Revision and integration of Maxwell's and Navier-Stokes' Equations and the origin of quantization in Superfluids and Spacetime itself

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"I hope that someone will discover a more realistic way,
or rather a more tangible basis than it has been my lot to find."

Albert Einstein**.**

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Abstract. It is well known that the Maxwell equations predict the behavior of the electromagnetic field very well. However, they predict only one wave equation while there are significant differences between the "near" and "far" fields and various anomalies have been observed involving the detection of super luminous signals in experiments with electrically short coaxial cables[1,2], microwaves[3,4,5,6,7,8,9,10,11,12], optical fibers[13,14,15,16] as well as other methods[17,18,19,20]. We show that the mathematical Laplace operator defines a complete set of vector fields consisting of two potential fields and two fields of force, which form a Helmholtz decomposition of any given vector field **F**. We found that neither in Maxwell's equations nor in fluid dynamics vector theory this result has been recognized, which causes the potential fields to not be uniquely defined and also makes the Navier-Stokes equations unnecessarily complicated and introduces undesirable redundancy as well. We show that equivalents to both the Maxwell equations as well as the Navier-Stokes equations can be directly derived from a single diffusion equation describing Newton's second law in 3D. We found that the diffusion constant ν in this equation has the same value as the speed of light squared, but has a unit of measurement in meters squared per second thus uncovering problems with time derivatives in current theories, showing amongst others that the mass-energy equivalence principle is untenable. Finally, we show that the diffusion equation we found can be divided by mass density ρ, resulting in a velocity diffusion equation that only has units of measurement in meters and seconds, thus decoupling the dynamics of the medium from it's substance, mass density ρ. This reveals the quantized nature of spacetime itself, whereby the quantum circulation constant ν is found to govern the dynamics of physical reality, leading to the conclusion that at the fundamental quantum level only dynamic viscous forces exist while static elastic forces are an illusion created by problems with a number of time derivatives in current theories.

With our equivalents for the Maxwell equations three types of wave phenomena can be described, including super luminous longitudinal sound-like waves that can explain the mentioned anomalies. This paper contributes to the growing body of work revisiting Maxwell's equations[21,22,23,24,25,26,27,28,29,30] by deriving all of the fields from a single equation, so the result is known to be mathematically consistent and free of singularities and uniquely defines the potential fields thus eliminating gauge freedom. Unlike Maxwell's equations, which are the result of the entanglement of Faraday's circuit level law with the more fundamental medium arguably creating most of the problems in current theoretical physics, these revisions describe the three different electromagnetic waves observed in practice and so enable a better mathematical representation.

Keywords: Classical Electrodynamics, Superfluid medium, Fluid Dynamics, Theoretical Physics, Vector Calculus.

Introduction

In 1861, James Clerk Maxwell published his paper "On Physical Lines of Force"[31], wherein he theoretically derived a set of twenty equations which accurately described the electro-magnetic field insofar as known at that time. He modeled the magnetic field using a molecular vortex model of Michael Faraday's "lines of force" in conjunction with the experimental result of Weber and Kohlrausch, who determined in 1855 that there was a quantity related to electricity and magnetism, the ratio of the absolute electromagnetic unit of charge to the absolute electrostatic unit of charge, and determined that it should have units of velocity. In an experiment, which involved charging and discharging a Leyden jar and measuring the magnetic force from the discharge current, they found a value 3.107e8 m/s, remarkably close to the speed of light.

In 1884, Oliver Heaviside, concurrently with similar work by Josiah Willard Gibbs and Heinrich Hertz, grouped Maxwell's twenty equations together into a set of only four, via vector notation. This group of four equations was known variously as the Hertz-Heaviside equations and the Maxwell-Hertz equations but are now universally known as Maxwell's equations.

The Maxwell equations predict the existence of just one type of electromagnetic wave, even though it is now known that at least two electromagnetic wave phenomena exist, namely the "near" and the "far" fields. The "near" field has been shown to be a non-radiating surface wave that is guidable along a completely unshielded single conductor[32] and can be applied for wide band low loss communication systems. The Maxwell equations have not been revised to incorporate this new knowledge.

Given the above, the following questions should be asked:

- What is charge?
- Why is it a property of certain particles?

As long as we insist that charge is an elemental quantity that is a property of certain particles, we cannot answer these questions. Also, when the wave particle duality principle is considered in relation to what is considered to be the cause for electromagnetic radiation, charged particles, in Maxwell's equations electromagnetic radiation is essentially considered to be caused by (quanta of) electromagnetic radiation, an obvious case of circular logic which is not desirable.

In the area of vector calculus, Helmholtz's theorem, also known as the fundamental theorem of vector calculus, states that any sufficiently smooth, rapidly decaying vector field in three dimensions can be resolved into the sum of an irrotational (curl-free) vector field and a solenoidal (divergence-free) vector field; this is known as the Helmholtz decomposition. A terminology often used in physics refers to the curl-free component of a vector field as the longitudinal component and the divergence-free component as the transverse component. This theorem is also of great importance in electromagnetic (EM) and microwave engineering, especially for solving the low-frequency breakdown issues caused by the decoupling of electric and magnetic fields.[33] Further, a vector field can be uniquely specified by a prescribed divergence and curl and it can be shown that the Helmholtz theorem holds for arbitrary vector fields, both static and time-dependent[34].

In potential theory, the study of harmonic functions, the Laplace equation is very important, amongst other with regards to consideration of the symmetries of the Laplace equation. The symmetries of the n-dimensional Laplace equation are exactly the conformal symmetries of the n-dimensional Euclidean space, which has several implications. One can systematically obtain the solutions of the Laplace equation which arise from separation of variables such as spherical harmonic solutions and Fourier series. By taking linear superpositions of these solutions, one can produce large classes of harmonic functions which can be shown to be dense in the space of all harmonic functions under suitable topologies.

The Laplace equation as well as the more general Poisson equation are 2nd order differential equations, in both of which the Laplacian represents the flux density of the gradient flow of a function. In one dimension, the Laplacian simply is $\partial^2/\partial x^2$, representing the curvature of a given function *f*. For scalar functions in 3D, the Laplacian is a common generalization of the second derivative and is the differential operator defined by:

$$\nabla^2 f = \frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} + \frac{\partial^2 f}{\partial z^2} \tag{1}$$

The Laplacian of a scalar function is equal to the divergence of the gradient and the trace of the Hessian matrix. The vector Laplacian is a further generalization in three dimensions and defines the second order spatial derivative of any given vector field $\boldsymbol{F}$, the “3D curvature” if you will, and is given by the identity:

$$\nabla^2 \boldsymbol{F} = \nabla(\nabla \cdot \boldsymbol{F}) - \nabla \times (\nabla \times \boldsymbol{F}) \tag{2}$$

Whereas the scalar Laplacian applies to a scalar field and returns a scalar quantity, the vector Laplacian applies to a vector field, returning a vector quantity. When computed in orthonormal Cartesian coordinates, the returned vector field is equal to the vector field of the scalar Laplacian applied to each vector component.

With this identity, a full 3D generalization of the Poisson equation can also be defined, the vector wave equation, which has three independent solutions[35], the vector spherical harmonics:

$$\nabla^2 \boldsymbol{F} + k^2 \boldsymbol{F} = \nabla \nabla \cdot \boldsymbol{F} - \nabla \times \nabla \times \boldsymbol{F} + k^2 \boldsymbol{F} = 0. \tag{3}$$

Methods

The terms in the definition for the vector Laplacian can be negated:

$$-\nabla^2 \boldsymbol{F} = -\nabla(\nabla \cdot \boldsymbol{F}) + \nabla \times (\nabla \times \boldsymbol{F}) \tag{4}$$

and then the terms in this identity can be written out to define a vector field for each of these terms:

$$\begin{aligned} \boldsymbol{A} &= \nabla \times \boldsymbol{F} \\ \varphi &= \nabla \cdot \boldsymbol{F} \\ \boldsymbol{B} &= \nabla \times \boldsymbol{A} = \nabla \times (\nabla \times \boldsymbol{F}) \\ \boldsymbol{E} &= -\nabla \varphi = -\nabla(\nabla \cdot \boldsymbol{F}) \end{aligned} \tag{5}$$

And, since the curl of the gradient of any twice-differentiable scalar field φ is always the zero vector ($\nabla \times (\nabla \varphi) = 0$), and the divergence of the curl of any vector field $\boldsymbol{A}$ is always zero as well ($\nabla(\nabla \times \boldsymbol{A}) = 0$), we can establish that $\boldsymbol{E}$ is curl-free and $\boldsymbol{B}$ is divergence-free, and we can write:

$$\begin{aligned} \nabla \times \boldsymbol{E} &= 0 \\ \nabla \cdot \boldsymbol{B} &= 0 \end{aligned} \tag{6}$$

As can be seen from this, the vector Laplacian establishes a Helmholtz decomposition of the vector field $\boldsymbol{F}$ into an irrotational or curl free component $\boldsymbol{E}$ and a divergence free component $\boldsymbol{B}$, along with associated potential fields φ and $\boldsymbol{A}$, all from a single equation c.q. operator.

