriding effect of the exponential the potential returns to zero as r tends to zero. The Neo-Coulombic potential is so well behaved that all of its derivatives are also non-singular. This property will prove to be of extreme value when considering such a potential in quantum mechanic systems since no renormalization is required. Therefore, the usual problems arising with renormalization do not appear with this potential.

The Neo-Coulombic potential gives the electric field radial component a long range $1/r^2$ dependence that we know for the electric field,

$$E_r = \frac{Zk}{r^2}\left(1 - \frac{l}{r}\right)e^{-\frac{l}{r}}. \tag{24}$$

It also requires that the electric field rise to a maximum absolute value as r decreases from infinity, go to zero as r approaches lambda, reverse sign as r becomes smaller than lambda, go to another maximum absolute value and then approach zero as r tends to zero. This short range behavior is drastically different from that of the usual electrostatic field and will have enormous consequences for the nuclear phenomena wherein the radial separations are of the order of the lambdas of the fundamental particles.

The next thing noticed about the gauge potentials arrived at by the above method is that the new three dimensional vector field has two multiplicative factors, for

$$V_r = W(1+bt)\frac{1}{r^2}\left(1 - \frac{l}{r}\right)e^{-\frac{l}{r}} \tag{25}$$

The first factor has the same radial dependence of the electric field and hence the long range $1/r^2$ dependence. If this is to represent a physical field other than the electric field then it must be the gravitational field. To further confuse the issue, the second multiplicative factor involves a dependence upon time. At first this may seem to run counter to all knowledge of gravitational effects; however, later it shall be shown that this time dependence is all important in gravitational phenomena.

Is it possible then that the ten gauge field components may be made up of the three electric field components, three magnetic field components, three gravitational field components, and the gravitational potential? Only by working through the predictions of the theory in the various areas of physical phenomena can it be determined whether the predictions can be supported by the experimental evidence or if the predictions run counter to the evidence. If there exists experimental evidence that is in measurable direct conflict with the predictions of the theory then the theory must be wrong. On the other hand, if the predictions are supported by the evidence and predictions exist which may be used to test the validity of the theory then the theory deserves more than a offhand dismissal just because it disagrees with existing theories or beliefs.

Quantization Derived

The strength of the quantum-theoretical structure is such that it has swept aside virtually every attack upon it. However, using classical definitions of commutivity it may be shown[9] that the anti-commutivity of the position and momentum is dependent upon the metric approximating a flat metric. If a realm of conditions exists that does not allow a flat metric approximation then the commutators must depend upon the geometry. One finds that

$$[x^j, p^k]\Psi = i\hbar g^{kl}\left[d_{jl} + \begin{pmatrix} j \\ sl \end{pmatrix} x^s\right] y$$

where the

$$\begin{pmatrix} j \\ sl \end{pmatrix}$$

are the Christoffel symbols. This much does not depend upon any theory whatsoever, but only upon the mathematics of differentiation. Since the quantum Poisson brackets must correspond to the classical Poisson brackets, then they also depend upon the geometry in the same fashion. In the past it has been possible to argue that if the only physical field that affects the geometry is the Einsteinian gravitational field, then it is possible to ignore this geometrical effect upon the commutivity of space and momentum in nuclear phenomena. If, however, the gravitational field is described by a gauge field then this argument is nullified because the gauge fields do play a large role in the realm of nuclear physics.

The German physicist London produce a quantization of Weyl's theory in 1927. In his work, London showed that if the arc length of the metric was required to return to its original value, a quantization was produced and that the wave function was proportional to this arc length. However, there was a difficulty with his work; it required an imaginary distance.

The proposed theory not only removes the difficulty of the imaginary distance but further, logically produces the quantization conditions when the system is placed under an additional restriction. The quantum condition, as stated before, comes from restricting one's attention to systems which are isentropic. The requirement that the system have a constant entropy is the simplest restriction that produces London's quantization. The imaginary distance appearing in London's work also appears here in the entropy manifold. However, the attractive electromagnetic force comes from a negative gauge function which couples the "distance" in the manifold with the Weyl geometry to the entropy manifold. In the entropy manifold the change in entropy is the distance and, therefore, distance must always be real and non-negative for an isolated system because of the principle of increasing entropy.

