A PLANCK-LENGTH ATOMISTIC KINETIC MODEL OF PHYSICAL REALITY

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A model of physical reality is presented that combines the ancient atomistic hypothesis with modern kinetics and wave mechanics; it agrees with experimental findings, and is intuitively comprehensible. Electric charge and gravitational mass are shown to be expressible in terms of fluid mechanics, and all physical quantities solely in terms of length and time.

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INTRODUCTION

Among the queries with which Isaac Newton (1642-1727) concluded his book on optics is the following statement:

"To tell us that every Species of Things is endow'd with an occult specifick Quality by which it acts and produces manifest Effects, is to tell us nothing: But to derive two or three general Principles of Motion from Phenomena, and afterwards to tell us how the Properties and Actions of all corporeal things follow from those manifest Principles, would be a very great step in Philosophy, though the Causes of those Principles were not yet discover'd: And therefore I scruple not to propose the Principles of Motion above-mention'd, they being of very general Extent, and leave their Causes to be found out."[1]

This shows clearly that Newton was already searching for something analogous to a unified field theory. Even earlier, the concept that a fundamental substance produces all observed natural phenomena gave rise to the ancient Greek atomistic hypothesis attributed to Leucippus and Democritus (400 B.C.), and similar ideas pervade the Hindu and Chinese cosmologies. Subsequently, MacCullagh, Kelvin, Maxwell, and Lorentz, among others, attempted to describe electromagnetic phenomena in terms of various aether models, but these efforts failed to produce a theory that agreed with experimental findings reported by Oersted, Biot, Savart, Ampere, Arago, Fresnel, Faraday and Henry. Nevertheless, James Clerk Maxwell (1831-1879) concluded his 'Treatise on Electricity and Magnetism' with the following paragraph:

"But in all of these theories the question naturally occurs: - If something is transmitted from one particle to another at a distance, what is its condition after it has left the one particle and before it has reached the other? ... Hence, all these theories lead to the conception of a medium in which the propagation takes place, and if we admit this medium as an hypothesis, I think it ought to occupy a prominent place in our investigations, and that we ought to endeavor to construct a mental representation of all the details of its action, and this has been my constant aim in this treatise"[2].

Although Hendrik Antoon Lorentz (1853-1928) derived the correct mathematical representation for moving electrons, and the apparent absence of Doppler effect in the aether, as evidenced in the Michelson-Morley experiments, could have been accounted for by accepting Fitzgerald's idea on material contraction, no sensible explanation was found for the obvious absence of aether drag on matter. Albert Einstein broke this stalemate in physics by rejecting concepts based on comprehensible physical models, and instead postulated mathematical concepts based on ideas introduced earlier by Bernhard Riemann and Ernst Mach. The success of Einstein's special theory of relativity, and explanation of the photoelectric effect, in conjunction with the development of quantum mechanics with its peculiar views on physical reality, directed physics away from classical mechanistic modeling. However, Einstein still pursued the goal of developing a unified field theory by formulating his general theory of relativity but, to this day, this approach has not yielded a theory that accounts for all known experimental facts. The major obstacle seems to be the lack of a comprehensible adequate model upon which the mathematical structure could be erected.

The purpose of this paper is to reintroduce the concept of a universal aether into physics, thus providing a physical substrate from which various manifestations on a larger scale can be explained. However, it must be emphasized that the structure of the aether introduced here differs substantially from that of the luminiferous aether intended to account exclusively for electromagnetic phenomena. An excellent review of this subject was made by Whittaker [3], while recently Builder [4], Dewdney, Edmonds, and others [5], have anticipated some aspects of the model proposed here, and Honig [6] presented a succinct outline of the criteria that a viable new model must possess. It is assumed that all known physical phenomena can be derived from the proposed model when a mathematical formulation that connects the kinetics of the aether with field representations of the various manifestations of kinetic energy is developed.

Thus it will be shown that the putative aether, consisting of very small immutable oblong particles, can qualitatively generate all observed large scale phenomena. Particularly, it is demonstrated that the electromagnetic field is completely equivalent to the velocity field of the aether. Furthermore, it is shown that this equivalence can exist only when the mass is described in kinetic terms, yielding a system of measuring units expressed in terms of length and time only. It is also shown how the gravitational field can be described in terms of fluid dynamics without the need to introduce either singularities or non-Euclidean geometries. The validity of the principle of least action, and hence the Hamiltonian formulation of mechanics, is ascribed to the phenomenon of minimum in phase space describing the aether kinetics; and Heisenberg's indeterminacy relations are viewed as a natural consequence of density fluctuations in the phase space.

The probability density of quantum mechanical states is shown to be proportional to aether density, and the Ψ function to represent the number of fundamental aether particles that move in a given orientation with respect to their velocity in a given volume of space. It is also pointed out why the Ψ function, being a complex scalar quantity, cannot adequately describe phenomena that are consequences of directed transport in the aether, hence explaining the difficulties in attempts to incorporate quantum mechanics into unified field theories.

The Lorentz transformation and special theory of relativity are shown to be consequences of the Doppler effect in the aether, while the Michelson-Morley results are accounted for through the Fitzgerald contraction of all material structures. Material particles and charge are modeled as vortices in the aether, and a field equation is derived that seems to describe the velocity field of the electron vortex. Efforts are under way to solve and model this non-linear partial differential equation, but larger composite dynamic structures, describing heavier material particles, such as the proton, present much greater difficulties.

The other major challenge is the development of the kinetics that will be applicable to the aether. To handle non-spherical particles with gyroscopic effects in phase space representation is clearly not a simple task. Unfortunately, the precise field representation can probably be derived only from kinetics but, since we have no direct information on the particle parameters, the kinetic formulation will have to depend on observations of large aggregates of particles. Clearly, the kinetic models that deal with quantized molecular parameters are not applicable to the gyrons, but in a series of papers Curtiss [8] provided a derivation of the Boltzmann collision equation for rigid nonspherical rotors, based on Newtonian mechanics, that appears suitable for the task at hand when suitably modified.

The model introduced here is basically a synthesis of the Greek atomistic hypothesis and modern kinetics and wave mechanics. The "atoms", being the ultimate indivisible entities, are endowed with appropriate physical properties, and constitute a compressible fluid that used to be called aether, but, as will be shown, the proposed model of this fluid overcomes all the difficulties for which it was rejected at the turn of our century.

Since we are faced with Dalton's misappropriation of the term "atom", it is probably better to rename the putative fundamental material entity. A good descriptive choice is "gyron". In connection with this I want to mention Joseph Newman's book on his "Energy Machine"[7], where he uses the term "gyroscopic action particles" to designate the basic material entities. Although I disagree with a number of his concepts, he should be given credit for insisting on the existence of such fundamental entities.

In the model outlined below all observable forms of energy and matter consist of dynamic states in the aether that, in its steady state, represents the vacuum. It turns out that, aside from the specification of the gyron's form, the separate conservation of linear and angular momenta is the only assumption required to derive all known physical phenomena. Individually, the gyrons obey Newtonian mechanics, while collectively their kinetics produces wave phenomena in the fluid that they comprise. Thus, with this model it is not necessary to invoke the incomprehensible particle-wave duality, and the uncertainty principle can be explained on a physical basis.

The postulated gyrons have a size around $10^{-33} cm$ (the Planck length), so that the "elementary particles", with sizes around $10^{-13} cm$, are relatively of galactic proportions and, hence, are governed by the "large scale" fluid dynamics of the aether for which, due to the wave phenomena, the "relativistic" Lorentz frame of reference is valid. Consequently, the Lorentz transformation is not due to some mysterious relationship between space and time, but occurs naturally as a consequence of wave mechanics in the aether.

Thus, space and time can fundamentally be considered as Euclidean Continua that, in conjunction with the kinetics of the gyrons, produce the phenomenologically observable wave phenomena in the aether governed by the Lorentz relationships.

The above reasoning, however, was secondary in the construction of the proposed model, the primary aim of which was to find a mechanism that explains gravity. It turns out that this phenomenon can also be attributed to the aether if the gyrons have an appropriate geometrical form, and this in turn is related to neutrinos.