Thus we have shown that the mathematical definitions for potential fields are hidden within the Laplace operator c.q. the fundamental theorem of vector calculus c.q. the second order spatial derivative, which has tremendous consequences for both the analytical analysis of the electromagnetic field as well as fluid dynamics vector theory. The symmetry between the fields thus defined is fundamental and has been mathematically proven to be correct, so it is vital to maintain this fundamental symmetry in our physics equations.

So far, we have considered the general case, which is valid for any given vector field **F**. In the following, we will use the $_m$ subscript to refer to the electromagnetic domain along Maxwell's equations, while the $_f$ subscript is used for the fluid dynamics domain.

In Maxwell's equations, the curl of the electric field $\boldsymbol{E}_m$ is defined by the Maxwell-Faraday equation:

$$\nabla\times\boldsymbol{E_m}=-\frac{\partial\boldsymbol{B_m}}{\partial t}, \tag{7}$$

which is obvious not equal to zero for electromagnetic fields varying with time and therefore the dynamic Maxwell equations cannot be second order spatial derivatives of any vector field $\boldsymbol{F}_m$ as defined by the Laplacian.

Herewith, we have shown that no vector field $\boldsymbol{F}_m$ exists for which Maxwell's equations are the second order spatial derivative and therefore Maxwell's equations do not satisfy the vector Laplace equation. The end result of this is that while the solutions of Laplace's equation are all possible harmonic wave functions, with Maxwell's equations there is only one resulting wave equation which defines a "transverse" wave, whereby the $\boldsymbol{E}_m$ and $\boldsymbol{B}_m$ components are always perpendicular with respect to one another. This is also the reason why no separate wave equations can be derived for the "near" and "far" fields.

Furthermore, in Maxwell's equations, the two potential fields which are used with Helmholtz's theorem are the electrical potential φ_m and the magnetic vector potential $\boldsymbol{A}_m$, which are defined by the equations[36]:

$$\begin{aligned} \boldsymbol{B_m} &= \nabla\times\boldsymbol{A_m} \\ \boldsymbol{E_m} &= -\nabla\varphi_m-\frac{\partial\boldsymbol{A_m}}{\partial t} \end{aligned} \tag{8}$$

where $\boldsymbol{B}_m$ is the magnetic field and $\boldsymbol{E}_m$ is the electric field.

The Helmholtz theorem can also be described as follows. Let **A** be a solenoidal vector field and φ a scalar field on $\mathbf{R}^3$ which are sufficiently smooth and which vanish faster than $1/r^2$ at infinity. Then there exists a vector field **F** such that:

$$\nabla\boldsymbol{F}=\varphi \text{ and } \nabla\times\boldsymbol{F}=\boldsymbol{A} \tag{9}$$

and if additionally, the vector field **F** vanishes as $r\to\infty$, then **F** is unique[37].

Now let us consider the units of measurement involved in these fields, whereby the three vector operators used all have a unit of measurement in per meter [/m]. The magnetic field $\mathbf{B}_m$ has a unit of measurement in Tesla [T], which is defined in SI units as [kg/s^2-A]. So, for the magnetic vector potential $\mathbf{A}_m$ we obtain a unit of [kg-m/s^2-A] and for $d\mathbf{A}_m/dt$ we obtain a unit of [kg-m/s^3-A]. The electric field $\mathbf{E}_m$ has a unit of measurement in volt per meter, which is defined in SI units as [kg-m/s^3-A], which matches that for $d\mathbf{A}_m/dt$. So, for the electric scalar potential φ_m we obtain a unit of [kg-m^2/s^3-A].

However, neither the units of measurement for $\mathbf{E}_m$ and $\mathbf{B}_m$ are the same, nor are the units of measurements for φ_m and $\mathbf{A}_m$. This is in contradiction with Helmholtz's theorem, which states that a vector field $\mathbf{F}_m$ exists that should have a unit of measurement equal to that of φ_m and $\mathbf{A}_m$ times meters or that of $\mathbf{E}_m$ and $\mathbf{B}_m$ times meters squared.

Thus, we have shown that Maxwell's equations are in contradiction with Helmholtz's theorem as well, which means that the potential fields defined by Maxwell are mathematically inconsistent and should therefore be revised.

It can be shown[38] that by using the 19th Century's atomic vortex postulate in combination with a superfluid model for the medium, it is possible to construct a single simple integrated model which covers all major branches of physics including kinetic, fluid, gravitation, relativity, electromagnetism, thermal, and quantum theory. With this method, it can also be shown that anomalous observations such as Pioneer's drag and the electron's magnetic moment can be directly accounted for by the model. Furthermore, with this model all units of measurements are defined in terms of just three fundamental units of measurement: mass, length, and time.

It should be noted that there are two distinct levels in this model, with each playing their own role. The first consists of basic media quanta, which forms a superfluid model for the medium itself. The second describes vortices within the fluid, which forms a particle model on top of the medium model. The lower base level is assumed to be an (if not ideal, nearly so) in-viscous superfluid system obeying the defined rules of basic kinetic theory and that is the model this paper is originally based on, which means that the equations presented in this paper do not depend on the higher level Atomic Vortex Hypothesis based model. However, during the course of this work it became clear that viscosity plays a crucial role in our model, which has as consequence that an in-viscous superfluid model is insufficient to describe the behavior of the medium.

Of course, a (viscous) superfluid model can also be described in vector notation and since this model essentially describes a fluid/gas like medium, we can apply continuum mechanics fluid dynamics vector calculus methods to re-derive the Maxwell equations from the basic model. As is common practice in continuum mechanics fluid dynamics vector theory, we can describe its dynamic behavior by working with the medium's flow velocity vector field[39] $\mathbf{v}$, with $\mathbf{v}$ representing the local average bulk flow velocity.

It should be noted that because we use continuum mechanics, the equations presented in this paper are independent on the detailed description of the constituents of the medium itself and that there is a lower limit with respect to scale below which the medium can no longer be considered as a continuum. In that case, the model is no longer applicable, which is a well-known limitation of continuum mechanics. The Knudson number can be used to estimate this limit.

Within the fluid dynamics domain, a scalar potential field φ_f and a vector potential field $\mathbf{A}_f$ are generally described for an incompressible fluid ($\nabla \mathbf{v}_f = 0$) with a flow velocity field $\mathbf{v}_f$ as follows[40] (eq. 17-19):

$$\boldsymbol{v}_f = \nabla \varphi_f + \nabla \times \boldsymbol{A}_f \tag{10}$$

where the velocity potential φ_f is a scalar potential field, satisfying the Laplace equation:

$$\nabla^2 \varphi_f = 0 \tag{11}$$

and the vorticity potential $\mathbf{A}_f$ is a solenoidal (i.e. $\nabla . \boldsymbol{A}_f = 0$) vector potential field satisfying the Poisson equation:

$$\nabla^2 \boldsymbol{A}_f = -\nabla \times (\nabla \times \boldsymbol{A}_f) = -\boldsymbol{\omega}_v, \tag{12}$$

where $\boldsymbol{\omega}_v = \nabla \times \mathbf{v}_f$ is the velocity vorticity field.

However, with this definition, the potential fields are not uniquely defined and the boundary conditions on φ_f and $\mathbf{A}_f$ depend on the nature of the flow at the boundary of the flow domain and on the topological properties of the flow domain, respectively.