The proposed theory then logically produces London's assumption and removes the difficulty with imaginary distances. Further, it is found that the quantization conditions are limited to a system with a distance curvature, or gauge function. Thus, the interpretation of universal application of a non-varying, least unit of action coming from Heisenberg's Uncertainty Principle rests with the existence, or lack, of a distance curvature and not with the existence of a vector curvature. Equivalently, only forces that may be expressed in terms of a gauge function, or distance curvature, may exhibit quantization, while forces describable by only a vector curvature cannot be quantized. If the above interpretation of the new field components as gravitational field components holds up as gauge field components then gravitational effects may be quantized as well as the electromagnetic effects.

This description of the derivation of quantum mechanics from generalizations of the classical thermodynamics runs counter to the commonly held belief that one may derive classical thermodynamics using statistical methods and a variety of force laws. This contention is, however, without rigorous support, as may be seen when one considers the development of statistical thermodynamics. For instance, in order to talk of a statistical temperature one must start by assuming Newtonian physics (this constitutes three fundamental assumptions). Given Newtonian, or other physics, one can talk of an energy distribution, canonical ensembles and statistical temperature; however, one must make an additional fundamental assumption (the Equipartition Law) before the statistical heat capacities may be obtained.

In order to obtain thermodynamics two more assumptions are required. It was pointed out by Peter G. Bergmann[10] that using the statistical approach one may obtain an expression for the difference in the heat exchanged between the system and the surroundings and the element of work done. In classical thermodynamics this difference is the change in internal energy which is path independent. In the statistical approach the difference is obtained without reference to the internal energy. To claim that the statistically derived expression is an exact differential is a logically new assertion; it constitutes the First Law of Thermodynamics. In addition, the assumptions of statistical thermodynamics allow the derivation of the fact that the differential of heat exchanged must be greater than, or equal to, the multiplication of the statistical temperature by the differential change in the statistical entropy. This product of statistical thermodynamic properties is similar to an identical product of thermodynamic properties. In statistical thermodynamics it is asserted that the ratio of the statistical temperature and the classical temperature is Boltzman's constant. Once this assertion is made, the statistical entropy may be related to the classical entropy. However, there is no logical necessity that the ratio of temperatures be a constant from the statistical approach; only if it is a constant can there be a one-to-one correspondence between the statistical entropy and the classical entropy.

The above quantum condition establishes the conditions assumed by London and, therefore, one may follow his work in deriving the Schrodinger quantum mechanics. London's work establishes how quantum mechanics may be derived within the framework of a larger theory and will not be repeated here. Rather, a sketch of the five-dimensional quantum mechanics will be presented[11].

The variational principle required by the entropy principle is given by Eqn. (11). Because multiplication by a constant does not change the problem, one may write

$$d \int g\, c^2 \sqrt{(dq^0)^2} = 0. \tag{26}$$

By defining the velocity vector as $u^j = dx^j/dq^0$ and the momentum as $p_j = ãcg_{jk}u^k$, where the fact that $g_{jk}u^ju^k = 1$ has been used, one may show that $p_jp^j = ã^2c^2$, which is the five-dimensional "momentum-energy" relation.

Because of the benefits of a first-order differential wave equation, Dirac sought to find a first-order operator equation that also satisfied the second 0-order Klein-Gordon equation (the operator equivalent to the momentum-energy relation). This can also be done in five dimensions by taking the specific Hamiltonian operator to be

$$h = i\left(a_1 \frac{\partial}{\partial x^1} + a_2 \frac{\partial}{\partial x^2} + a_3 \frac{\partial}{\partial x^3} + a_4 \frac{\partial}{\partial x^4} \right) - b\,. \tag{27}$$

By taking the four partial derivatives in Eqn. (27) as the components of the four-vector specific momentum operator, one may write

$$h = -(\bar{a}\_\bar{P} + b\ ) \tag{28}$$

where natural units, h = c = 1, have been used.