This model can account qualitatively for all known physical phenomena, and the restoration of common sense notions to physics should facilitate the quantitative testing of this hypothesis. This task nevertheless presents considerable difficulties, as currently there are no known analytical procedures for solving the non-linear partial differential equations that describe the behavior of this fluid; however, the powerful modern computational facilities offer some alternative possibilities.

1 The Fundamental Relationships

In the proposed model, space and time are considered to be Euclidean Continua to which no size or direction can be assigned. Embedded in these continua are permanent three-dimensional objects (gyrons) with a well-defined form and inertial parameter M that move with various translational velocities $\vec{\eta}$ and angular velocities $\vec{\omega}$. Thus, these objects correspond to the "atoms" postulated by the ancients. For reasons that will become clear later, the following assumptions are made: the gyrons (atoms) are completely rigid; they have an axially symmetrical form with a length α and a much smaller diameter β; and they are in perpetual motion, conserving momentum and energy in mutual collisions. Since these objects have five degrees of freedom, this kinetic process can be described in terms of a ten-dimensional phase space: 3 location, 2 orientation, 3 linear momentum, and 2 angular momentum coordinates.

The gyrons constitute a compressible fluid, called the aether, that permeates all of the known universe. All physical phenomena are the result of the dynamics in this fluid which is homogeneous but, unlike a molecular gas, exhibits anisotropic properties due to the shape and spin of its constituents, the gyrons. It will become clear later that the aether must be a relatively tenuous fluid, that is, the fraction of space occupied by the volume of the gyrons is much smaller than the available space in which they move. The density of the aether, corresponding to the number of gyrons per unit of space volume at a given location, is nevertheless very large, possibly on the order of 10^{90} in each cubic centimeter. This number is subject to statistical fluctuations, as is the mean free path and time between collisions. In phase space these fluctuations cause the uncertainty relations of the form $\Delta p_x \Delta x = h/2\pi = \hbar$. Also, the kinetic fluid aggregate always tends toward a minimum in phase space density, giving rise to the principle of least action that was originally propounded by Maupertuis (1698-1758), and mathematically formulated by Euler (1707-1783) and Lagrange (1736-1813).

An exact deterministic kinetic description of the aether is clearly not feasible, consequently a statistical collision approach analogous to that developed by Daniel Bernoulli (1700-1782), Maxwell, Ludwig Boltzmann (1844-1906), and elaborated upon by Joseph Liouville (1809-1882) and Josiah Willard Gibbs (1839-1903) must be employed. The aether presents a more difficult problem, mainly because the exact shape of the non-spherical gyron is still unknown, however, some simplification results due to the fact that no forces aside from the collision events need be considered. Nevertheless, based on analogies to an ideal gas model and known physical laws, it is possible qualitatively to explain all known physical phenomena in terms of the behavior of the aether. To do this it is necessary to provide some further details on the parameters describing the gyrons.

The moment of inertia *I*, which is specified by a 3 x 3 tensor, plays the central role in characterizing the dynamic behavior of the aether. Let the z-direction coincide with the vector $\vec{\alpha}$ and assign it to the long axis of the gyron. Due to the assumed axial symmetry, the moments of inertia along the principal axes bear the relationship $I_{xx} = I_{yy} \gg I_{zz}$. The dynamic behavior of a single gyron is then described by Euler's equations for a symmetrical top under no forces. Between collisions the spin momentum $\mathbf{S} = I\vec{\omega}$ maintains its direction in space, while $\vec{\alpha}$ and $\vec{\omega}$ in general precess around it.

The gyron thus can spin in two stable orientations, namely, either with $\vec{\alpha}$ and $\vec{\omega}$ lined up in nearly the same direction or nearly perpendicular to each other, but since I_{zz} is much smaller than I_{xx} and I_{yy}, the latter orientation is more stable and will, therefore, be predominant in the aether, except in a conceivable condensed state in which the less stable orientation is maintained by mutual steric constraints. In the longitudinal, less stable orientation, $\vec{\omega}$ lies between $\mathbf{S}$ and $\vec{\alpha}$, while in the transverse orientation, $\mathbf{S}$ lies between $\vec{\omega}$ and $\vec{\alpha}$. In contrast to molecular gases, in the aether the mean free path between collisions is not merely a function of the density, but instead depends strongly on the orientation between $\vec{\alpha}$ and the velocity $\vec{\eta}$. The failure to realize this was the major reason for the unsuccessful modeling efforts during the nineteenth century. I cannot yet ascertain that all the laws of thermodynamics are applicable to the aether, or that equipartition of energy is valid, but it is intuitively clear that energy in the rotational and translational forms is exchanged between the gyrons.

Let us now examine the motion of a gyron in greater detail, and from this infer the properties of the aether. It turns out that this simple model explains the paradoxes of Zeno, Berkeley's objections to calculus, as well as most of the mysteries of current quantum mechanics.

It must be realized that the moving gyron represents the only measure of extension in space and time, and that this extension is manifested to us only indirectly through the kinetics of large assemblies. Thus, while the motion of gyrons never begins or stops, the center of mass of a dynamic assembly can be at rest or it can move with a speed that does not exceed the RMS speed of the gyrons in the assembly, that is the speed of light, corresponding to the speed of wave propagation in this medium. Furthermore, since the space continuum is not densely packed, the moving gyrons represent the physical differential geometry of space and time, and as already stated by Parmenides (450 B.C), it is hard to conceive of a different arrangement that is not completely static forever. In calculus, higher order differentials can be neglected because the fundamental processes can be described in linear terms. It actually turns out that the mean orientation of the gyrons is congruent with the field vector operator ∇. Also, Eddington's conjectures regarding fluctuations in physical measurements have some validity [9, 10].

During the inter-collision time Δt, the gyron moves a distance $\eta\Delta t$, and rotates an angle $\omega\Delta t$, but how much space is swept out depends on the mutual orientations between $\vec{\eta}$, $\vec{\omega}$ and $\vec{\alpha}$. The amount of space swept out in turn determines the mean free path and inter-collision time. Consequently, one must consider separately the longitudinal and the transverse modes of travel because they yield enormously different values for the mean free path, and this in turn produces very different large-scale phenomena.

Let us first consider the stable, transverse, mode of travel. In this case, during the time interval Δt the gyron sweeps out an area $\pm(1/2)\vec{\alpha}\times\vec{\alpha}\times\vec{\omega}\Delta t$ due to rotation, and a volume $\Delta V = \pm(1/2)(\vec{\alpha}\times\vec{\alpha}\times\vec{\omega}\Delta t)\cdot\vec{\eta}\Delta t$ due to the simultaneous travel over the distance $\vec{\eta}\Delta t$. The $\pm$ signs of this pseudo-scalar represent the two possible directions of a gyron's spin. This expression relates space and time to the fundamental parameters associated with the gyron that impart a metric to these continua in phase space, but these relationships become manifested only indirectly in various large-scale phenomena. For example, in Kepler's third law $a^3\Omega^2 = G(m+M)$, space and time are related with these same dimensions. Gravitational mass and electric charge are also consequences of this relationship, which can also be written as:

$$\begin{aligned} \Delta V/(\Delta t)^2 &= \pm(1/2)(\vec{\alpha}\times\vec{\alpha}\times\vec{\omega})\cdot\vec{\eta} \\ &= \pm(1/2)\Big[(\vec{\alpha}\cdot\vec{\alpha})(\vec{\omega}\cdot\vec{\eta}) - (\vec{\alpha}\cdot\vec{\omega})(\vec{\alpha}\cdot\vec{\eta})\Big] \end{aligned} \tag{1.1}$$

Time occurs in the second order because its measure arises from the translational and angular momenta that are separately conserved and, thus, mathematically represent two dimensions. Since collisions are not central, the total angular momentum is conserved in the aether but not that of the spin separately. Actually, in the vacuum, where the gyrons exist in an equilibrium distribution, the angular momentum averages out to zero, while the net linear momentum could differ from zero, but this is not observable on a finite scale.

