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Derivation of Biot-Savart Law and Lorentz Force and Unification of Gravitational and Electromagnetic Forces

Ling Jun Wang

Tennessee at Chattanooga, 615 McCallie Av, Chattanooga, TN 37403, USA

ABSTRACT

We have derived the empirical Biot-Savart law and Lorentz force as well as the dynamic term of the gravitational force based on *Ether Dynamics*. The dynamic term of gravitation, together with the static term of Newton's law of gravitation, allows unification of gravitational and electromagnetic forces. It turns out that the gravitational interaction propagates through a space medium ether. A moving object in ether is in direct contact with it, causing ether to move like a highly viscous and incompressible fluid. The movement of ether propagates thorough space following the laws of fluid dynamics, exerting a force on any object moving in ether.

It has been shown that the magnetic field is linearly proportional to the local vorticity of ether, which produces all features of Biot-Savart law including the inverse square law, the linear proportionality of the magnetic field on the velocity of the moving charge, and the sinusoidal dependence of magnetic field on the angle between the velocity and the displacement vector. The vorticity of ether (the magnetic field) then exerts a force on any moving charge in space, following exactly the law of Lorentz force. The vorticity of ether is responsible for the dynamic gravitation as well. The dynamic term of gravitation leads to a gravitational wave equation, solving the historical problem of action-at-distance.

*Corresponding author

Ling Jun Wang, Tennessee at Chattanooga, 615 McCallie Av, Chattanooga, TN 37403, USA.

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Introduction

Historically, Kepler obtained three empirical laws of planetary movements, which was accepted as observational fact, all be it somewhat mysterious. Then Isaac Newton came up with a theoretical explanation of these empirical laws by proposing a universal gravitational force. Newton's new theory successfully derived Kepler's laws and advanced our understanding of physics of the planetary movements to a much deeper level, which was one of the greatest discoveries in physics.

In the field of electromagnetism, we have a similar situation. There are two very important empirical laws – the Biot-Savart law and the Lorentz' law of magnetic force. It would be of great interest to have a theoretical derivation of these important empirical laws which, as Newton's law of gravitation did in the past, would deepen our understanding of the electromagnetic interaction.

We have been able to do just this recently in our newly proposed Ether Dynamics. The theory is based on the fluid dynamics of the space medium ether, a politically not very correct term. The basic idea is that both gravitational and electromagnetic forces are transmitted through a space medium called ether that is a

fluid capable of local movement upon disturbance by a moving object, be it charged or neutral. The moving object is the source that disturbs the ether near nearby, causing the fluid to move. The movement of the ether then propagates away into space, causing local movement throughout the whole space. The intensity of the local movement reduces according to the inverse square law. The ether movement causes vorticity everywhere in space. The vorticity exerts a force on a moving object on the way, which is nothing but the Lorentz force. A classical fluid dynamic is sufficient to derive all the details of Biot-Savart Law and Lorentz force of electrodynamics.

Based on Ether Dynamics, we have successfully derived not only the two important empirical laws of electrodynamics, but also a dynamic term of gravitation that is to be added to Newton's law of static gravitation. The complete law of gravitation including both static and dynamic terms is then naturally unified with electromagnetic force.

We will explain this new theory of ether dynamics in more detail in the following sections.

Viscous Incompressible Fluid Ether Moving Around a Solid Sphere

The equation of motion of a fluid is described by the Navier-Stokes equation [1,2]. For an incompressible fluid, the Navier-Stokes equation reduces to [3]

$$\nabla p = \mu \nabla^2 \mathbf{v} \quad (1)$$

where μ is the viscosity coefficient, p the pressure, and \mathbf{v} the velocity of fluid.