If one takes the $p^0|> = h|>$ and requires that the alphas and beta are to be chosen such that solutions of this equation are also solutions of Eqn. (28), one finds the restrictions imposed upon the choice of the alphas and beta to be

$$(\bar{a}\_\bar{P})^2 = P^2,$$
$$b^2 = 1,$$
$$\bar{a}b + b\bar{a} = 0.$$

(29)

The set of 4 x 4 matrices satisfying the requirements of Eqn. (29) is given as

$$b = \begin{pmatrix} I & 0 \\ 0 & I \end{pmatrix},$$
$$a_j = \begin{pmatrix} s_j & 0 \\ 0 & s_j \end{pmatrix}; \; j = 1,2,3,,$$
$$a_4 = \begin{pmatrix} -s_2 & 0 \\ 0 & -s_2 \end{pmatrix}$$

(30)

where I is the 2 by 2 identity matrix and the sigmas are the 2 by 2 Pauli spin matrices.

Then the five-dimensional Dirac equation may be taken to be

$$i\frac{\partial}{\partial t}y(t) = i(\bar{a}\_\bar{\Delta} - b)y(x)$$

(31)

where we have used the four-dimensional vector operator. By defining

$$g^0 = b; \quad g^j = -ba_j; \quad j = 1,2,3,4,$$

then Eqn. (31) may be written as

$$(i\partial_j g^j + 1)y(x) = 0.$$

(32)

Taking into consideration Eqn. (32) with the gauge fields of Eqn. (16), one arrives at

$$\left[(i\partial_j - f_j)(i\partial^k - f^k) - 1 - \frac{1}{2}i F_{jk} s^{jk}\right] y = 0$$

(33)

where

$$s^{jk} = \begin{pmatrix} 0 & \dot{x}^1 & \dot{x}^2 & \dot{x}^3 & \dot{x}^4 \\ -\dot{x}^1 & 0 & -2is^3 & 2is^2 & 2iu^1 \\ -\dot{x}^2 & 2is^3 & 0 & -2is^1 & 2iu^2 \\ -\dot{x}^3 & -21s^2 & 2is^1 & 0 & 21u^3 \\ -\dot{x}^4 & -2iu^1 & -2iu^2 & -2iu^3 & 0 \end{pmatrix} \qquad (34)$$

and s is the usual intrinsic spin while u is a new spin appearing because of the added dimension. By expanding, one finds that Eqn. (33) becomes

$$[(i\partial_j - f_j)(i\partial^k - f^k) - 1 + 2\bar{B}\bullet\bar{s} + 2\bar{V}\bullet\bar{u} + i\bar{E}\bullet\bar{v} - iV_4\dot{x}^4]y = 0. \qquad (35)$$

Recalling the field equations of Eqn. (17), even a particle without an electric charge (that is an electrically neutral particle) may have a magnetic moment because, for ñ = J = 0, one finds

$$\bar{\Delta}\bullet\bar{E} = -a_0\frac{\partial V_4}{\partial g} \quad \bar{\Delta}x\bar{B} - \frac{1}{c}\frac{\partial\bar{E}}{\partial t} = -a_0\frac{\partial\bar{V}}{\partial g}. \qquad (36)$$

If these new fields are to be interpreted as the gravitational fields then Eqn. (36) may be interpreted as requiring a magnetic moment for spinning, gravitating particles.

An interesting result occurs when one looks at the allowed fundamental spin states. In the five-dimensional quantization of the space-time-mass manifold, three spin vectors appear. One of these is the familiar three-component spin vector of relativistic quantum mechanics; the second of the three is a new three-component spin vector; the remaining is a four-component spin vector defined below.