We can can *attempt* to resolve this problem for the general case of a fluid that is both compressible and rotational by defining a compressible irrotational velocity field $\mathbf{E}_f$ for the scalar potential φ_f and an incompressible solenoidal velocity field $\mathbf{B}_f$ and associated vorticity field $\boldsymbol{\omega}$ for the vector potential $\mathbf{A}_f$ using the Helmholtz decomposition and negating the commonly used definition for the velocity potential φ_f:

$$\boldsymbol{v}_f = -\nabla \varphi_f + \nabla \times \boldsymbol{A}_f = \boldsymbol{E} + \boldsymbol{B} \tag{13}$$

$$\begin{aligned} \boldsymbol{E}_f &= -\nabla \varphi_f \\ \boldsymbol{B}_f &= \nabla \times \boldsymbol{A}_f \\ \boldsymbol{\omega} &= \nabla \times \boldsymbol{B}_f \end{aligned} \tag{14}$$

This way, the $\boldsymbol{E}_f$ and $\boldsymbol{B}_f$ fields describe flow velocity fields with a unit of measurement in [m/s] and both the velocity potential and the velocity vorticity potential describe fields with a unit of measurement in meters squared per second [m^2/s]. However, the primary vector field $\boldsymbol{F}_f$ thus has a unit of measurement in [m^3/s], which describes a vector field for a volumetric flow rate or volume velocity. This can be considered as the flow velocity vector field $\mathbf{v}_f$ times a surface S perpendicular to $\mathbf{v}_f$ with a surface area proportional to h^2 square meters [m^2], with *h* the physical length scale in meters [m]. This results in the zero vector when taking the limit for the length scale *h* to zero, which is obviously problematic.

So far, we have considered the general mathematical case for the Helmholtz decomposition of any given vector field $\boldsymbol{F}$ as well as its common use in both the electrodynamics and the fluid dynamics domains, whereby we encountered a number of problems. In order to resolve these problems and avoid confusion with the various fields used thus far, let us first introduce a new set of fields along equation (5):

$$\begin{array}{lcl} \Pi & = & \nabla \cdot \boldsymbol{C} \\ \boldsymbol{\Omega} & = & \nabla \times \boldsymbol{C} \\ \boldsymbol{L} & = & -\nabla \Pi = -\nabla(\nabla \cdot \boldsymbol{C}) \\ \boldsymbol{R} & = & \nabla \times \boldsymbol{\Omega} = \nabla \times (\nabla \times \boldsymbol{C}), \end{array} \tag{15}$$

where $\boldsymbol{C}$ is our primary vector field, Π is the scalar potential or pressure, $\boldsymbol{\Omega}$ is the vector potential or angular pressure, $\boldsymbol{L}$ is the longitudinal or translational force density and $\boldsymbol{R}$ is the rotational or angular force density. Hereby, Π and $\boldsymbol{\Omega}$ have a unit of measurement in Pascal [Pa] or Newtons per square meter [N/m^2] and $\boldsymbol{L}$ and $\boldsymbol{R}$ are in Newtons per cubic meter [N/m^3]. $\boldsymbol{C}$ is in Newtons per meter [N/m] or kilograms per second squared [kg/s^2], thus representing an as of yet undefined quantity. Further down, we will see that for the medium this unit corresponds to the Ampere, hence the choice for using the symbol $\boldsymbol{C}$ for "current".

Let us now consider the 3D generalization of Newton's second law for a substance with a certain mass density, expressed in densities or per unit volume:

$$\boldsymbol{f}_n = \rho \boldsymbol{a} = \rho \frac{d\boldsymbol{v}}{dt} = -\nabla \Pi, \tag{16}$$

with $\boldsymbol{f}_n$ the force density in [N/m^3], ρ the mass density of the substance, **v** the velocity field, **a** the acceleration field and Π the pressure or scalar potential field in Pascal [Pa], defined as the divergence of some primary field $\boldsymbol{C}$. Since $\boldsymbol{C}$ should exist according to the Helmholtz decomposition and should have a unit of measurement in [kg/s^2] or [N/m], we can define $\boldsymbol{C}$ as follows:

$$\boldsymbol{C} = \eta \boldsymbol{v}, \tag{17}$$

with η the viscosity of the substance in [kg/m-s]. This way, we obtain a full 3D generalization of Newton's second law per unit volume, describing not only a longitudinal force density field $\boldsymbol{L}$ but also a rotational or angular force density field $\boldsymbol{R}$:

$$\rho \frac{d\boldsymbol{v}}{dt} = -\nabla^2 \boldsymbol{C} = -\nabla^2 \eta \boldsymbol{v} = -(\boldsymbol{L} + \boldsymbol{R}). \tag{18}$$

This definition also allows us to work with the vector wave equation(3):

$$\nabla^2 \boldsymbol{C} + k^2 \boldsymbol{C} = \nabla \nabla \cdot \boldsymbol{C} - \nabla \times \nabla \times \boldsymbol{C} + k^2 \boldsymbol{C} = 0. \tag{19}$$

This is a full 3D vector wave equation, in contrast to the complex wave function that is often used in Quantum Mechanics. With wave functions there are only two axis, the real and the imaginary, which is simply insufficient to fully describe phenomena in three dimensions. In other words: current Quantum Mechanics theories lack the required dimensionality in order to be capable of fully describing the phenomena and are therefore incomplete.

When we divide equation (18) by mass density ρ, we obtain the velocity diffusion equation:

$$\boldsymbol{a} = \frac{d\boldsymbol{v}}{dt} = -\nabla^2 \nu \boldsymbol{v} = -\nabla^2 \Lambda, \tag{20}$$

with $\boldsymbol{a}$ the acceleration field in [m/s^2], ν the diffusivity or kinematic viscosity, defined by:

$$\nu = \frac{\eta}{\rho}, \quad (21)$$

and Λ the volumetric acceleration field, defined by:

$$\Lambda = \nu \boldsymbol{v}. \quad (22)$$

This results in the diffusivity for the medium ν having a unit of measurement in meters squared per second [m^2/s] and a value equal to light speed c squared (c^2), so there is a per second [/s] difference in the unit of measurement, suggesting that in our current models the dimensionality of certain quantities is off by a per second. As we shall see, this has profound consequences for our understanding of physical reality including the mass-energy equivalence principle.

This per second difference in units of measurement suggests that in our current models there are a number of problems involving time derivatives that have not been properly accounted for. When we consider that the solutions of the vector wave equation are harmonic functions, characterized by sine and cosine functions of time, it becomes clear how these problems could have arisen. Since the cosine is the time derivative of the sine function and vice versa, there is only a phase difference between the two. When we consider that all known particles adhere to the wave-particle duality principle and have characteristic oscillation frequencies that are very high, it becomes clear that the quantum scale phase differentials between a force acting upon a particle and the resulting (time delayed) acceleration of that particle are virtually undetectable at the macroscopic level.

Note that with this diffusion equation, the only units of measurement are the meter and the second, which means that we have succeeded in separating the dynamics over space and time from the substance (mass density) that's being diffused over space and time. In other words: with this diffusion equation we have described the quantum characteristics of spacetime itself.

Analogous to equation (20), we can also define a second order diffusion equation:

$$\boldsymbol{j} = \frac{d\boldsymbol{a}}{dt} = -\nu\nabla^2\boldsymbol{a} = -\nu\nabla^2(-\nu\nabla^2\boldsymbol{v}), \quad (23)$$

which we can work out further by multiplying by mass density ρ to define the radiosity or intensity field ***I*** in Watts per square meter [W/m^2], representing a heat flux density:

$$\rho\,\boldsymbol{j} = \rho\frac{d\boldsymbol{a}}{dt} = -\rho\,\nu\nabla^2\boldsymbol{a} = -\nabla^2\boldsymbol{I} = -\eta\nabla^2\boldsymbol{a} = -\nu\nabla^2(\boldsymbol{L}+\boldsymbol{R}), \quad (24)$$

or:

$$\boldsymbol{I} = \nu(\boldsymbol{L}+\boldsymbol{R}) \quad (25)$$

From this, we can derive additional fields analogous to equation (15), which results in fields representing power density in Watts per cubic meter [W/m^3] for the first spatial derivatives and jerk ***j*** times mass density in [N/m^3-s^3] for the second spatial derivatives and thus we find that the spatial derivatives of the intensity field ***I*** are the time derivatives of the corresponding spatial derivatives of our primary field ***C***.

The process of taking higher order derivatives can be continued indefinitely, whereby for harmonic solutions we end up with the same results over and over again, resulting in only a phase differential between subsequent results.