Equation (1) can be applied to the problem of a steady uniform flow around a sphere at rest. This problem was first solved by Stokes and is often referred to as Stokes' Law [1]. The solution is the first order spherical harmonics (Legendre polynomial):

$$p = p_0 - \frac{A \cos \theta}{r^2} = p_0 - \frac{Az}{r^3} \quad (2)$$

and

$$\begin{cases} v_x = -V \left[\frac{3 R z x}{4 r^3} \left(\frac{R^2}{r^2} - 1 \right) \right] \\ v_y = -V \left[\frac{3 R z y}{4 r^3} \left(\frac{R^2}{r^2} - 1 \right) \right] \\ v_z = -V \left[\frac{3 R z^2}{4 r^3} \left(\frac{R^2}{r^2} - 1 \right) + 1 - \frac{3 R}{4 r} - \frac{1 R^3}{4 r^3} \right] \end{cases} \quad (3)$$

In the spherical coordinate system, the velocity components are:

$$\begin{cases} v_r = -V \cos \theta \left(1 - \frac{3 R}{2 r} + \frac{1 R^3}{2 r^3} \right) \\ v_\theta = V \sin \theta \left(1 - \frac{3 R}{4 r} - \frac{1 R^3}{4 r^3} \right) \\ v_\phi = 0 \end{cases} \quad (4)$$

The pressure is

$$p = p_0 + \frac{3}{2} \mu V R \frac{z}{r^3} \quad (5)$$

A Solid Sphere Moving in Viscous Incompressible Fluid

Equation (4) gives the velocity of a fluid moving against a solid sphere at rest with the velocity V in the direction of negative

z -axis. If a velocity of $\mathbf{V}_0 = V \hat{\mathbf{k}} = V \cos \theta \hat{\mathbf{r}} - V \sin \theta \hat{\boldsymbol{\theta}}$

is added to Eq(4), it gives the velocities of a fluid ether disturbed by a solid sphere moving with of a velocity of $\mathbf{v} = v \hat{\mathbf{k}}$ in the positive z -direction:

$$\begin{cases} v_r = V \cos \theta \left(\frac{3 R}{2 r} - \frac{1 R^3}{2 r^3} \right) \\ v_\theta = -V \sin \theta \left(\frac{3 R}{4 r} + \frac{1 R^3}{4 r^3} \right) \\ v_\phi = 0 \end{cases} \quad (6)$$

The radius R in Eq (6) is the *effective radius* to be determined later. It may or may not be equal to the actual radius of the sphere.

Neglecting the higher order, Eq(6) becomes:

$$\begin{cases} v_r = \frac{3 R}{2 r} V \cos \theta \\ v_\theta = -\frac{3 R}{4 r} V \sin \theta \\ v_\phi = 0 \end{cases} \quad (7)$$

Vorticity and Dynamic Field

With the velocity at hand in Eq(7), the vorticity $\boldsymbol{\Omega}$ can be easily calculated [1]:

$$\dot{\mathbf{U}} = \nabla \times \mathbf{v} = \frac{3 R V}{2 r^2} \sin \theta \hat{\boldsymbol{\phi}} = \frac{3 R}{2 r^2} \mathbf{v} \times \hat{\mathbf{r}} \quad (8)$$

The vorticity $\boldsymbol{\Omega}$ causes the local fluid to rotate. If a fluid is rotating with angular velocity $\boldsymbol{\omega}$, the linear velocity v at the radius r is

$$v = r \omega$$

The vorticity $\boldsymbol{\Omega}$ is

$$\boldsymbol{\Omega} = |\nabla \times \mathbf{v}| = \lim_{r \rightarrow 0} \frac{\oint \mathbf{v} \cdot d\mathbf{l}}{\pi r^2} = \lim_{r \rightarrow 0} \frac{v 2\pi r}{\pi r^2} = 2\boldsymbol{\omega} \quad (10)$$

Using Eq(8),

$$\dot{\mathbf{u}} = \frac{\dot{\mathbf{U}}}{2} = \frac{3 R V}{4 r^2} \sin \theta \hat{\boldsymbol{\phi}} = \frac{3 R}{4 r^2} \mathbf{v} \times \hat{\mathbf{r}}$$