Using the theorem, if α satisfies $\alpha^2 = a^2$ where a is a number, then the eigenvalues of α are $\pm$a, it is not difficult to show that the component eigenvalues are:

$$s_a = \pm\frac{1}{2},\ u_a = \pm\frac{1}{2},\ S_j^{\,2} = \frac{3}{4};\ a = 1,2,3\ j = 1,2,3,4. \qquad (37)$$

If, in analogy with the eigenvalues for the total angular momentum, one writes

$$S_j^{\,2} = \frac{3}{4} = S_j(S_j+1)$$

then the possible eigenvalues become

$$s_a = +\_\frac{1}{2},\; u_a = +\_\frac{1}{2},\; S_j = \frac{1}{2},\text{-}\frac{3}{2}.$$

However, the following relations, which specify the components of a four-dimensional spin vector which, when added to the angular four-momentum, commutes with the specific Hamiltonian, restrict the number of possible combinations of these eigenvalues.

$$S_1 = s_1 - u_2 - u_3,\; S_2 = s_2 + u_1 - u_3$$
$$S_3 = s_3 + u_1 + u_2,\; S_4 = s_1 - s_2 + s_3.$$

The question to be asked now seems to be, how many combinations of the above eigenvalues are allowed? The answer may be shown to be octets. This predicted result compares with the experimental findings of Gel Mann.

By deriving the quantization conditions and using London's derivation of the quantum mechanics from this condition one obtains classical atomic physics by assuming that the effects of the gravitational gauge field components may be neglected. Thus, there appears to be no effect of the proposed theory upon the atomic physics that is now known.

There is an astonishing effect of the Neo-Coulombic potential upon how one might describe nuclear phenomena. One of the first features noted about the potential was its return to a zero value as the radial value approaches zero. This has the effect of producing a force given by,

$$F = \left(\frac{q_1 k}{r^2}\right)\left(1 - \frac{l_1}{r}\right)e^{-\frac{l_1}{r}}. \tag{38}$$

If this force is repulsive when r is infinite for like particles, it becomes zero when the separation is at the distance lambda and becomes a strongly attractive force when the separation becomes less than lambda. This is just the sort of behavior found when proton-proton scattering was first done at high enough energies to see a deviation from Coulombic scattering. The expression for the Neo-Coulombic scattering cross-section was found to be

$$ds = \left(\frac{q_1 q_2}{2mV_0^{\,2}}\right)\left[\frac{2p\sin q\,dq}{\sin^4(\frac{q}{2})}\right]d,$$

where

$$d = \frac{1+6\left(\frac{4lE}{k}\right)^2 \sin^4(\frac{q}{2})\left[1+\frac{1}{2}(p-q)\tan(\frac{q}{2})\right]}{\left[1+\frac{3}{2}\left(\frac{4lE}{k}\right)^2 \sin^2(\frac{q}{2})\sin q(p-q)\right]^4}.$$

This scattering cross section for like-particle interaction appears to have the right dependencies to explain the scattering data. It remains to compare prediction with existing experimental data to determine the validity of the predictions and the ability of the Neo-Coulombic potential to explain the Strong Nuclear Force with that portion of its radial dependence that causes the value of the potential to return to zero.

When unlike particles are considered care must be taken to keep the lambdas in the forces straight. The force on any charged particle due to the presence of another, second particle, is the product of the charge of the first particle and the field of the second particle. Thus, the force on the first particle goes to zero at the lambda of the second. For the force on a proton due to the field of an electron

$$F_p = q_p E_e = \left(-\frac{k}{r^2}\right)\left(1-\frac{l_e}{r}\right)e^{-\frac{l_e}{r}} \qquad (39)$$

while the force on an electron due to the field of a proton is

$$F_e = q_e E_p = \left(\frac{k}{r^2}\right)\left(1-\frac{l_p}{r}\right)e^{-\frac{l_p}{r}}. \qquad (40)$$

By looking at proton and electron like-particle scattering data it would appear that the lambda of the proton must be much larger than that of the electron. If this is the case then the force on the electron due to the near presence of the proton goes to zero while the proton is still attracted to the electron. Any further decrease in the separation causes the electron to experience a repulsive force; although the proton is still attracted to the electron. This immediately raises the eyebrows. Can it be that Newton's Third Law, concerning the equal and opposite forces, does not hold in Nature? The answer is, certainly. Newton's Third Law does <u>not</u> hold in high-speed electromagnetic interactions when viewed by the retarded potentials; it was found to be violated during beta decay until the hypothesis of the neutrino reinstated the summation of particle spins. Should one then throw out the unlike-particle forces because they violate Newton's Third Law without seeing what predictions these forces might lead to?