The remaining task is to relate the above kinetic parameters to various large-scale phenomena. In mathematical terms this requires deriving the field equations that govern the behavior of the aether as a fluid from the kinetics of the gyrons. Before this missing link is established, it is nevertheless possible to relate these phenomena in semi-quantitative terms through various known relationships.

The total energy in the aether resides in two forms of kinetic energy, translational and rotational, expressed as M$v^2 = (1/2)$M$< \eta^2 > +(1/2)I < \omega^2 >$
and consequently the MS speed is

$$v^2 = (1/2)[< \eta^2 > +(I/M) < \omega^2 >] \tag{1.2}$$

where $< \eta^2 >$ and $< \omega^2 >$ represent the mean of the square values of the translational and angular velocities of gyrons. Thus, v is the effective RMS speed, and in the equilibrium state, that is, in the vacuum, represents the speed of light c, but this can vary wherever this distribution changes. In the undisturbed vacuum the vectorial means $< \vec{\eta} >$ and $< \vec{\omega} >$ are both zero; only when linear momentum is imparted to a group of gyrons does the kinetic equilibrium change, and consequently $< \vec{\eta} >$ and $< \vec{\omega} >$ also change so that their vectorial sums do not vanish, and hence are manifested in the aether. Such a disturbance can appear in three forms:

1. waves
2. creation of a pair of opposite vortices
3. reorientation of the gyrons from the transverse to the longitudinal mode of travel

On a large scale these kinetic processes manifest themselves as:

1. electromagnetic waves, corresponding to gyron spin waves; and deBroglie material waves, corresponding to aether density waves
2. creation of matter and anti-matter with associated charge
3. production of neutrinos, and gravity

Process 2 always gives rise to process 3, but not the reverse.

If in the aether we designate the momentum density by the vector $\vec{\mathbf{g}}$ and stress by the tensor *T*, then one would expect the dynamics of this fluid to be described by the generalized Euler fluid dynamics equation $d\vec{\mathbf{g}}/dt = \nabla * T$. This equation, in conjunction with the equations of state and continuity, should in principle yield the field equations for the aether. The divergence of the tensor deals with the anisotropic properties of this fluid in contrast to the gradient of pressure that applies to the isotropic ideal gas. Also, on account of the possible longitudinal travel of the gyrons, both $\vec{\mathbf{g}}$ and *T* will in general contain complex numbers or even quaternion components. Complex numbers were introduced by Johann Karl Friedrich Gauss (1777-1855), and quaternions by William Rowan Hamilton (1805-1865).

From the above, it is clear that we are faced with formidable mathematical complexities. Also, this model shows clearly why the efforts to describe the dynamics of physical reality solely in terms of the scalar wave function, Ψ, cannot succeed.

2 The Electromagnetic Field

Maxwell has already shown that the electric **E**, and the magnetic **B**, fields can be specified in terms of the scalar potential V, and the vector potential **A**, that was introduced by Franz Neumann (1798-1895).

$$\begin{aligned} \mathbf{E} &= -\nabla V - \partial \mathbf{A}/\partial t && (2.1) \\ \mathbf{B} &= \nabla \times \mathbf{A} && (2.2) \\ \partial V/\partial t &= -c^2 \, \nabla * \mathbf{A} && (2.3) \end{aligned}$$

Furthermore, the magnetic field strength **H**, and the electric displacement **D**, are related respectively to the above field by the permeability μ_o, and permittivity ϵ_o, and these in turn are tied to the speed of wave propagation c_o, and the impedance Z_o, in the vacuum.

$$\begin{aligned} \mathbf{H} &= (1/\mu_o)\mathbf{B} && (2.4) \\ \mathbf{D} &= \epsilon_o \mathbf{E} && (2.5) \\ c_o &= 1/(\mu_o \epsilon_o)^{1/2} && (2.6) \\ Z_o &= (\mu_o/\epsilon_o)^{1/2} && (2.7) \end{aligned}$$

It turns out that the above electromagnetic field has a complete analogy in the velocity field for the aether:

$$\begin{aligned} \vec{a} &= (1/2)\nabla v^2 + \partial \vec{v}/\partial t && (2.8) \\ 2\vec{w} &= \nabla \times \vec{v} && (2.9) \\ (1/2)\partial v^2/\partial t &= -c^2 \, \nabla * \vec{v} && (2.10) \end{aligned}$$

Notice that the last equation, which was introduced into the electromagnetic field definition as an auxiliary gauge transformation, emerges in the aether velocity field naturally as a consequence of fluid mechanics.

Thus, the electric and magnetic fields correspond respectively to the acceleration and vorticity in the aether. This in turn implies that the velocity $\vec{v}$ of the field is related to the mean velocity of the gyrons $< \vec{\eta} >$, and the vorticity $\vec{w}$ to the mean angular velocity of the gyrons $< \vec{\omega} >$. Consequently, by means of the following substitutions, Maxwell's equations and all electromagnetic phenomena can be described in mechanical terms:

(vector potential)	$\mathbf{A} \Longleftrightarrow \vec{v}$	(velocity)
(scalar potential)	$V \Longleftrightarrow (1/2)v^2 = (1/2)\vec{v} * \vec{v}$	
(electric field)	$\mathbf{E} \Longleftrightarrow -\vec{a} = -d\vec{v}/dt$	(negative acceleration)
(magnetic induction)	$\mathbf{B} \Longleftrightarrow 2\vec{w} = \nabla \times \vec{v}$	(vorticity)

[Please see comment at the end of this section.]

For practical reasons, it is sometimes advantageous to represent the velocity field with a position field in the manner that was introduced by D'Alembert to convert dynamics into statics. The latter corresponds also to MacCullagh's formulation of the quasi-elastic solid aether which is, of course, physically infeasible. Similarly, Kelvin's gyrostatic aether model could not yield all the required properties for the vacuum because it did not represent the angular momentum associated with the magnetic field as a statistical mean value of individual gyron spins that react to twisting. This model that came closest to the one proposed here was subsequently elaborated, but because it was not recognized that the velocity field represents the vector potential, completely consistent representation could not be derived [11]. Furthermore, until the equivalence between energy and matter was established, it was not possible to formulate a unified field model.

The Lorentz invariance of Maxwell's equations follows from the fact that this velocity field in the aether is a group velocity phenomenon, and this is formally derived from the D'Alembertian that describes the group behavior in this fluid.

When a vortex pair is formed, two opposite circulations are established, each centered around its vortex core structure, corresponding to a positron – electron pair. These circulations in turn produce radial pressure gradients that manifest themselves as the electric fields of the particles, and that in mechanical terms represent the centrifugal accelerations in balance with the pressure gradients, while the vorticity gives rise to the associated magnetic fields. The electrical charges attract or repel each other depending on the directions of their circulation. Two circulations with the same direction repel each other because the increased collision frequency among the gyrons increases the pressure in the region between the two vortex structures, while in the case of two opposite circulations this pressure drops due to the Bernoulli effect. The permanence of vortices in ideal fluids was theoretically demonstrated by Hermann Helmholtz (1821-1894).

In fluid mechanics the convective derivative represents the total derivative of velocity with respect to time, and this corresponds to acceleration which must be zero where no external forces exist. Thus,

$$d\vec{v}/dt = \vec{a} = (\partial\vec{v}/\partial\vec{r})(d\vec{r}/dt) + \partial\vec{v}/\partial t = (\vec{v} * \nabla)\vec{v} + \partial\vec{v}/\partial t = 0,$$

and since we are interested only in the steady-state situation, where

$$\frac{\partial\vec{v}}{\partial t} = 0,$$

this becomes

$$(1/2)\nabla v^2 - \vec{v} \times \nabla \times \vec{v} = 0$$

which can be written as

$$\nabla v^2 \quad = \quad 2\vec{v} \times \nabla \times \vec{v} \tag{2.11}$$

and which is in turn equivalent to

$$\nabla V \quad = \quad \mathbf{A} \times \mathbf{B} \tag{2.12}$$

Physically, these equations express the fact that a pressure gradient in the aether is balanced by the centrifugal force due to the circulation around a vortex and, consequently equation (2.11) describes the velocity field associated with the elementary charges in the form of positrons and negatrons. The polarity of the charges is determined by the direction of the circulation, that is, by the relative orientation between $\vec{v}$ and $\nabla \times \vec{v}$. A general analytical solution of (2.11) has not yet been found, but a suitable solution may be derived by considering specific known physical facts about the electron.