The Force of Ether on a Moving Object

Referring to Figure 1, if a mass m' is moving with velocity \mathbf{v}' in a rotating fluid with angular velocity $\boldsymbol{\omega}$, its velocity would change due to rotational dragging by the ether, which is caused by the viscosity of Ether. The component of \mathbf{v}' parallel to $\boldsymbol{\omega}$ does not change, but the component perpendicular to $\boldsymbol{\omega}$ will change. Suppose the angle between $\boldsymbol{\omega}$ and \mathbf{v}' is θ , the change in velocity (the acceleration \mathbf{a}) caused by the rotation is

$$\mathbf{a} = \frac{d}{dt} (\alpha \theta v' \sin \theta) = \alpha \omega v' \sin \theta \quad (12)$$

where α is the *dragging coefficient* dependent on the friction between the ether and the moving object m' :

$$0 < \alpha \leq 1 \quad (13)$$

In vector form

$$\mathbf{a} = \frac{d\mathbf{v}'}{dt} = \alpha \boldsymbol{\omega} \times \mathbf{v}' \quad (14)$$

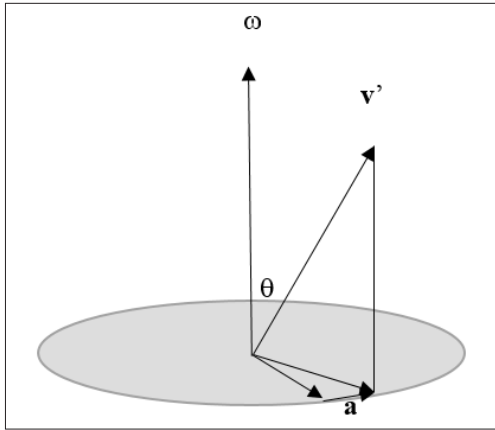


Figure 1: Acceleration of a moving object due to local rotation of fluid

The force exerted on the mass m' is

$$\mathbf{F} = m' \mathbf{a} = m' \alpha \boldsymbol{\omega} \times \mathbf{v}' = -\frac{3\alpha R m'}{4r^2} \mathbf{v}' \times (\mathbf{v}' \times \hat{r}) \quad (15)$$

This is exactly the dynamic term of gravitational force given by Wang [4, 5]:

$$\mathbf{F} = -\frac{G m m'}{c^2 r^2} \mathbf{v}' \times (\mathbf{v}' \times \hat{r}) \quad (16)$$

Comparing Eqs(15) and (16) gives

$$\alpha \cdot R = \frac{4Gm}{3c^2} \quad (17)$$

The product of the two constants α and R are determined by G and m .

The Derivation of Biot-Savart Law and Lorentz force

If a charged particle is moving in ether, it disturbs the ether in the same way as a neutral mass does. The only difference is that the effective radius is going to be different, and the local angular velocity Ω_{em} is given by, according to Eq(11):

$$\Omega_{em} = \frac{3 R_{em} V}{2 r^2} \sin \theta \hat{\varphi} = \frac{3 R_{em}}{2 r^2} \mathbf{v}' \times \hat{r} = 2 \boldsymbol{\omega}_{em} \quad (18)$$

where R_{em} is the *electromagnetic effective radius* of the charged particle. The change in velocity (the acceleration a_{em}) of a moving charge q' with velocity v' is

$$a_{em} = \frac{d}{dt} (\alpha_{em} \theta v' \sin \theta) = \alpha_{em} \omega_{em} v' \sin \theta \quad (19)$$

Where α_{em} is the *dragging coefficient* dependent on the friction between the ether and the moving charge q' .

The force exerted on the charge q' is

$$\mathbf{F}_{em} = m' \mathbf{a}_{em} = m' \alpha_{em} \boldsymbol{\omega}_{em} \times \mathbf{v}' = -\frac{3\alpha_{em} R_{em} m'}{4r^2} \mathbf{v}' \times (\mathbf{v}' \times \hat{r}) \quad (19)$$

Eq (20) is the theoretically derived expression of the empirical Lorentz force. Comparing Eq(20) to the Lorentz force of electrodynamics:

$$\mathbf{F}_{em} = q' \mathbf{v} \times \mathbf{B} = \frac{k_1 q' q}{c^2 r^2} \mathbf{v}' \times (\mathbf{v}' \times \hat{r}) \quad (21)$$

We have

$$\alpha_{em} \cdot R_{em} = -\frac{4k_1 q q'}{3c^2 m'}$$

Eq(22) says that the product of the *dragging coefficient* and the *effective radius* ($\alpha_{em} \cdot R_{em}$) is determined by the source q , the Coulomb constant k_1 and the specific charge (q'/m').