An interesting detail is that the intensity field ***I*** can also be defined as:

$$\boldsymbol{I} = -\kappa \boldsymbol{v}, \tag{26}$$

with κ the modulus or elasticity in [Pa] or [kg/m-s^2], which has a unit of measurement that differs by a per second [/s] from the unit of measurement for viscosity η in [Pa-s] or [kg/m-s].

This reflects the difference between elastic forces and viscous (shear) forces, namely that the elastic force is proportional to the amount of deformation, while the viscous one is proportional to the rate of deformation. So, it appears we can conclude that in physical reality there are no actual static (elastic) forces (at the quantum level) and that deep down there are only dynamic forces and interactions which are governed by the velocity diffusion equation(20), whereby what we observe as static forces are in reality the time derivatives of fundamentally viscous forces.

This brings us to the mass energy equivalence principle:

$$E = mc^2, \tag{27}$$

which can now alternatively be formulated by:

$$L = m\nu, \tag{28}$$

with L the angular momentum in [kg-m^2/s] of a particle with mass m and ν the diffusivity or kinematic viscosity. This way, the Planck-Einstein relation becomes:

$$L = hf, \tag{29}$$

with f the characteristic oscillation frequency of the particle.

This can be related to the unusual behavior of superfluids such as ^{3}He, which spontaneously creates quantized vortex lines when the container holding the liquid is put into rotation[41], thus forming a quantum vortex. This is a hollow core around which the superfluid flows along an irrotational vortex pattern (i.e. $\nabla \times \boldsymbol{v} = 0$). This flow is quantized in the sense that the circulation takes on discrete values[42]. The quantum unit of circulation or quantum circulation constant is h/m, where h is Planck's constant and m is the mass of the superfluid particles.

For the medium, we can equate this quantum circulation constant to ν, the diffusivity or kinematic viscosity, which we can now also refer to as the quantum circulation constant, and thus we can compute the mass of an elemental aether particle along:

$$m_{elemental} = \frac{h}{\nu}, \tag{30}$$

which computes to approximately 7.372e-51 kg, about 20 orders of magnitude lighter than the electron.

When we compute the Compton wavelength for such a particle, we obtain the value of the speed of light c, but with a unit of measurement in meters [m] rather than velocity [m/s], while it's associated frequency computes to 1 Hertz [Hz]. Since the Compton wavelength of a particle is equal to the wavelength of a photon whose energy is the same as the mass of that particle along the mass-energy equivalence principle, this puts serious question marks to the mass-energy equivalence principle in favor of our alternative in equation (28), whereby we conclude that the quantization that is observed in physics is not a quantization of mass/energy, but one of angular momentum. And since angular momentum is represented by the magnetic field, we can also conclude that it's the magnetic field that is quantized and that magnetic field lines are actually irrotational hollow core vortices in a superfluid medium with a circulation equal to the quantum circulation constant ν.

Now let us consider the Cauchy momentum equation without external forces working on the fluid:

$$\rho \frac{d\boldsymbol{v}}{dt} = -\nabla \cdot \boldsymbol{P}, \tag{31}$$

with $\boldsymbol{P}$ the Cauchy stress tensor, which has a unit of measurement in [N/m^2] or [Pa] and is a central concept in the linear theory of elasticity for continuum solid bodies in static equilibrium, when the resultant force and moment on each axis is equal to zero. It can be demonstrated that the components of the Cauchy stress tensor in every material point in a body satisfy the equilibrium equations and according to the principle of conservation of angular momentum, equilibrium requires that the summation of moments with respect to an arbitrary point is zero, which leads to the conclusion that the stress tensor is symmetric, thus having only six independent stress components, instead of nine.

In our model, we have only four independent stress components, namely the scalar and vector potentials Π and **Ω**.

From this momentum equation, the Navier-Stokes equations can be derived, of which the most general one without external (gravitational) forces is:

$$\rho \frac{D\boldsymbol{v}}{Dt} = \rho\left(\frac{\partial \boldsymbol{v}}{\partial t} + \boldsymbol{v}\cdot\nabla\boldsymbol{v}\right) = -\nabla p + \nabla\cdot\left\{\eta\left(\nabla\boldsymbol{v} + (\nabla\boldsymbol{v})^T - \frac{2}{3}(\nabla\cdot\boldsymbol{v})\boldsymbol{I}\right) + \zeta(\nabla\cdot\boldsymbol{v})\boldsymbol{I}\right\}, \tag{32}$$

with p the pressure, **I** the identity tensor and ζ the volume, bulk or second viscosity. This can be re-written to:

$$\rho \frac{\delta v}{\delta t} = -\nabla p - \rho(v\cdot\nabla v) + \eta\nabla\cdot\left(\nabla v + (\nabla v)^T\right) + \left(\zeta - \frac{2\eta}{3}\right)(\nabla\cdot\nabla\cdot v)I. \tag{33}$$

This is also a second order equation, whereby notably for the viscous term $\eta\nabla\cdot\left(\nabla v + (\nabla v)^T\right)$ the order of the differential operators is reversed compared to the definition of the second spatial derivative, the vector Laplace operator, while for the elastic term, $\left(\zeta - \frac{2\eta}{3}\right)(\nabla\cdot\nabla\cdot v)I$, the divergence of the divergence is taken. Also, a separate term is introduced for pressure as well as a convective term, $\rho(v \cdot \nabla v)$. All this not only causes the complexity of the equations to increase dramatically while introducing redundancy in the symmetric stress tensor, it also ignores the fundamental symmetry between the compressible, irrotational components and the incompressible, solenoidal components as prescribed by the Helmholtz decomposition.

When we compare this with our proposal, we end up with two fundamentally different approaches:

1 A solution that fundamentally only has viscosity and one fundamental interaction of Nature, yields harmonic solutions c.q. builds upon deterministic (spherical) harmonics and provides a basis for the observed quantization as well as a 3D generalization of the currently used under-dimensioned wave functions;
2 A solution that has both viscosity as well as elasticity, the latter of which builds upon Brownian statistical mechanics and thus requires randomness and is therefore non-deterministic.

However, with our solution so far, we have lost the description of elastic behavior and thus our model is incomplete. This again brings us to the unusual behavior of superfluids, which is currently described with a two-fluid theory[43]. Donnely notes a/o the following:

1. In superfluid state, liquid helium can flow without friction. A test tube lowered partly into a bath of helium II will gradually fill by means of a thin film of liquid helium that flows without friction up the tube's outer wall.
2. There is a thermo-mechanical effect. If two containers are connected by a very thin tube that can block any viscous fluid, an increase in temperature in one container will be accompanied by a rise in pressure, as seen by a higher liquid level in that container.
3. The viscous properties of liquid helium lead to a paradox. The oscillations of a torsion pendulum in helium II will gradually decay with an apparent viscosity about one-tenth that of air, but if liquid helium is made to flow through a very fine tube, it will do so with no observable pressure drop—the apparent viscosity is not only small, it is zero!

He also describes "second sound", fluctuations of temperature, which according to him "has turned out to be an incredibly valuable tool in the study of quantum turbulence" and provides a condensed summary:

"After one of his discussions with London and inspired by the recently discovered effects, Tisza had the idea that the Bose-condensed fraction of helium II formed a superfluid that could pass through narrow tubes and thin films without dissipation. The uncondensed atoms, in contrast, constituted a normal fluid that was responsible for phenomena such as the damping of pendulums immersed in the fluid. That revolutionary idea demanded a "two-fluid" set of equations of motion and, among other things, predicted not only the existence of ordinary sound—that is, fluctuations in the density of the fluid—but also fluctuations in entropy or temperature, which were given the designation "second sound" by Russian physicist Lev Landau. By 1938 Tisza's and London's papers had at least qualitatively explained all the experimental observations available at the time: the viscosity paradox, frictionless film flow, and the thermo-mechanical effect."

This leads to the question of whether or not the effects described by the current "two-fluid" theory can also be described by the (spatial derivatives) of the two related fields we have defined, our primary field [C] and the intensity field [I], since we already noted that the intensity field [I] does appear to describe elastic behavior (eq (26)), apart from a per second difference in units of measurement, and that when dealing with harmonic functions of time, such as those describing elemental particles, it is all too easy to get these time derivatives mixed up, because there is only a phase differential between the [C] and [I] fields and their respective spatial derivative fields.