If one proceeds with the unlike-particle forces, he finds very quickly that it appears possible that the proton might find a very close orbit, at a separation from the electron by a distance lambda, in which it could settle down into a Bohr orbit around the electron. On the other hand the electron would experience no force from the orbiting proton. Such a state might cause one to think of the neutron. Here one runs into the question of particle spins that beta decay brought out and which led to the hypothesis of the neutrino. Also, the argument is offered that Heisenberg's Uncertainty Principle requires that the electron could never be in an orbit so tightly bound that the orbit is less than nuclear separations. This argument hinges upon the unit of action being Planck's constant. But remember the dependence of the Poisson brackets upon the geometry?

Another argument against the neutron being an electron and proton in nuclear-sized orbits is based on an argument that the principle of angular momentum cannot be conserved. The neo-coulombic forces, which require that the force between the electron and proton be directed on a line between them, also requires that the angular momentum be conserved. However, the unit of action depends upon the gauge function and this requires that, when Bohr-type orbits are considered, there is an effective unit of action for the electron orbit and a different effective unit of action for the proton orbit. Thus, the effective unit of action for the electron orbit requires that in the neutron the orbital angular momentum would be given by h_e and its intrinsic spin angular momentum would be $(1/2)h_e$. Similarly, for the proton the orbital angular momentum would be h_p and the spin $(1/2)\, h_p$.

After the neutron decays, the angular momentum is the sum of the two particles' intrinsic spin angular momenta, which is given by because both particles are free and therefore, each has an intrinsic spin angular momentum of (1/2) h. Thus, the conservation of angular momentum is expressed as

$$\frac{1}{2}(\pm\hbar_e \pm \hbar_p) + \hbar_e + \hbar_p = \hbar. \tag{41}$$

Experimental evidence of orbital and/or spin angular momentum is contained in the experimental magnetic moments. If one equates the intrinsic and orbital magnetic moments of the electron and proton while they are in the orbital configuration to the experimental value of the neutron's magnetic moment they have

$$\pm\frac{1}{2}\left(\frac{\hbar_e}{\hbar}\right)m_B \pm \left(\frac{\hbar_p}{\hbar}\right)m_n - \tag{42}$$

where ì$_B$ is the Bohr magneton and ì$_n$ is the nuclear magneton. Eqn.s (41) and (42) require that $h_e = 8.0517 \times 10^{-4}h$ and $h_p = 0.66585h$. Thus, within the proposed theory the neutron appears to be a proton in orbit around an electron.

Not surprisingly then, it is possible to build a nuclear model of the protons-around-electrons, and electrons-around-positrons, states that allow one to predict the masses of the nuclei which have a mass number less than 10 amu with better RMS error than the best of the semi-empirical mass formulas have for mass numbers greater than oxygen[13]. This should possibly be considered all the more significant since the semi-empirical mass formulas have ever increasing errors for the low mass numbers and are not even used below an amu of 16. It remains for this nuclear model to be extended to the higher mass numbers, but it appears from the work done thus far that one can only expect that the correspondence with experiment will improve with increasing mass numbers.

Is it possible that the Neo-Coulombic forces can explain the phenomena associated with the weak forces? Certainly the nuclear mass predictions argues that a nuclear model based upon these orbits does not miss far and is a much cleaner model than currently used. Initial looks at the neutrino experiments using the proposed theory offer other explanations for these experimental results but are too lengthy to include here. It should be remembered that these experiments must be explained by the proposed theory if the unlike forces are to fully account for phenomena that the weak nuclear forces are now thought to explain.