Experimentally we also know that for $r > r_o$, that is, outside of the vortex core of the electron, $\nabla V = -Q\hat{r}/4\pi\epsilon_o r^2$, and correspondingly, $(1/2)\nabla v^2 = -Q\hat{r}/4\pi\epsilon_o r^2$. Therefore, the radial component of the electric field, corresponding to the pressure gradient in the aether, gives rise to the expression: $Q\hat{r} = \pm 4\pi\epsilon_o r^2\, \vec{v}\times\nabla\times\vec{v}$. This shows that charge may be considered merely a parameter in the velocity field whose dimensionality is $\epsilon_o[L^3/T^2]$.

Taking the divergence of (2.11) yields

$$\nabla * \nabla v^2 = \nabla^2 v^2 = 2(\nabla\times\vec{v})^2 - 2\vec{v} * (\nabla\times\nabla\times\vec{v})$$

[The last term is zero.] and since the Maxwell equation $\nabla * \mathbf{D} = \rho = \epsilon_o\nabla * \mathbf{E} = -(1/2)\epsilon_o\nabla^2 V$, expressed in mechanical form gives $(1/2)\epsilon_o\nabla^2 v^2 = -\rho$, it is possible to equate the Laplacians and obtain for charge density also the expression:

$$\rho = -(1/2)\epsilon_o\nabla^2 v^2 \quad = \quad -\epsilon_o\left[(\nabla\times\vec{v})^2 - \vec{v} * (\nabla\times\nabla\times\vec{v})\right] \tag{2.13}$$

Clearly then, what appears as charge density may then be viewed as a dynamic balance in the velocity field described by the equation (2.11). Neither (2.11) nor (2.13) fully describe the electron; these expressions merely specify the relations in the large scale velocity field, and do not deal with the spin phenomenon of the elementary particles. The reason for this lies in the fact that the derivation of these equations is based on a model in which the gyrons are represented by linear field infinitesimals, while in reality, in addition to possessing the translational momentum, they are three-dimensional objects with a form and inherent spin.

A physical quantity can be considered an infinitesimal at a level at which no further phenomena exist. Thus, for Maxwell's equations the gyron can be considered to be a simple infinitesimal in extension, while to account for the spin phenomenon of the electrons, it is necessary to consider the gyron to be an "infinitesimal gyroscope", and if the equations were also to be valid for describing in detail such phenomena as gravity and neutrinos, then the size of the field infinitesimal must be reduced to a scale that reflects the form of the gyron. In a general sense, it all boils down to information density and thus the complexity that one can or wishes to handle. Field equations are merely a means by which these choices are made. These points will be further elucidated in subsequent sections; here I wish merely to add some comments regarding the dimensionality of electromagnetic quantities.

The Lorentz equation $\mathbf{F} = d\vec{p}/dt = \pm Q(\mathbf{E} + \vec{u}\times\mathbf{B})$ that relates electromagnetic and mechanical quantities, when expressed in the equivalent mechanical form $m(d\vec{u}/dt) = \pm Q[(-d\vec{v}/dt) + \vec{u}\times\nabla\times\vec{v}]$ allows the Q/m ratio to be expressed as

$$(Q/m) \quad = \quad (d\vec{u}/dt)/[\vec{u}\times\nabla\times\vec{v} - (d\vec{v}/dt)] \tag{2.14}$$

This shows that the mechanical representation of the electromagnetic field becomes dimensionally consistent with the rest of physics if the dimensionalities for charge and mass are the same. Furthermore, since Coulomb's law states that $m(du/dt) = Q^2/4\pi\epsilon_o r^2$, both m and Q must have the dimensionality $[length^3/time^2]$, while ϵ_o must be dimensionless and, for some qualitative reasons, may turn out to be equal to the fine structure constant F. Thus, if $\epsilon_o = F$, then $\mu_o = 1/Fc^2$, $Z_o = 1/Fc$, and Coulomb's law becomes $Q^2/4\pi Fr^2$. The 4π factor has geometrical and physical significance, and should, in a concise formulation, appear also explicitly in Newton's formula for gravity.

With the exception of mass, this system of units is dimensionally equivalent to the electrostatic system formulated by Gauss. This also implies that the gravitational constant G in Newton's law of gravity must be a number without dimensionality. As was pointed out earlier, charge and gravitational mass have the same dimensionality as the rate at which space is swept out by the gyrons, and are related to these parameters. Max Planck (1858-1947), who discovered that electromagnetic radiation is quantized in h units of action, has also commented on the possibility to express all physical quantities in terms of "natural measuring units" that he derived from the relationships occurring in the theory of radiation [12]. The currently accepted Planck units are: length = 1.6×10^{-33} cm, mass = 2.2×10^{-5} gram, time = 5.4×10^{-44} sec, and temperature = 1.4×10^{32} K. It is my thesis that Planck's empirically derived results are related to the fundamental parameters characterizing the aether. Thus, there exist no potentials and forces in the traditional sense, as these are merely convenient mathematical representations of dynamic states that result in pressure gradients in the aether. Since the absolute pressure in the aether is enormous, possibly as high as 10^{107} atmospheres, even nuclear forces are the result of only minor deviations of this pressure. This leads to a completely self-consistent system of units expressed solely in terms of length (distance), and time (duration). The following are some examples:

DIMENSION	**PHENOMENON**
$[L^3/T^2]$	charge Q, mass m
$[L^2/T]$	magnetic flux ϕ
$[L^4/T^3]$	momentum $\vec{p}$
$[L^4/T^4]$	force $\vec{F}$
$[L^5/T^4]$	energy W
$[T/L]$	impedance Z
$[L]$	capacitance
$[T^2/L]$	inductance
$[T^2/L^2]$	permeability μ_o
$[1]$	permittivity ϵ_o

In this system of units the energy density with the dimension $[L^2/T^4]$ becomes compatible in mechanical and electrical field representations.

$$\begin{aligned} (1/2)[\mathbf{D} * \mathbf{E} + \mathbf{H} * \mathbf{B}] &\implies (1/2)[\epsilon_o a^2 + (4/\mu_o) w^2] = \\ = (1/2)\epsilon_o[a^2 + 4c^2 w^2] &= (1/2)\epsilon_o[(d\vec{v}/dt)^2 + (c\,\nabla \times \vec{v})^2] \end{aligned} \tag{2.15}$$

Likewise, the momentum density and Maxwell's stress tensor for the electromagnetic field can be understood intuitively. Furthermore, the Lagrangean density for the electromagnetic field can then be expressed as

$$L = (1/2)\epsilon_o \left[(d\vec{v}/dt)^2 - (c\nabla \times \vec{v})^2 \right] \tag{2.16}$$

thus showing that the potential energy in this field resides in the rotational kinetic energy of the gyrons. This Lagrangean and the field definitions yield the Maxwell equations including Ampere's law, and the wave equation

$$\begin{aligned} \nabla \times \mathbf{E} + \partial \mathbf{B}/\partial t &= 0 \\ \nabla \times \mathbf{H} - \partial \mathbf{D}/\partial t &= \rho \vec{u} \\ \nabla \cdot \mathbf{B} &= 0 \\ \nabla \cdot \mathbf{D} &= \rho \\ \nabla^2 \mathbf{A} - \left(1/c^2\right) \partial^2 \mathbf{A}/\partial t^2 &= -\mu \rho \vec{u} \end{aligned}$$

or in mechanical form

$$
\begin{aligned}
\nabla \times \vec{a} - 2\, \partial \vec{w} / \partial t &= 0 \\
2\, \nabla \times \vec{w} + (1/c^2)\, \partial \vec{a} / \partial t &= -\mu \vec{u}\, \nabla^2 v^2 / 2 \\
\nabla \cdot \vec{w} &= 0 \\
\nabla \cdot \vec{a} &= \nabla^2 v^2 / 2 \\
c^2 \nabla^2 \vec{v} - \partial^2 \vec{v} / \partial t^2 &= \vec{u}\, \nabla^2 v^2 / 2
\end{aligned}
$$