Further, since electric current can be associated with both the curl of the magnetic field as well as with electric resistance and thus dissipation, it seems clear that rather than associating the absence of dissipation/resistance with the absence of viscosity, this absence should be associated with the absence of vorticity or turbulence.

This brings us to the idea of the "vortex sponge"[44], devised by John Bernoulli in 1736, although in the shape of vortex tubes rather than ring vortices, which gives rise to elastic behavior of the medium because of momentum transfer effects arising from the fine-grained vorticity. This idea matches seamlessly to a vortex theory of atoms[45], which was developed after around 1855 a new type of vortex theory emerged, the so-called 'vortex sponge theory'. Instead of viewing atoms as consisting out of small, separate vortices, this type of theory supposed that the ether was completely filled with tiny vortices. These tiny, close-packed vortices made up large sponge-like structures, which gave this category of models its name.

When we consider the basic idea that particles consist of a number (quantized) vortex rings, we would then consider these to form such a vortex sponge, especially in the case of crystalline materials such as silicon. Therefore, we would associate a material substance to such a dynamic vortex sponge rather than considering the aether itself to be universally filled with tiny vortices. And since in this view there are no stiff, point-like particles that bounce onto one another in a random manner, we would also do away with Brownian statistics and consider the interactions between the vortices to occur along harmonic functions of time.

The question then becomes whether or not the static forces we consider at the macroscopic level really are forces along Newton's third:

$$F = m a, \tag{34}$$

or are actually time derivatives thereof, yank, along:

$$Y = m j, \tag{35}$$

with j the jerk, the time derivative of acceleration. The derivative of force with respect to time does not have a standard term in physics, but the term "yank" has recently been proposed in biomechanics[46].

This would also offer further insight into what inertia, resistance to "change", actually is, because the dynamic viscous forces we have described thus far are proportional to a rate of deformation and describe something dynamic, whereby there is a continuous flow of mass along quantized irrotational vortices. In a way, this can be seen as the opposite of resistance to "chance" and could perhaps rather be thought of as conductance of "change".

Let's illustrate that along the rotating superfluid wherein quantum vortexes are formed. Once a certain angular speed has been established with the rotating container, a certain number of quantum vortices have formed and the system is in equilibrium. In that situation, the vortices are irrotational and therefore no vorticity nor turbulence and thus no resistance nor dissipation. In other words: there is a steady-state situation, which could easily be confused with a "static" situation, were it not that these the vortex lines are visible.

When we wish to increase the rotation speed of the rotating container, we must exert a "force" and thus we introduce turbulence until a new equilibrium is established. This way, we convert the energy we provide into the rotating superfluid, whereby the steady state situation becomes disturbed and turbulence is introduced, which results in more quantum vortices forming until eventually the turbulence dies out and a new equilibrium is established. Thus, from the outside it appears as though the rotating mass in the container resists change, but in reality it sort of stores "change" by forming additional vortices until there is no more turbulence.

Now let us look back at equation (20), the velocity diffusion equation:

$$\boldsymbol{a} = \frac{d\boldsymbol{v}}{dt} = -\nabla^2 \nu \boldsymbol{v} \tag{36}$$

with $\boldsymbol{a}$ the acceleration field in [m/s^2], ν the diffusivity, kinematic viscosity or quantum circulation constant. This is an equation with only meters and seconds and by dividing by velocity we can find that the time derivative operator can be related to the second spatial derivative by a single constant:

$$\frac{d}{dt} = -\nu \nabla^2, \tag{37}$$

which suggests space and time are indeed closely related.

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Intermezzo: my current “to do” list, some cut&pastes from discussions on researchgate:

Where we are now is that we can describe both the quantum level as well as the superfluid level (quantum phenomena at a macroscopic scale) with the same equations, only different parameters like mass density and quantum circulation constant, whereby we find that fundamentally there are only viscous forces.

What we see with superfluids is that when temperature rises (power density increases), elastic behavior emerges, which is currently described with a two-fluid model.

It seems that this effect can be attributed to the formation of some kind of vortex sponge which gives rise to elastic behavior. And it also seems we can describe the effects this creates within a continuum by the definition of fields that are derived from the intensity field [I] rather than our primary field [C].

The fields that can be defined as the second spatial derivatives of [I] have a unit of measurement describing the time derivative of force density, which would be yank density.

What it appears to come down to is that within current physics Force and Yank have been considered as one and the same thing, resulting in 3D equations that break the fundamental symmetry demanded by the vector Laplace operator.

So, it seems that there are actually two versions of Newton's law, which have currently been taken together into one:

1) F = m a,
2) Y = m j,

and the challenge thus comes down to figuring out which one of the two applies where.

When we put these quantities in a table:

Action:	kg-m^2/s.	Momentum mv:		kg-m/s.	Momentum density:	kg/m^2-s
Energy:	kg-m^2/s^2	Force	ma:	kg-m/s^2	Force density:	kg/m^2-s^2
Power:	kg-m^2/s^3	Yank	mj:	kg-m/s^3	Yank density:	kg/m^2-s^3

it also seems that additional fields can be defined to describe action density and its spatial derivative, momentum density.

"Sorry, but the root of your special problem is not vector analysis. It is your naïve assumption that you are free in selecting parts of the Navier Stokes equation to handle special problems."

Well, I must confess I was a bit too fast by assuming that because I started from the vector Laplace operator and all seemed to fit seamlessly, I had solved the puzzle and that the loss of a few independent stress components was nothing to worry about. So, guilty as charged in that respect.

However, it was not an exercise in selecting parts of Navier Stokes equations that met my needs, it was an attempt to derive equivalents of Navier Stokes from vector potential theory and to align these with equivalents of Maxwell and to derive both from one and the same equation, which turned out to represent Newton's third in 3D.

Since I was familiar with the scalar and vector potentials used in Maxwell and I found that the terms in the vector Laplace operator can be written out and define fields that establish a Helmholtz decomposition, I became convinced that this is the way it should be done. When I searched for usage of a vector potential in fluid dynamics, I found this paper and not much more:

https://pdfs.semanticscholar.org/9344/48b028a3a51a7567c2b441b5ca3e49ebb85c.pdf

As I wrote in my paper, I attempted to define a primary vector field for the Laplace operator to work on for these, since that should exist according to the Helmholtz decomposition. It seemed that all I needed to do was negate the definition for the scalar potential, but then the unit of measurement for the primary field turned out to be in [m^3/s], denoting a volumetric flow velocity, which results in the null vector when taking the limit of the volume to zero. So that didn't work out very well.

After a lot of puzzling, I found a solution that involved viscosity, whereby I found that the kinematic viscosity nu yielded a value equal to light speed squared for the aether, but a mismatch in units of measurement by a per second, pointing to problems here and there with time derivatives. When I realized that this constant nu can also be seen as the quantum circulation constant, I became convinced I'm on the right track and that the thus far mysterious properties of superfluids (quantum phenomena on a macroscopic scale) offer the key to unlocking the mysteries of quantum mechanics.

"The Navier Stokes equations have been derived from momentum conservation. For an in-compressible fluid we get two partial differential equations for density and pressure. For a compressible fluid the energy balance must be considered, which brings temperature and heat capacity into the game."

It is rather interesting that the fields I derived from my primary field [C] do seem to describe an incompressible fluid (viscous behavior), while we seem to have lost compressibility and that that should bring temperature and heat capacity into the game.

My working hypothesis is that temperature is a measure of power density and has a unit of measurement in Watts per cubic meter [W/m^3], but that may not be correct since Stowe (see below) found a unit in [kg-m/s^3].

I found a paper regarding superfluids, wherein it is stated that "second sound" waves exist in a superfluid, which incorporates the propagation of fluctuations in temperature:

https://sites.fas.harvard.edu/~phys191r/References/e1/donnelly2009.pdf

According to Donnely, this phenomena “has turned out to be an incredibly valuable tool in the study of quantum turbulence”.

Thus, we have quite some hints suggesting that elastic behavior, or compressibility, indeed has to do with the (spatial derivatives of) the intensity field [I] I thus far payed little attention to. I've updated my overview table and also included another primary field [Q] of which the second spatial derivatives yield momentum density or mass flux, which I see as another step forward.