The long range $1/r^2$ dependence of the new three-dimensional vector gauge field component suggests that these components are the components of the gravitational field. If this is to be the case the proposed theory must then explain the same phenomena that the General Theory of Relativity predicts. First, note that the gravitational field components in the gauge field tensor must have units equivalent to the electric field components. Following up on this, one finds that a charge-to-mass ratio is needed to convert the gravitational field units from the familiar units of acceleration to the volts/meter units used in the gauge field tensor. By considering the new fields and comparing them to the currently used fields one finds that this ratio is given by the square root of the product of the gravitational constant and the dielectric constant, or

$$b = \sqrt{eG} = 2.4296 x 10^{-11} \ \ coul/kg. \tag{43}$$

An interesting result follows immediately. If the fundamental charge-to-mass ratio works as it appears to, and electrically neutral spinning bodies have magnetic moments, then the predictions of magnetic moments for electrically neutral bodies may be made by determining the effective charge density of the rotating gravitating body using the charge-to-mass ratio and the spin of the body. A simple calculation of the earth's magnetic moment, assuming uniform mass distribution, by this method produced a prediction of the magnetic moment 1.06 times the actual value[14]. This prediction seems surprisingly close considering the uncertainties in the density measurements of the mass distribution of the earth.

One of the predictions of Einstein's General Theory of Relativity concerns the tendency of light from stars and other objects in the heavens to be shifted towards the red color end of the spectrum. Looking at the emission and reception of light within the framework of the proposed theory one finds that the unit of action, which establishes the energy of any state, depends upon both the relative time and the gravitational field at the time and place of the emission and reception. This is so because the theory holds the gravitational field to be a gauge field and it is the gauge function that determines the applicable unit of action. It is not difficult to show that

$$[x^j, p^k] y = i\hbar g^{kl}\left[d_{jl} + \begin{pmatrix} j \\ sl \end{pmatrix} x^s \right] y \, . \tag{44}$$

Thus, for a metric with only a gauge function the effective unit of action would be given by

$$\hbar' = \hbar \exp[2 f_t f_r f_g]. \tag{45}$$

By recalling the gauge gravitational field of Eqn. (25), one may use Eqn. (45) to find the expression for the unit of action for emission of a photon to be

$$\hbar_e = \hbar \exp\left[\frac{W_e(1+bt_e)}{R_e} e^{-\frac{l_e}{R_e}} \right] \tag{46}$$

where the subscript, e, denotes emission. Similarly, the unit of action for the reception of a photon can be found to be

$$\hbar_r = \hbar \exp\left[\frac{W_r(1+bt_r)}{R_r} e^{-\frac{l_r}{R_r}} \right]. \tag{47}$$

If photon energy is conserved between emission and reception then

$$\hbar_e n_e = \hbar_r n_r \, . \tag{48}$$

If one sets $t_e = 0$, $t_r = L/c$, $W = (-GM/c^2)$, and $b = -H$, then they find the shift in frequency given by

By looking at the first order approximations of this prediction one finds that the time dependence of the gravitational field produces the linear dependence and is given by Hubble's constant while the gravitational potential produces the same prediction that comes from Einstein's theory.

$$\frac{\Delta l}{l_e} = \exp\left[\left(-\frac{G}{c^2}\right)\left[\frac{M_r e^{-\frac{l_r}{R_r}}}{R_r} - \frac{M_e e^{-\frac{l_e}{R_e}}}{R_e}\right] + \left(\frac{HL}{c}\right) e^{-\frac{l_r}{R_r}}\right] - 1. \qquad (49)$$

Looking a little closer one finds that the time dependence of the red shift produces an experimental number, $H^{-1} = (5.6+0.6) \times 10^{17}$ sec. ($1.61 \times 10^{-18}\ \text{sec}^{-1} < H < 2.0 \times 10^{-18}\ \text{sec}^{-1}$), that corresponds to the same time dependence that has been measured and reported for the moon's orbit[15] ($b=1.9 \times 10^{-18}\ \text{sec}^{-1}$), well within experimental error. It is somewhat pleasing that a prediction coming from the same time dependence originating in the gauge function leads to a comparison of phenomena involving cosmological distances agrees with phenomena involving the much shorter distance involved in the moon's orbit. Another possible plus to this prediction is that, because the prediction involves an exponential dependence upon time and gravitational potential between the emission and reception of the light, then the distances that are currently ascribed to distant bodies by their red shifts may be much greater than the actual distances. Also, the possible red shifts from dense gravitating bodies may be much greater than is now believed possible thereby removing the mystery from many objects.