Comment: *Investigation following this publication led to the realization that the vector potential cannot be identical to velocity, but is instead equivalent to what I termed "*moventum*", which is the product of velocity and "stiffness" of the aether; i.e.* $\mathbf{A} = \gamma \vec{v}$*, and the scalar potential becomes* $V = \gamma c^2$*. Where* $\gamma = \frac{vol_o}{vol - vol_o}$*; vol representing the volume of the free space or the void, and* vol_o *designating the volume occupied by the gyrons. (Ref. Phys. Essays* **7***, pp.14, 1994).*

3 Quantum Wave Mechanics

As pointed out earlier, quantization is a natural consequence in a fluid consisting of finite sized gyrons moving with discrete momenta. Also, since detailed kinetics of gyrons is intractable, wave mechanics of the aether is an effective substitute for dealing with the dynamic phenomena on a larger scale.

It remains to be explained what the complex Ψ function represents in the aether. The square of its magnitude $|\Psi|^2 = \Psi\Psi^*$, which by convention is normalized to unity in order to correspond to probability density, actually corresponds to density deviations from the average density of the aether $N = |\Psi_o|^2$. Dimensionally this represents a number per unit of volume in space $[1/L^3]$. Thus Ψ, being the square root of this density deviation, specifies the average deviation of the number of gyrons moving in any given direction. This is because the resultant magnitude of N random vectors is equal to the square root of N, and Ψ is complex to take into account the relative orientation between the long axis of the gyron and the direction of its linear momentum. It must be appreciated that the mutual orientation between the colliding gyrons strongly influences the dynamic equilibrium. In contrast, in an ideal gas the point particles are isotropic, and their density can be represented by a real number. Even the complex Ψ function in reality does not adequately describe the gyron because it does not account for the rotational aspects of this object, consequently a spin vector with complex or quaternion components would be required.

In the vacuum, representing the undisturbed aether in a dynamic equilibrium state, all momenta add up to zero and consequently, aside from the random fluctuations, it does not manifest any observable property. Only when net momentum is imparted to a group of gyrons is there created a gradient in the phase space, and hence this also produces a gradient in the density of the aether. Thus, the empirically established relationship associating momentum with the gradient operator ($\vec{p} \Rightarrow -i\hbar\nabla$) on Ψ, or equivalently ($\nabla \Rightarrow i\vec{p}/\hbar$), becomes intuitively evident. The imaginary factor indicates that the momentum is effectively transferred only to those gyrons that are on the average oriented perpendicular to their directions of motion, while $\hbar = Mc\alpha$ represents the smallest unity or quantum in phase space. A useful review of formulation of quantum mechanics in phase and Hilbert spaces was recently provided by Long [13].

It is also intuitively clear that the changes in the equilibrium state induced by the imparted momentum will not take place instantaneously, consequently there will exist an accompanying temporal change in the density function, and Schroedinger's wave equation tells us that the time rate of change of Ψ is proportional to its spatial concentration.

$$i\hbar\partial\Psi/\partial t \quad = \quad (-\hbar^2/2m)\nabla^2\Psi + V\Psi \tag{3.1}$$

Physically, this represents a diffusion process in which the concentrated gyrons at a given location can escape the hot spot by tilting their orientation towards their direction of travel. The presence of the potential V, which is equivalent to the square of velocity in the aether, merely tells us that the density is also modified by some other process that causes a deviation from the vacuum state, such as a circulation associated with a vortex. It is clear that since this representation of the dynamic process neglects the gyroscopic properties of the gyron, it cannot account for the spin phenomenon of the electron. By introducing an equation that incorporates Pauli's spin matrices Dirac has surmounted this inadequacy.

$$i\hbar\partial\Psi/\partial t \quad = \quad i\hbar c\vec{\alpha} * \nabla\Psi - \gamma m_o c^2\Psi + V\Psi \tag{3.2}$$

Since $\vec{\alpha}$ and γ consist of 4x4 matrices, this expression represents four coupled first order partial differential equations. While Schroedinger's equation deals only with isotropic density concentrations, Dirac's equation may be interpreted to account for the gradients produced in the aether due to gyrations of the gyrons, and the term $m_o c^2$ accounts for the modification of the aether density produced by the electron vortex structure. This also explains why the former is nonrelativistic and the latter relativistic.

Dirac's equation is derived from the following Hamiltonian: $H = -c\vec{\alpha} * \vec{p} - \gamma m_o c^2 + V$. According to my model, the dot product $\vec{\alpha} * \vec{p}$ specifies the degree of alignment between the group momentum $\vec{p}$ and the longitudinal direction of the gyrons within the dynamic aggregate representing the electron. Assuming that the structure of Dirac's $\vec{\alpha}$ is a suitable representation for the direction of the gyron, then the insertion of the components of the vector $\vec{\alpha}$

$$\alpha_x = \begin{pmatrix} 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \end{pmatrix} \qquad \alpha_y = \begin{pmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & -1 \\ 1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \end{pmatrix} \qquad \alpha_z = \begin{pmatrix} 0 & 0 & 0 & -i \\ 0 & 0 & i & 0 \\ 0 & -i & 0 & 0 \\ i & 0 & 0 & 0 \end{pmatrix}$$

into (1.1) yields the equivalent expression

$$\begin{aligned} \Delta V/(\Delta t)^2 &= \pm\alpha^2(\eta_x\eta_y\eta_z) \begin{pmatrix} 1 & \mp 1/2 & \pm i/2 \\ \pm 1/2 & 1 & -i/2 \\ \mp i/2 & i/2 & 1 \end{pmatrix} \begin{pmatrix} \omega_x \\ \omega_y \\ \omega_z \end{pmatrix} \\ &= \pm\alpha^2 \vec{\eta}_t M_s \vec{\omega} \end{aligned} \tag{3.3}$$

This takes care of the major steric aspects among the gyrons, but does not yet include their inertial properties. Therefore, the moments I and products P of inertia must be combined with the matrix M_s, and (3.3) then becomes

$$\Delta V/(\Delta t)^2 \quad = \pm\vec{\eta}_t M \vec{\omega} = \pm\, \vec{\eta} * \mathbf{S} \tag{3.4}$$

where *M* represents the complex moment of inertia, and **S** the complex spin vector.

$$\mathbf{S} = M\vec{\omega} \quad = \quad \begin{pmatrix} I_{xx} & \mp(1/2)P_{xy} & \pm(i/2)P_{xz} \\ \pm(1/2)P_{yx} & I_{yy} & -(i/2)P_{yz} \\ \mp(i/2)P_{zx} & (i/2)P_{zy} & I_{zz} \end{pmatrix} \begin{pmatrix} \omega_x \\ \omega_y \\ \omega_z \end{pmatrix} \tag{3.5}$$

Here $I_{xx} = I_{yy}$, $P_{xz} = P_{zx} = P_{yz} = P_{zy}$, and $P_{xy} = P_{yx}$.
Note that spin is quantized in units of $\hbar/2$ because in rotation the gyron sweeps out only half the space compared to translation.