What I think is an important detail is that the vector Laplace operator is the 3D generalization of the second spatial derivative, which would be d^2/dx^2 in 1D. This means that the 3D complexity of the vector equations we can define with these three vector fields [Q], [C] and [I], such as the vector wave equation, can be effortlessly reduced to one dimension to describe phenomena like for instance the mechanical behavior of a long rod or a long thin tube filled with a fluid.

"The possible approximations are “incompressibility”, “ideal gas”, or even ”perfect gas” with a constant heat capacity. Another issue are the boundary conditions inclusive external sources and sinks, which define the geometry of the considered problem. Finally, the initial values are important.

With your approach you stay outside of the terminology used to define Navier Stokes types of problems."

So far, I haven't solved the problem of temperature and black body radiation, but now that I realize the importance of the intensity field [I] and it's consequence that we have to consider yank rather than force, it seems it is only a matter of time before we can come full circle.

First of all, it is rather interesting that the gas law also involves quantization denoted by n:

P V = n Kb T, (eq 1)

With T the temperature in Kelvin,

P the pressure,
V the volume,
n the number of quanta,
and Kb Boltzmann's constant.

Second, I found the work of Paul Stowe very interesting, but very hard to comprehend. On the one hand, he managed to express all the major constants of nature in terms of just 5 constants and expressed all units of measurement in just three: mass, length and time, while on the other he managed to write it all down in a manner that I found very confusing, for instance because he refers to charge q as "divergence" while meaning "divergence of momentum density":

https://vixra.org/pdf/1310.0237v1.pdf

Nonetheless, valuable insights can be obtained from his work, if only as a starting point for further considerations. With respect to temperature and the gas law, in his eq. 20 we find a relationship between electrical charge and Boltzmann's constant:

Kb = h/(qc), (eq 2)

with q elemental charge and h Planck's constant, which results in the conclusion that the quantization in the gas law is related to the quantization of the medium, which is governed by the quantum quantization constant nu. While it is nice that this equation yields the right number, this does not necessarily mean this equation is 100% correct as written, but it certainly seems to point in the right direction.

Another interesting paper on the subject of black body radiation in relation to aether theory is this one by C.K. Thornhill, which gives a valuable starting point for deriving Planck's law:

https://etherphysics.net/CKT1.pdf

His main argument:

"Another argument against the existence of a physical ethereal medium is that Planck's empirical formula, for the energy distribution in a black-body radiation field, cannot be derived from the kinetic theory of a gas with Maxwellian statistics. Indeed, it is well-known that kinetic theory and Maxwellian statistics lead to an energy distribution which is a sum of Wien-type distributions, for a gas mixture with any number of different kinds of atoms or molecules. But this only establishes the impossibility of so deriving Planck's distribution for a gas with a finite variety of atoms or molecules. To assert the complete impossibility of so deriving Planck's distribution it is essential to eliminate the case of a gas with an infinite variety of atoms or molecules, i .e . infinite in a mathematical sense, but physically, in practice, a very large variety. The burden of the present paper is to show that this possibility cannot be eliminated, but rather that it permits a far simpler derivation of Planck's energy distribution than has been given anywhere heretofore."

What is interesting, is that he found a relationship between the adiabatic index ω and the number of degrees of freedom α of (aether) particles, which leads to the conclusion that α must be equal to 6 and he concludes:

"Thus, the quest for a gas-like ethereal medium, satisfying Planck's form for the energy distribution, is directed to an ideal gas formed by an infinite variety of particles, all having six degrees of freedom."

It is this adiabatic index which provides a relationship to heat capacity, since it is also known as the heat capacity ratio:

https://en.wikipedia.org/wiki/Heat_capacity_ratio
"In thermal physics and thermodynamics, the heat capacity ratio, also known as the adiabatic index, the ratio of specific heats, or Laplace's coefficient, is the ratio of the heat capacity at constant pressure (C_P) to heat capacity at constant volume (C_V)."

So, while we clearly have not yet cracked the whole nut, it seems to me we are on the right track towards the formulation of a "theory of everything", that holy grail that has thus far proven to be unreachable, which I'm sure will turn out to be attributable to ignoring the implications of the vector Laplace operator.

Personally, I have no doubt both the weak and strong nuclear forces can be fully accounted for by our model c.q. electromagnetic forces, once completely worked out, and that the gravitational force also propagates through the aether, as actually confirmed by the Michelson-Morley experiment, so that we will end up with a model that is much, much simpler and only has one fundamental interaction of nature.

To illustrate the argument that the nuclear forces can be fully accounted for by electromagnetic forces, I wholeheartedly recommend the experimental work of David LaPoint, who shows this in his laboratory:

https://youtu.be/siMFfNhn6dk

[end intermezzo]

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So far, we have shown that it is possible to derive a complete and mathematically consistent set of fields from a single equation, the 3D generalization of Newton’s second law, by using the LaPlace operator and working out the terms thereof. With this equation, we can use the vector wave equation, which has harmonic solutions, just like the wave function currently used in Quantum Mechanics. This makes it possible to extend the current Quantum Mechanical wave function solutions into full 3D solutions in a manner that maintains the fundamental symmetry of the Helmholtz decomposition within a framework of uniquely defined fields without gauge freedom. We have also shown that we can decouple the dynamics of the medium from it’s substance, mass density, with the velocity diffusion equation which reveals that the dynamics of the medium are governed by a single constant ν, the quantum circulation constant. And we have shown that we can take higher order derivatives of these equations over and over again, resulting in only phase differentials for the resulting vector spherical harmonic solutions.

What this comes down to is that we have come to a deeper model of physical reality, which reveals a number of intricate relationships between various fields defined so far, whereby the quantum circulation constant ν determines that at the quantum level there is an intricate balance between translational and angular momentum. This ultimately governs the possible harmonic solutions that can exist in the shape of particles, the oscillating dynamic structures that can be described by the vector spherical harmonics.

This model offers a new tangible basis for theoretical physics that may eventually very well lead to an an integrated "theory of everything", which is however by no means an easy task.

So far, it has proven to be very challenging even to integrate Maxwell's equations with this basis in a manner that is completely consistent with the current model and it's units of measurement. Maxwell's equations essentially describe a phenomenological model that is based upon the assumption that some kind of fundamental quantity called "charge" exists, to which a unit of measurement in Coulombs [C] has been assigned. All of the units of measurement within the electromagnetic domain can be derived from the Coulomb within this model, but there is no definition of what charge actually is nor what current actually is. Also, there is no explanation for why charge is considered to be polarized.

However, the model presented thus far has as big advantage that it describes a fluid-like medium and thus we can use fluid dynamics phenomena as analogies in our analysis.

Let us start with Ampere's original law to define current density $\boldsymbol{J}$:

$$\boldsymbol{J} = -\nabla \times \boldsymbol{R}. \tag{38}$$

And let us provide an overview of the fields defined thus far, along with their units of measurement:

	$\mathbf{\Lambda} = \ \nu\, \mathbf{v}$	$\mathbf{Q} = \ \tau\, \nu\, \rho\, \mathbf{v}$	$\mathbf{C} = \eta\, \mathbf{v} = \ \nu\, \rho\, \boldsymbol{v}$	$\mathbf{I} = \eta\, \mathbf{a} = \nu\, \rho\, \boldsymbol{a} = \nu(\mathbf{L}+\mathbf{R})$
Λ, **Q,** **C,** **I**	[m³/s²]	[kg/s], [N-s/m], [J-s/m²], [Pa-s-m], [C] (charge)	[kg/s²], [N/m] [J/m²], [Pa-m], [A] (current, action flux)	[kg/s³], [N/m-s], [J/m²-s], [Pa-m/s], [W/m²] (radiosity $\mathbf{J}_e$, intensity **I,** energy flux)
S, Σ P, **Ω** **T**, **χ**	[m²/s²]	[kg/m-s], [N-s/m²], [J-s/m³], [Pa-s], [V-s] (action density, momentum density flux)	[kg/m-s²], [N/m²], [J/m³], [Pa], [A/m], [V] (energy density, momentum flux, force density flux, pressure)	[kg/m-s³], [N/m²-s], [J/m³-s], [Pa/s], [W/m³], [K] (power or heat density, force flux, yank density flux, temperature)
M, Λ **L**, **R** **Y, Ψ**	[m/s²] (**a** = d**v**/dt, acceleration)	[kg/m²-s], [N-s/m³], [Pa-s/m] (ρ **v**, momentum density, mass flux)	[kg/m²-s²], [N/m³], [Pa/m], [A/m²], [C/m²-s] (ρ **a**, force density, charge flux)	[kg/m²-s³], [N/m³-s], [J/m⁴-s], [Pa/m-s], [J/m⁴-s], [W/m⁴] (ρ **j**, yank density, current flux)
J = curl **R** (electric current density)			[kg/m³-s²], [N/m⁴], [Pa/m²], [A/m³] (d²ρ/dt²)	

Table 1, overview of fields defined thus far.