The time dependence of the gravitational field stems from the principle increasing entropy and is a direct result of this inflation-like effect imposed upon the universe by the denial of perpetual motion. An additional implication follows for the use of dating processes which depend upon radioactive processes in that the unit of action changes with time in accordance with that same time dependence. The results would be that all of the dates would have to be adjusted downward.

The prediction of the advance of the perihelion of the planetary orbits is the one prediction of Einstein's General Theory of Relativity that requires the entire formal theory. Within the proposed theory one obtains an advance to the planetary orbital perihelion by simply using the low velocity Newtonian equations of motion with the Neo-Coulombic gravitational potential, which is

$$d_q \approx 2p\left(\frac{3l\,GMm^2}{L^2}\right) \tag{50}$$

The perihelion advance predicted by the General Theory of Relativity is given by[16]

$$d_{qGTR} = 2p\left(\frac{3G^2M^2m^2}{c^2L^2}\right) \tag{51}$$

Thus, the lambda of the sun would have to be given by

$$l_{sun} = \frac{GM}{c^2} \tag{52}$$

if the proposed theory is to be identical in its prediction of planetary perihelion advance to Einstein's General Theory of Relativity.

Currently there is much discussion of experimental evidence of the need for a fifth, and even a sixth, force in Nature. The evidence points to a decreased gravitational strength when compared with Newtonian gravitation. Consider the Neo-Coulombic gravitational force which must go to zero at some value of distance that is representative of the body in question. The obvious conclusion is that the gravitational force in the proposed theory must become less than the Newtonian value as distance is decreased. Thus, a new independent force may not be necessary at this time.

There are numerous implications of this feature of the Neo-Coulombic force which will have large effects upon the concept of the universe presented by the proposed theory. For example, a gravitational force which becomes repulsive with decreasing distance denies the type of gravitational collapse now discussed by cosmologists. Neither can it support the singularities now called Blackholes. The possibility of the existance of distant bodies so massive that light cannot escape their gravitational pull has not yet been investigated.

A number of possible experimental tests have been considered. A few of these will be presented here.

The proposed theory presents a picture of the universe in which the electromagnetic and gravitational fields are components of a single gauge field tensor and, therefore, are fields on equal footing and also, more importantly, inductively coupled. This implies that manipulation of one field will inductively produce another of the fields. It is this type of inductive coupling which causes a magnetic field to be created by the flow of current. The electric field which is the source of the voltage in the alternator providing the power for home use was inductively created by passing a conductor through a magnetic field. Is it not then possible to create a gravitational field by the manipulation of the electromagnetic fields if the inductive coupling presented in the proposed theory exists?

Where might this inductive coupling most likely show up? One area of phenomena is in wave properties such as electromagnetic or, in this case, electromagnetogravitic waves. The five-dimensional wave solutions have an additional transverse field component[17] which is opposite in direction to the electric field component. This additional component is the gravitational field component. One of the results of the possible existence of this gravitational component is that while the wave energy density depends upon the sum of the squares of all wave components, the radiation pressure depends upon the sum of the squares of the electric and magnetic components, but the square of the gravitational component is subtracted from the sum of the others. This implies that the radiation pressure would always be a little less than the energy density rather than always equal to it. The initial experiments on radiation pressure and energy density showed just this difference, however, the difference was within experimental error. To date the known experimental techniques do not appear to have sufficient accuracy to measure the expected difference in these quantities.

Another experimental technique which has a much better chance of detecting the new wave component is the neutron interferometer device. Here the gravitational component is directed opposite the electric and a polarized laser beam may be used to deflect one leg of the neutron's path without causing an interaction between the magnetic component and the neutron's magnetic moment. The sensitivity of the interferometer is such that even an extremely small amount of energy in this component might be discernable.

The phase velocity of the five-dimensional waves are found to be dependent upon any divergence in the flow of a medium through which the wave is passing. This allows the possibility of slowing down the wave significantly by causing a divergent flow. The divergence possible from nozzles in continuous flow is too small to allow for other difficult factors affecting the speed of light, such as the index of refraction, to be accounted for with sufficient effect left over for clean measurement of the slow down. On the other hand, if the divergent flow were created using explosives, the one might be able to slow down gamma rays to about half the speed of light. This would involve all the usual difficulties of one-shot testing plus some other possible problems.