Expressions (2.13) and (3.4) imply that the charge density

$$\rho = \nabla * \mathbf{D} \quad = \quad -(\frac{1}{2})\epsilon_o \nabla^2 v^2 = \pm(\kappa/\Delta V)\, \vec{\eta} * \mathbf{S} \tag{3.6}$$

where $\kappa/\Delta V$ stands for the proper density distribution function, and is related to $|\Psi|^2$. The "source" of the electric field, termed the charge density,is therefore a consequence of a non-random distribution of spins and velocities of the gyrons. Due to the complex nature of Ψ, a vortex in the aether does not have the same structure as a vortex in a gas, thus the structure of the electron does not resemble an ordinary vortex. As pointed out earlier, the electric field produced by charge is due to the circulation around the vortex core that causes a gradient in the velocity field, but the gravitational field is independent of charge and must therefore be explained by a different mechanism, and this is dealt with in the next section. Here I want to conclude by pointing out that what has been termed the "quantum field potential" is related to aether density, while the electrical and gravitational potentials are proportional to the square of the magnitudes of the respective velocity fields.

4 Gravitation and Neutrinos

The gyrons normally spin in an orientation with the greatest moment of inertia, that is, perpendicular to their long axis. However, in the electron vortex there seems to exist a mechanism that causes one out of $4.17x10^{42}$ (Dirac number) gyrons to line up so that it spins around $\vec{\alpha}$ instead of perpendicular to it. It is conceivable that if a gyron penetrates the vortex wall, it can be forced to line up longitudinally and to be ejected in this new stable orientation. This somewhat resembles the situation where a straw enters a vortex spout. Since in this process the angular momentum is also conserved, one would expect that the resulting angular velocity will be greatly increased because the moment of inertia is much smaller around the z-axis. Thus, if $I_{xx}\omega_x = I_{yy}\omega_y = I_{zz}\omega_z$, then $\omega_z = (I_{xx}/I_{zz})\omega_x = (I_{yy}/I_{zz})\omega_y$, and since $I_{xx} \gg I_{zz}$, then $\omega_z \gg \omega_x = \omega_y$. This effect is demonstrated by ballet dancers and skaters when they contract their arms and legs during a spin.

The orientation of these longitudinally moving gyrons is stabilized by their angular momentum due to the axial spin and, like rifled bullets, they can travel large distances before they encounter a collision with enough force that reverts their orientation to the more stable transverse mode of travel. As these longitudinally oriented gyrons leave the vortex, the local density within the dynamically balanced aggregate decreases, and in order to maintain equilibrium, the transversely oriented gyrons from the vicinity keep drifting towards the vortex. In the velocity field this represents a divergence, but since the gyrons are constantly escaping lengthwise from the center of the vortex, the problem with material continuity does not arise. Consequently, the gravitational force is the net result of the impacts of transversely oriented gyrons that keep replacing the longitudinally oriented gyrons that have escaped from the vortices without colliding.

The "longitudinally" oriented gyrons that "escaped" the local dynamic aggregate have a finite probability for colliding with the "transversely" oriented gyrons and, therefore, returning to the "transverse" orientation. This process, however, demands that the formula for gravitational force contains a factor that falls off faster than the geometrical inverse square. Since it is sensible to expect that the rate at which the gyrons will be flipped over is proportional to the number present, an exponential factor arises, thus, changing Newton's formula to:

$$F = -Gm_1m_2/r^2 exp\,(r/R) \qquad (4.1)$$

Clearly *R* must be very large so that this effect would be observable only at galactic distances.

This formula does apparently not account for the advance of the perihelion of the planet Mercury, but recently Nedvěd [14] pointed out that Newtonian physics may account for this phenomenon if all the interactions in the solar system were taken into account. Also an additional dependence may emerge when the exact field equations are established and solved for the motion of this dynamic state in the aether, because the dynamic density gradient might well introduce second order effects. Besides, the reported speed of about 600 km/s in absolute motion through the aether, modulated by the 39 to 59 km/s orbital speed of Mercury, further complicates the situation due to relativistic effects.

The following quotation from 'Querie 21' in Newton's 'Opticks' shows that he attempted to explain gravity on the basis of a density gradient in the aether, but he did not provide an explanation of the mechanism that maintains such a gradient:

"Is not this Medium (Aether) much rarer within the dense Bodies of the Sun, Stars, Planets and Comets, than in empty celestial spaces between them ? And in passing from them to great distances, doth it not grow denser and denser perpetually, and thereby cause the gravity of those great Bodies towards one another, and of their parts towards the Bodies; every Body endeavoring to go from the denser parts of the Medium towards the rarer ? For if this Medium be rarer within the Sun's Body than at its Surface, and rarer there than at the hundredth part of an Inch from its Body, and rarer there than at the Orb of Saturn; I see no reason why the Increase of density should stop anywhere, and not rather be continued through all distances from the Sun to Saturn, and beyond. And though this Increase of density may at great distances be exceedingly slow, yet if the elastick force of this Medium be exceedingly great, it may suffice to impel Bodies from the denser parts of the Medium towards rarer, with all that power which we call Gravity . . . "

A density gradient causes flow in a fluid, and in the case of gravity requires a sink which implies a singularity in the field, but with the mechanism of a "lengthwise" counterflow of gyrons, this problem is resolved.

Expression (1.1) relates the parameters of a gyron to space and time, but does not deal with any field properties that emerge from the collective behavior of large numbers of gyrons. When the distribution of the various parameters is not random, then the mutual orientation between the gyrons and their velocities must be described. It turns out that the quaternion offers a suitable representation. If both, the translational velocity $\vec{\eta}\exp(i\theta)$, and the angular velocity $\vec{\omega}\exp(i\phi)$, are represented by complex vectors which indicate their direction with respect to the orientation of the gyron, then the vector quaternion for momentum density

$$< \vec{q} > \;=\; (\rho/2)^{1/2} < \vec{\eta} > \exp(i < \theta >) + \left[(\sigma/2)^{1/2} < \vec{\omega} > \exp(i < \phi >)\right] j, \qquad (4.2)$$

composed of the two complex vectors, can represent all the mutual orientations, and its norm is related to the total energy of the gyrons:

$$< q^2 > \;=\; (\rho/2) < \eta^2 > + (\sigma/2) < \omega^2 > . \qquad (4.3)$$

Thus, the continuity equations for mass and energy are expressible with real variables, while those dealing with momenta are complex, and can account for the counter-flows that maintain the density gradient that Newton postulated. Above, ρ represents mass density, while σ stands for moment of inertia density. The angle θ specifies the orientation of the translational velocity vector $\vec{\eta}$ with respect to the orthogonal direction of the gyron $\vec{\alpha}$, while ϕ specifies the corresponding relationship for the angular velocity $\vec{\omega}$. This quaternion momentum density field can be constructed in a sort of double Hilbert space that could play a role in the aether mechanics analogous to that of Hilbert space in quantum mechanics.

The neutrinos are the only basic phenomenon that remains to be explained. Based on the proposed model, these entities also represent groups of gyrons in the longitudinal mode of travel, and are indistinguishable from the gravitational fluxes, except for possible higher concentrations produced in nuclear disintegrations. The large amount of energy carried by neutrinos in meson decay implies that in baryons, such as the proton, the gyrons might be sterically confined in the longitudinal orientation. In beta decay, the fraction of energy carried by the gyrons in the neutrino seems to be a random value, but there is no inherent problem with the conservation laws.

Also, the apparent deficit in neutrinos from the sun may be due to the fact that the longitudinal gyron streams fan out with distance to the extent that the density is inadequate to induce nuclear reactions in a detector on the earth. Finally, radioactivity in general can be explained as instability of dynamic structures due to density fluctuations in the aether.

5 Material Particles and Relativity

According to the model presented here, all material particles may be considered to be composites of positrons and negatrons, and the charge conservation law is a result of the conservation of angular momentum in these vortices. The neutron is clearly composed of a proton and an electron, and the fact that proton annihilation cascades through meson production instead of direct conversion into gamma rays, points towards a composite structure.

Sternglass[15] proposed that the proton consists of four negatrons and five positrons organized in a tetrahedral structure in which the two hundred-fold mass increase of the component rest mass is the consequence of relativistic orbital velocities of this electron assembly. This model has credence because the π and μ mesons have masses near this value. It is an accepted fact that electron orbits produce chemical elements and that the nuclei are also organized in shell structures, so it should not be surprising that the nuclear particles are also dynamic composites.