This way, we would think of the electric field as being described by $\boldsymbol{L}$, the translational force density field, and the magnetic field as being described by $\boldsymbol{R}$, the angular force density field. And thus current would represent vorticity, which aligns pretty well with observations such as Elmore's non-radiating guided surface wave[47]. From equation (38), this gives us a unit of measurement in kilograms per second square [kg/s²] for the Ampere and we can define the Ampere as well as the Coulomb by:

$$1 \text{ Ampere} = 1 \text{ kilogram per second squared.} \tag{39}$$

$$1 \text{ Coulomb} = 1 \text{ kilogram per second.} \tag{40}$$

We can subsequently define charge density as the divergence of momentum density:

$$\rho_q = \nabla \cdot (\rho \boldsymbol{v}), \tag{41}$$

resulting in a unit of measurement for charge density ρ_q in kilograms per cubic meter per second [kg/m^3-s].

With this definition, the charge to mass ratio of a particle results in a unit of measurement in per second or Hertz [Hz], yielding a characteristic longitudinal oscillation frequency for such a particle. For the electron, this frequency computes to approximately 175.88 GHz, which falls within 10% of the calculated spectral radiance dEν/dν in the observed cosmic background radiation which peaks at 160.23 GHz and is calculated from a measured CMB temperature of approximately 2.725 K[48] suggesting a possible connection.

This suggestion leads to the idea that even though we can describe the medium itself as a superfluid, we cannot consider even the vacuum in outer space as devoid from any particles, disturbances or (zero point) energy and thus we can consider it to have a certain charge density ρ_{qb0}, a background charge density, which would be depending on the material or medium we are working with, just like the permeability and permittivity are.

This way, we can define the electric field ***E*** as follows:

$$\boldsymbol{E} = \frac{1}{\rho_{qb}} \boldsymbol{L}, \tag{42}$$

with ***L*** as defined in equation (15) and ρ_{qb} the background charge density, resulting in a unit of measurement for the electric field ***E*** in meters per second [m/s]. Coulomb's law then becomes:

$$\boldsymbol{F} = q\,\boldsymbol{E} = \frac{q}{\rho_{qb}} \boldsymbol{L}. \tag{43}$$

The electric (scalar) potential φ can subsequently be defined as:

$$\varphi = \frac{1}{\rho_{qb}} \Pi, \tag{44}$$

with Π the scalar pressure in Pascal [Pa] as defined in equation (15), yielding a unit of measurement in meters squared per second [m^2/s] for the scalar electric potential φ and thus we can define the Volt as:

1 Volt = 1 square meter per second. (45)

We can now also work out the unit of measurement for permittivity ε, which has an SI unit in [C^2/N-m^2]. By substitution we find that this results in a unit of measurement in kilograms per cubic meter [kg/m^3] and we can equate the mass density of the medium ρ to its permittivity:

$$\rho = \epsilon \tag{46}$$

For the magnetic field, we start out at the unit of measurement for permeability μ, which is defined in SI units as Newtons per Ampere squared [N/A^2]. By substitution we find that this corresponds [m-s^2/kg], the inverse of the modulus/elasticity in [Pa] or [kg/m-s^2]. The latter differs by a per second to the unit of measurement for viscosity η in [Pa-s] or [kg/m-s], the same difference we encountered earlier and which led us to conclude that in our current models the dimensionality of certain quantities is off by a per second. Therefore, we define the *value* of viscosity η but not its unit of measurement by:

$$\eta=\frac{1}{\mu}. \tag{47}$$

We can now define the magnetic field strength:

$$\boldsymbol{H}=\boldsymbol{R}, \tag{48}$$

with ***R*** the angular force density in Newton per cubic meter [N/m^3], resulting in a unit of measurement for the magnetic field strength in Ampere per meter squared [A/m^2], which differs from the SI definition which is in Ampere per meter [A/m].

The magnetic flux density then becomes:

$$\boldsymbol{B}=\mu\,\boldsymbol{H}=\mu\,\boldsymbol{R}, \tag{49}$$

and has a unit of measurement in per meter [/m].

The magnetic (vector) potential ***A*** can subsequently be defined as:

$$\boldsymbol{A}=\Omega, \tag{50}$$

with ***Ω*** the angular vector pressure in Pascal [Pa].

This leaves us with a problem in the dimensionality of the Lorentz force, however, which is not easily resolved in a satisfactory manner, although dimensionally, we can resolve the problem by defining the Lorentz force as:

$$\boldsymbol{F}_L=q\,\lambda\,(\boldsymbol{v}\times\boldsymbol{B})=m\,c\,(\boldsymbol{v}\times\boldsymbol{B}), \tag{51}$$

whereby λ is the wavelength of the particle along λ=c/f. With f=q/m we then obtain qλ=mc.

This brings us in the situation whereby we have obtained a fluid dynamics medium model that is capable of bridging the gap between the Quantum Mechanic and macroscopic worlds in a deterministic manner, but leaves us with open questions around the detailed nature of the Coulomb and Lorentz forces, especially in relation to the nature of charged particles and their mass/charge ratios.

However, it is clear that the irrotational vortex plays a dominant role in magnetics and these can also form closed loop rings, which explains why magnetic field lines are always closed. This suggests that toroidal ring models like Parson's[49] can be integrated with our model, especially because solid spherical harmonics can be expressed as series of toroidal harmonics and vice versa[50] and it is known that the solutions to the vector wave equation are the spherical harmonics.

When we assume that particles can indeed be considered as consisting of a number of closed loop hollow core vortex rings, then the physics of the vortex ring can also be expected to provide further insight in the nature of the Lorentz force working on charged particles. It is for example known that a vortex ring moves forward with its own self-induced velocity v[51]. And since a vortex ring has two axis of rotation, poloidal and toroidal, this could also offer an explanation for the existence of the polarization currently attributed to charge.

Either way, since all our fields are uniquely defined as solutions of the vector Laplace equation, we can establish that with deriving all fields from equation (18), we have eliminated "gauge freedom" and since we know these equations can be transformed using the Galilean coordinate transform, we have also eliminated the need for the Lorentz transform and are thus no longer bound to the universal speed limit.

With this application of the fundamental theorem of vector calculus, we have thus come to a revised version of the Maxwell equations that not only promises to resolve all of the problems that have been found over the years, we also obtain a model that is easy to interpret and can be easily simulated and visualized with finite-difference time-domain methods (FTDT) as well.

Now let us consider the difference between the definition we found for **E** and the corresponding definition in Maxwell's equations:

$$\boldsymbol{E_m} = -\nabla \varphi_m - \frac{\partial \boldsymbol{A_m}}{\partial t}, \tag{52}$$

When considered from the presented perspective, this is what breaks the fundamental result of Helmholtz' decomposition, namely the decomposition into a rotation free translational component and a divergence free rotational component, since $\mathbf{A}_m$ is not rotation free and therefore neither is its time derivative.

When taking the curl on both sides of this equation, we obtain the Maxwell-Faraday equation, representing Faraday's law of induction:

$$\nabla \times \boldsymbol{E_m} = -\frac{\partial \boldsymbol{B_m}}{\partial t}, \tag{53}$$

Faraday's law of induction is a basic law of electromagnetism predicting how a magnetic field will interact with an electric circuit to produce an electromotive force (EMF), which is thus a law that applies at the macroscopic level. It is clear that this law should not be entangled with a model for the medium and therefore our revision should be preferred.

Discussion and Conclusions

We have shown that the terms in the Laplace operator can be written out to define a complete and mathematically consistent whole of four closely related vector fields which by definition form solutions to the vector Laplace equation, a result that has tremendous consequences for both the analytical analysis of the electromagnetic field as well as fluid dynamics vector theory, such as weather forecasting, oceanography and mechanical engineering. The symmetry between the fields thus defined is fundamental and has been mathematically proven to be correct, so it is vital to maintain this fundamental symmetry in our physics equations.