The very nature of the five-dimensional manifold places restrictions upon some phenomena. For instance, when looking at shockwaves in material using the proposed theory it is found that the phenomena is predicted on a four-dimensional hypersurface embedded by the conservation of mass within the five-dimensional space. This has an effect that appears like a viscosity and puts a very distinctive anti-symmetrical profile into the shock front. The recent advances in our abilities to measures differential times and distances make it appear possible to measure the rise of a shock by using a Laser Velocity Interferometer with an electronic streak camera. The predicted asymmetry is such that it would be easy to discern it from the classical symmetrical Newtonian viscosity.

The preceding has presented the fundamental laws of the proposed theory and how each of the existing theories may be shown to be either within the scope of the new theory or superseded by it. All of the results of the assumption of the laws presented here have, of course, been arrived at through rigorous mathematical logic using these laws as the starting point. The mathematical derivations have been left to later chapters in order to provide for a better flow of the overview discussion and to limit the length of the overview.

The single most important concept hoped to have been conveyed in the preceding is that the classical laws of thermodynamics contain within them the generality, applicability, and strength to allow them to provide the basis for a description of a nature much more general than the sum of all the currently known theories and contain within it the current theories as subsets.

Starting from its general five-dimensional form, the theory provides a metric in the form of the stability conditions. Two variational principles are given by the basic laws. The first, and the more general, is a Principle of Minimum Free Energy, and has not been pursued in the above discussion. Secondly, the Entropy Principle has been used throughout the preceding discussion to limit the realm of phenomena to those for which current theories are used. The basic laws determined the type of geometry of the metric. The variational principle stemming from the Entropy Principle was used to obtain the equations of motion and the field equations when the appropriate restrictions were imposed. It was the restrictions employed that allowed the concentration upon phenomena related to certain current theories.

To help interpret the five-dimensional field components, the isentropic restriction was imposed. This restriction required a quantization from which it was found that one could derive quantum mechanical equations of motion, following London's work. When the characteristics of fundamental particle gauge potentials were sought which satisfied this quantization condition it was found that the Neo-Coulombic potential appeared, requiring that the gravitational field and potential be components of a gauge field on equal footing with the electric and magnetic fields. Thus, the isentropic restriction produces the subset in which Quantum Mechanics and the fields of the fundamental particles are found.

If the system is restricted to be an isolated one and one looks at the trajectories required by the Entropy Principle, he finds that they are given by equations of motion in five dimensions. By saying that mass density may be written as a function of space and time one finds that the trajectories lie on a four-dimensional, space-time, hyper-surface embedded within the five-dimensional manifold. If one further restricts his attention to those events near equilibrium states, the metric may be approximated by a flat metric, and one finds the equations of motion to be those of Einstein's Special Theory of Relativity. A further restriction to slow moving things brings about the reduction to Newtonian equations of motion.

Turning from equations of motion to the forces of Nature, the proposed theory presents only one type of force, the gauge force, which shows up in three, three-component vector fields plus a scalar field. These fields correspond to the fields now known as the electric, magnetic, gravitational fields and the gravitational potential. Because the proposed theory displays the three forces together in a single five-dimensional field one probably should refer to all three as components of the electromagnetogravitic (EMG) force.

The theory appears to describe the phenomena currently described by the Strong Nuclear Force by the Neo-Coulombic electrostatic force which reverses its sign as the separation of like particles is reduced. For the Weak Nuclear Force the theory offers the asymmetrical unlike-particle force.

The Neo-Coulombic gravitational force not only provides the classical gravitational predictions plus the planetary perihelion advance prediction, but includes a prediction which appears to correspond to the recently observed experimental results which have brought forth talk of a fifth force in nature.

Currently used cosmological and gravitational red shifts were found to be the first-order approximations to the red shift predictions from the proposed theory. The full exponential character of the time and gravitational potential dependence of the red shifts may find usefulness in helping to describe the universe by helping to clear up some of the mysteries of the cosmos.

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