Assuming then that all material particles represent some form of rotational structure corresponding to a circulation in the aether, and that in this fluid the phenomenon designated as the mass is expressed as $m = h\nu/c^2$, then the associated collision frequency of gyrons in the aether is given as $\nu = mc^2/h$, where h is Planck's constant, and c the speed of light.

When the center of mass of this rotational structure does not move, the associated frequency is ν_o, and the corresponding mass is m_o. Now, let us investigate what happens when this structure moves. Clearly, since the RMS velocity of all gyrons in the resting aether equilibrates to c, in a rotational structure moving with a group velocity u, the forward moving circulation will reduce the wave velocity to $c - u$, while the reverse moving part of the circulation will increase the wave velocity to $c + u$.

These different velocities in the circulation correspond to a compound Doppler effect for a moving source. Namely, the forward collision frequency will increase to $\nu_f = \nu_o c/(c - u)$, while the reverse collision frequency in the circulation will decrease to $\nu_r = \nu_o c/(c + u)$. Thus the resulting RMS frequency in the moving rotational aggregate will be

$$\begin{aligned} \nu &= (\nu_f \nu_r)^{1/2} = \Big[[\nu_o c/(c-u)][\nu_o c/(c+u)]\Big]^{1/2} \\ &= \nu_o/[1-(u/c)^2]^{1/2} \end{aligned} \tag{5.1}$$

and correspondingly for mass

$$m = m_o/[1-(u/c)^2]^{1/2} \tag{5.2}$$

This expression implies that the mass cannot move faster than the speed of light, but in principle, the vortex comprising the mass could briefly move faster than the speed of light, but would slow down by emitting Cerenkov radiation in a process analogous to the energy dissipation in supersonic motion. Of course in practice it is impossible to exceed the speed of light in the vacuum because there does not exist any structure in the aether that could impart the necessary momentum.

It is important to realize that the increase of frequency of an accelerated object does not come about as a result of change in motion in the circulation, but that instead the frequency increase has been imparted through the momentum that caused the change in motion. Therefore, the frequency increase is the cause of structural and motion changes in the vortex, and not the reverse.

Since the RMS inter-collision distance $\lambda = c/\nu$ is also influenced by the frequency increase, we get also a corresponding relationship for the apparent change in the size of the dynamic moving rotational aggregate, namely

$$\lambda \quad = \quad \lambda_o[1-(u/c)^2]^{1/2}. \tag{5.3}$$

This relationship corresponds to the Fitzgerald contraction of all materials, thus explaining the Michelson-Morley experiments.
The deBroglie wavelength is defined as

$$\lambda_u \quad = \quad h/p_u = h/mu = h[1-(u/c)^2]^{1/2}/m_o u. \tag{5.4}$$

The Compton wavelength is

$$\lambda \quad = \quad h/p = h/mc = h[1-(u/c)]^{1/2}/m_o c. \tag{5.5}$$

¿From the above it follows that

$$(1/\lambda)^2 \quad = \quad (1/\lambda_o)^2 + (1/\lambda_u)^2, \tag{5.6}$$

and therefore the corresponding relationship between the spatial frequencies $k = 1/\lambda$ becomes

$$k \quad = \quad [k_o^2 + k_u^2]^{1/2}. \tag{5.7}$$

By defining the temporal frequency corresponding to the deBroglie wavelength as

$$\nu_u \quad = \quad mcu/h = \nu_o/[(c/u)^2-1]^{1/2}, \tag{5.8}$$

it follows that

$$\nu \quad = \quad [\nu_o^2 + \nu_u^2]^{1/2}, \tag{5.9}$$

and since $\nu t\,[1-(u/c)^2] = \nu_o t_o,$ and if also $\nu_u t_u\,[(c/u)^2-1] = \nu_o t_o,$
then

$$t^2 \quad = \quad t_o^2 + t_u^2, \tag{5.10}$$

which agrees with the time dilation

$$t \quad = \quad t_o/[1-(u/c)^2]^{1/2}. \tag{5.11}$$

Thus, all postulates of Einstein's special theory of relativity emerge as the RMS relationships in the aether dynamics.

Similarly, Minkowski's space-time manifold fits neatly into this model, since all dynamic processes in the aether proceed in a manner that leads to the equalization of the RMS velocities. Thus,

$$[(d\vec{s}/dt)^2 + (d\vec{r}/dt)^2]^{1/2} = c$$

leads to

$$ds = [(cdt)^2 - (d\vec{r})^2]^{1/2},$$

and since $(d\vec{r}/dt) = \vec{v}$, while $(ds/dt_o) = c$, it also follows that

$$dt = dt_o/\left[1-(v/c)^2\right]^{1/2}.$$

An objective presentation and evaluation of the special theory of relativity and related topics was provided by Prokhovnik[16].

The above formulae are details of Schroedinger's relativistic formula for energy:

$$W \quad = \quad [p^2c^2 + m_o^2c^4]^{1/2}. \tag{5.12}$$

This expression implies that the energy associated with a moving mass resides in two forms in the dynamic structure: the m_oc^2 represents the rotational part that is associated with an angular momentum $\mathbf{J}$, while pc represents the increase due to the imparted linear momentum $\vec{p}$. If we express (5.12) in terms of the corresponding frequencies

$$\nu^2 \quad = \quad [\nu_o u/(c-u)][\nu_o u/(c+u)] + \nu_o^2 \tag{5.13}$$

we see that the Doppler effect occurs only on the energy of the translatory momentum and not on the rest mass energy associated with the intrinsic angular momentum of the particle structure

$$\mathbf{J} \quad = \quad \mathbf{L} + \mathbf{S} \tag{5.14}$$

This angular momentum, with the orbital $\mathbf{L}$ and the spin $\mathbf{S}$ parts, is in turn kinetically related to the angular momentum of individual gyrons. Thus, it is this independent conservation of the angular momentum that accounts for the elementary charge and spin conservation associated with the electron vortex structure and its various combinations. It is interesting that if one uses Dirac's Hamiltonian form for expressing the Doppler effect, the result yields anisotropic properties, and this might be of some practical interest. On a cosmic scale, the interplay between $\mathbf{L}$ and $\mathbf{S}$, based on the conservation of $\mathbf{J}$, $d\mathbf{J}/dt = 0$, that yields $d\mathbf{L}/dt = -d\mathbf{S}/dt$, offers abundant possibilities for manifesting various dynamic phenomena in the aether. The energy relationship for matter W and anti-matter W^* can then be expressed in quaternion form as:

$$WW^* = (c\vec{\alpha} * \vec{p} + w\vec{\varepsilon} * \mathbf{J}j)\,(c\vec{\alpha} * \vec{p} - w\vec{\varepsilon} * \mathbf{J}j) \tag{5.15}$$

where all terms are complex, $|w\vec{\varepsilon}{*}\mathbf{J}| = m_oc^2$, and possibly $\vec{\varepsilon} = \vec{\alpha}$.

6 Concluding Comments

Although the proposed model seems to be able to account qualitatively for all known physical phenomena, there remain a number of open philosophical questions and analytical problems. The foremost question regards more detailed knowledge of the nature of the gyrons: what is their exact form, and what precisely happens in a collision? Since momentum and energy are apparently exactly conserved, one would like to attribute perfect elasticity to the gyrons, but then their compressibility would have to be explained. One way out of this dilemma is to assume that the gyron is perfectly rigid, and that the collisions represent impulses in the form of Dirac's delta functions where an infinite force acts during zero time. Although incomprehensible within our normal concepts, the existence of a material with such properties is not harder to accept than the existence of infinite space and eternity. It appears that some aspects of reality may remain counter-intuitive. Being a finite entity in an infinite domain, we will probably have to accept this fate.