We have also shown that we can decouple the dynamics of the medium from it's substance, mass density, with the velocity diffusion equation which reveals that the dynamics of the medium are governed by a single constant ν, the quantum circulation constant. And we have shown that we can take higher order derivatives of these equations over and over again, re-sulting in only phase differentials for the resulting vector spherical harmonic solutions.

Revising Maxwell equations by deriving directly from a superfluid medium model using the Laplace operator, we have called upon vector theory for an ideal, compressible, viscous Newtonian superfluid that has led to equations which are known to be mathematically consistent, are known to be free of singularities and are invariant to the Galilean transform as well. This results in an integrated model which has only three fundamental units of measurement: mass, length and time and also explains what "charge" is: a compression/decompression oscillation of "charged" particles.

As is known from fluid dynamics, these revised Maxwell equations predict three types of wave phenomena, which we can easily relate to the observed phenomena:

1 Longitudinal pressure waves, Tesla's superluminal waves[52] c.q. the super luminal longitudinal dielectric mode, which he found to propagate at a speed of 471,240 kilometers per second, within 0.1% of π/2 times the speed of light. The factor π/2 coincides with the situation whereby the theoretical reactance of a shorted lossless transmission line goes to infinity[53] (eq 1.2) and thus does not support an electromagnetic wave propagation mode;

2 "Transverse" "water" surface waves, occurring at the boundary of two media with different densities such as the metal surfaces of an antenna and air, aka the "near field", Elmore's non-radiating surface waves that have been shown to be guidable along a completely unshielded conductor[54];

3 Vortices and/or vortex rings, the "far field", which is known to be quantized and to incorporate a thus far mysterious mixture of "particle" and "wave" properties aka "photons", the so called "wave particle duality" principle.

Even though the actual wave equations for these three wave types still need to be derived, we can already conclude these to exist and predict a number of their characteristics, because of the integration of the electromagnetic domain with the fluid dynamics domain. The latter has a tremendous advantage, namely that dynamic phenomena known to occur in fluids and gasses can be considered to also occur in the medium.

Further Research

Theoretical

While the revised Maxwell equations presented in this paper describe the motions of the medium accurately in principle, the actual wave equations for the three predicted wave types still need to be derived and worked out. This is particularly complicated for the "transverse" "water" surface wave, because of the fact that in current fluid dynamics theory the potential fields have not been defined along the Helmholtz decomposition defined by the vector Laplacian as we proposed, which leads to non-uniquely defined fields and associated problems with boundary conditions. In order to derive a wave equation for the "transverse" surface wave, the incompressibility constraint would have to be removed from the Saint-Venant equations[55] and these would subsequently need to be fully worked out using vector calculus methods.

Furthermore, we have also argued that Faraday's law should not be entangled with the model for the medium, which leaves us without revised equations for Faraday's law of induction. This leads to the question of why a DC current trough a wire loop results in a magnetic field, but the magnetic field of a permanent magnet does not induce a current in a wire wound around it. A similar question arises when a (neodymium) magnet is used as an electrode in an electrolysis experiment, which results in a vortex becoming visible in the electrolyte above the magnet.

It is expected the answers to these questions as well as Faraday's law of induction can be worked out by considering the physics of the irrotational vortex, given that we found that the current density is actually one and the same thing as the vorticity of the medium, apart from a constant. In the absence of external forces, a vortex evolves fairly quickly toward the irrotational flow pattern, where the flow velocity **v** is inversely proportional to the distance r. The fluid motion in a vortex creates a dynamic pressure that is lowest in the core region, closest to the axis, and increases as one moves away from it. It is the gradient of this pressure that forces the fluid to follow a curved path around the axis and it is this pressure gradient that is directly related to the velocity potential Φ_{fd} c.q. the velocity field component $\mathbf{E}_{fd}$.

Practical

The revised Maxwell equations presented in this paper open the possibilities of further considerations and research into the properties of the dielectric and gravitational fields and associated wave phenomena. Because both of these fields are considered as one and the same within the above presented revised Maxwell paradigm, a wide range of possible applications become conceivable, some of which are hardly imaginable from within the current paradigm and/or are highly speculative while others are more straightforward.

Superluminal communication

This is the most direct application of the theory presented in this paper, which is supported by a number of sources mentioned in the abstract, the oldest of which dates back to 1834, some theoretical methods[56,57,58,59] as well as some preliminary experimental work by the author[60]. There is active and ongoing experimental research in this area.

Experiments regarding gravitational effects, such as aimed at obtaining thrust.

The Biefeld-Brown effect is an electrical phenomenon that has been the subject of extensive research involving charging an asymmetric capacitor to high voltages and the effect is commonly attributed to corona discharges which occur only at the sharp electrode, which causes an imbalance in the number of positive and negative ions created in comparison to when a symmetric capacitor is used.

However, according to a report[61] by researchers from the Army Research Laboratory (ARL), the effects of ion wind was at least three orders of magnitude too small to account for the observed force on the asymmetric capacitor in the air. Instead, they proposed that the Biefeld–Brown effect may be better explained using ion drift instead of ion wind. This was later confirmed by researchers from the Technical University of Liberec[62].

If this is correct, then the need for an asymmetric capacitor raises the question if the resulting diverging electric field can indeed be used to obtain thrust by working on an electrically neutral dielectric, in this case a dielectric consisting of air and net neutral ions, and how this results in a net force acting upon the capacitor plates. It is known that a dielectric is always drawn from a region of weak field toward a region of stronger field. It can be shown that for small objects the force is proportional to the gradient of the square of the electric field, because the induced polarization charges are proportional to the fields and for given charges the forces are proportional to the field as well. There will be a net force only if the square of the field is changing from point to point, so the force is proportional to the gradient of the square of the field[63].

Another line of research in this regard has to do with the gravitational force itself, which can be speculated to be caused by longitudinal dielectric flux, which causes a pushing and not a pulling force. This is supported by Van Flandern[64], who determined that with a purely central pulling force and a finite speed of gravity, the forces in a two-body system no longer point toward the center of mass, which would make orbits unstable. The fact alone that a central pulling gravity force requires a practically infinite speed makes clear that pulling gravity models are untenable and recourse must be taken to a Lesagian type of pushing gravity model. The longitudinal dielectric flux which would thus describe gravity is probably caused by cosmic (microwave) background radiation. If this naturally occurring flux had an arbitrary frequency spectrum, superconductors would reflect this flux and would thus shield gravity, which does not happen.

However, acceleration fields outside a rotating superconductor were found[65,66], which are referred to as Gravitomagnetic effects, and also anomalous acceleration signals, anomalous gyroscope signals and Cooper pair mass excess were found in experiments with rotating superconductors[67].

It can be speculated that the relation Stowe and Mingst found between the characteristic oscillation frequency of the electron and the cosmic microwave background radiation is what causes the spectrum of the gravitational flux and that this is related to the characteristic oscillation frequencies of the electron, neutron and proton as well. If that is the case, then the incoming flux would resonate with the oscillating particles within the material at these specific frequencies, which would therefore not be blocked/reflected but would be absorbed/re-emitted along Huygens' principle.

It can further be speculated that when objects are rotated, their “clock”, the characteristic oscillation frequency of the elemental particles making up the material, would be influenced, causing them to deviate from the specific frequencies they otherwise operate at. It is conceivable that this would result in a condition whereby superconductors would indeed reflect the naturally occurring gravitational flux, which could explain this anomaly.

Acknowledgments

This work would not have been possible without the groundbreaking work of Paul Stowe and Barry Mingst, who succeeded in integrating the gravitational domain with the electromagnetic domain within a single superfluid based model. It is this integration that resolves the classic problems associated with aether based theories, namely that because the gravitational field was considered to be separate from the electromagnetic domain, the movements of planetary bodies would necessarily result in measurable disturbances in the medium. When no such disturbances were found in the Michelson-Morley experiment, the aether hypothesis was considered as having been disproven. But because the gravitational force is now considered to be a force caused by longitudinal dielectric waves, which propagate trough the medium, this argument no longer applies. And therewith there is no longer any reason to disregard an aether based theory as a basis for theoretical physics.

This work would also not have been possible without the work of Eric Dollard, N6KPH, who replicated a lot of Tesla's experiments in the 1980's. It is his demonstrations and analysis of Tesla's work that enabled the very consideration of an aether based theory as an alternative to the current theoretical model.

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