A somewhat less formidable problem concerns the specification of the moment of inertia tensor. This of course depends on the form of the gyron and the mass density distribution within it. Clearly, since it is impossible to measure these parameters directly, they will have to be computed on the basis of large scale phenomena. If it is assumed that equipartition of energy is valid in the aether, then for the gyron with five degrees of freedom, 3/5 of energy should reside in the translational, and 2/5 in the rotational motion. Consequently, according to the expression (1.2), $<\eta>= (6/5)^{1/2}c$, and $(I/M)^{1/2} <\omega>= (4/5)^{1/2}c$. If the gyron were a thin rod of uniform density with a length α, then its moment of inertia I would be $(M\alpha^2/12)$, so that $(I/M)^{1/2} <\omega>= \alpha/(12)^{1/2} <\omega>$. However, since one would expect that in the collision process $\alpha <\omega>$ would be near to $<\eta>$ or c, the above expression tells us that the moment of inertia must be larger than $M\alpha^2/12$. Consequently, if the gyron's mass density is uniform, its diameter would have to increase towards the ends.

If one assumes that the Planck constant $\hbar$ represents the dimensional unit of the phase space in the aether, so that $Mc\Delta x = \hbar = Mc^2\Delta t$, then, as expected, $\Delta x = c\Delta t$. Furthermore, by hypothetically equating the mass of the gyron with the Planck mass $M = (\hbar c/G)^{1/2}$, and its length with the Planck length $\alpha = (\hbar G/c^3)^{1/2}$, one can establish relationships with various other physical quantities. Also, by assuming that the gyron's effective diameter β is related to its length α as $(\alpha/\beta)^2 = F/G$, where F is the fine structure constant, and G the gravitational constant, then the ratio of the gyron's length to diameter turns out to be $(F/G)^{1/2} = 330.76$.

Similarly, if the aether density were related to the dimensions of the gyron as $N = F/\alpha^3$, then the relationships presented in the appendix are, at least in principle expressible in terms of the fundamental parameters α, β, N, and c.

The classical electron radius is derived by equating the rest mass energy to that of its electric field, which in mechanical terms represents the energy in the circulation; thus, $r = e^2/mc^2$, where e stands for the elementary charge.

Finally, by means of the definition of the fine structure constant as $F = e^2/\hbar c$, the charge and mass of the electron can be related to all the other fundamental constants. These relationships are mere conjectures; no factual data supports them, and I am presenting the formulas merely as an illustration to demonstrate that in principle such relationships could eventually be established.

The conversion relationship between the cgs and the cs units $1g = 1cm^3/sec^2$ is given only to preserve the numerical values of various physical constants, but its actual value will emerge when the aether kinetics is better understood.

I intended to stay out of the quantum mechanics fray because, until further details of the proposed hypothesis are worked out, one cannot make dependable statements; but since this issue is constantly brought up, I will express some opinions: Since the material particles do not generate the fields but are merely their manifestations, such phenomena as photoelectric effect, the double slit interference, and non- locality follow naturally. So far the only unresolved problem present the so-called "Einstein, Rosen, Podolsky" experiments that claim simultaneity of field couplings at a distance, thus implying an infinite speed in field propagation. Although I am not thoroughly familiar with the experimental setups and data interpretations, I am inclined to think that an explanation which overcomes this problem will be found. Clearly, since the total angular momentum in the aether is conserved, the mutual spin of particles will be conserved, but I doubt that it tracks instantly over very large distances. Also, by ascribing the quantum mechanical indeterminacy to the fluctuations in the aether, it is clear that the uncertainties in position and momentum are not localized to the emission and detection events, but accompany the particle on its path. Vacuum fluctuations have been experimentally verified and are becoming accepted by many physicists.

Such experimental data as reported by Panarella, Matteucci and Pozzi, and others, in conjunction with various theoretical arguments presented by Belinfante, Garuccio, Kypriamidis, Marshall, Santos, Salleri, Vigier, and others [5], indicate that the issues dealing with quantum mechanical interpretations are far from settled . Even if it turns out that complete determinism would have to be accepted to explain all aspects of physical reality, it would still be more rational than various schemes proposed by the adherents of the Copenhagen school. Einstein, Dirac, deBroglie, Schroedinger, and others [17] have been grappling with these questions since the twenties, but the models, from which the various fields were generated, lacked some essential properties. However, there is really no rational basis for the antagonism between the champions of determinism and dogmatic indeterminism because Heisenberg's statement, that energy and momentum are conserved statistically, is valid on a large scale, but it does not apply to the kinetics of individual gyrons in which these quantities are precisely conserved. Thus, while Einstein's faith in God's control over nature is reassured, we can observe only large-scale dynamic aggregates of gyrons, and therefore are able to predict the outcome of observations only in statistical terms. From this mass action law, applicable to the aether, it clearly follows that the processes involving low energies are least predictable. This is experimentally observed, but the fluctuations exist irrespective of our observations. It can therefore be hoped that physics could again be pursued in the manner that Newton and Maxwell envisioned, without the occultism that is currently in vogue.

APPENDIX

Speed of light		c	$= 2.998x10^{10} cm/s$
Mass of the gyron	Planck mass	M	$= 2.177x10^{-5} cm^3/s^2$
$M = (\hbar c/G)^{1/2} = \alpha c^2/G = \hbar/c\alpha = c^2/N\beta^2 = e/(FG)^{1/2}$			
Length of the gyron	Planck length	α	$= 1.616x10^{-33} cm$
$\alpha = (\hbar G/c^3)^{1/2} = G/N\beta^2 = MG/c^2 = e^2/FMc^2 = \hbar/Mc$			
Diameter of the gyron		β	$= 4.897x10^{-36} cm$
$\beta = \alpha(G/F)^{1/2} = (GFM/N)^{1/2}/e = c/(MN)^{1/2}$			
Density of the aether	$\|\Psi_o\|^2$	N	$= 1.724x10^{96}/cm^3$
$N = F/\alpha^3 = G/\alpha\beta^2 = e^2/Mc^2\alpha^4$			
Gravitational number		G	$= 0.6670x10^{-7}$
$G = N\alpha\beta^2 = F(\alpha/\beta)^2 = \hbar c/M^2 = \alpha^2 c^3/\hbar = \alpha c^2/M$			
Fine structure number		F	$= 0.7297x10^{-2}$
$F = N\alpha^3 = G(\alpha/\beta)^2 = e^2/GM^2 = e^2/\hbar c$			
Planck constant/2π		$\hbar$	$= 1.0545x10^{-27} cm^5/s^3$
$\hbar = Mc\alpha = GM^2/c = \alpha^2 c^3/G = \alpha c^3/N\beta^2 = e^2/cN\alpha^3 = mcr/N\alpha^3$			
Elementary charge		e	$= 4.8030x10^{-10} cm^3/s^2$
$e = M(FG)^{1/2} = c(FM\alpha)^{1/2} = \alpha c^2(F/G)^{1/2} = \alpha^2 c(MN)^{1/2} = c^2\alpha^2/\beta$			
Elementary flux		ϕ	$= 0.6897x10^{-17} cm^2/s$
$\phi = h/2e = \pi\hbar/e = \pi M\beta/c\alpha = \pi c/N\alpha\beta$			
Mass of the electron		m	$= 0.9109x10^{-27} cm^3/s^2$
$m = e^2/c^2 r = FGM^2/c^2 r = FM\alpha/r = F\hbar/cr = \hbar\omega/c^2 = c^2\alpha^4/r\beta^2$			
Radius of the electron		r	$= 2.818x10^{-13} cm$
$r = e^2/mc^2 = M^2FG/mc^2 = Fc/\omega = MFG/c\alpha\omega = FM\alpha/m$			
Angular velocity of the electron		ω	$= 0.7763x10^{21}/s$
$\omega = Fc/r = mc^2/\hbar = mc/M\alpha = FGM/cr\alpha = Nc\alpha^3/r$			
Dirac number		N_D	$= 4.1667x10^{42}$
$N_D = e^2/m^2 G = F(M/m)^2 = r^2/F\alpha^2 = r^2/N\alpha^5$			
Charge to mass ratio of the electron		e/m	$= 5.2727x10^{17}$
$e/m = r\beta/\alpha^2 = (r/\alpha)(G/F)^{1/2}$			
Conversion between cgs and cs units		$1g$	$= 1cm^3/s^2$

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