The Biot-Savart law of electrodynamics is

$$\mathbf{B} = \frac{k_1 q}{c^2 r^2} \mathbf{v} \times \hat{r} \quad (23)$$

Comparing Eq(23) with Eq(18), using Eq(22), we have

$$\mathbf{B} = \frac{\alpha_{em} m'}{2 q'} \boldsymbol{\Omega}_{em} = \frac{3\alpha_{em} R_{em} m'}{4q' r^2} \mathbf{v}' \times \hat{r} \quad (24)$$

Eq(24) states that the magnetic field is a measure of the local ether vorticity. Eq(24) is the theoretically derived Biot-Savart law, with the corresponding parameters given by Eq(22)

Dynamic Gravitation and Field Equations

Eqs (16) obtained above is the dynamic gravitational force that should be added to the static gravitational force in Newton's law, giving a complete description of gravitation:

$$\mathbf{F} = -G \frac{m m'}{r^2} \left[\hat{r} + \frac{1}{c^2} \mathbf{v}' \times (\mathbf{v}' \times \hat{r}) \right] \quad (25)$$

where \mathbf{v} and \mathbf{v}' are the velocities of the masses m and m' , respectively. The constant c is the speed of gravitational wave. The first term of the gravitational force is static:

$$\mathbf{F}_1 = -G \frac{m m'}{r^2} \hat{r} \quad (26)$$

We can define a static field:

$$\mathbf{g} = \frac{\mathbf{F}_1}{m'} = -G \frac{m}{r^2} \hat{r} \quad (27)$$

The second term can be written as

$$\mathbf{F}_2 = -G \frac{m m'}{r^2} \frac{1}{c^2} \mathbf{v}' \times (\mathbf{v}' \times \hat{r}) = -G \frac{m m'}{r^2} \left| \right.$$

$$\left. \left[(\boldsymbol{\beta}' \cdot \hat{r}) \boldsymbol{\beta} - (\boldsymbol{\beta}' \cdot \boldsymbol{\beta}) \hat{r} \right] = \mathbf{M} \cdot m' \boldsymbol{\beta}' \quad (28) \right.$$

where $\boldsymbol{\beta}$ and $\boldsymbol{\beta}'$ are the ratios of velocities over the speed c of gravitational wave in vacuum, The tensor \mathbf{M} is a second rank anti symmetric tensor constructed by the usual rule of dyadic of two vectors:

$$\mathbf{M} = \frac{Gm}{cr^3} (\vec{r}\mathbf{v} - \mathbf{v}\vec{r}) = \frac{Gm}{cr^3} \begin{pmatrix} 0 & v_y x - v_x y & v_z x - v_x z \\ v_x y - v_y x & 0 & v_z y - v_y z \\ v_x z - v_z x & v_y z - v_z y & 0 \end{pmatrix} \quad (29)$$

Since the angular momentum is

$$\mathbf{L} = \mathbf{r} \times \mathbf{p} = m\mathbf{r} \times \mathbf{v}$$

We have

$$\mathbf{M} = \frac{G}{cr^3} \begin{pmatrix} 0 & L_z & -L_y \\ -L_z & 0 & L_x \\ L_y & -L_x & 0 \end{pmatrix} \quad (31)$$

Define a vector \mathbf{h} :

$$\mathbf{h} = \frac{G}{cr^3} \mathbf{L} = \frac{Gm}{cr^2} \hat{r} \times \mathbf{v} = -\mathbf{g} \times \boldsymbol{\beta} \quad (32)$$

We have

$$\mathbf{M} = \begin{pmatrix} 0 & h_z & -h_y \\ -h_z & 0 & h_x \\ h_y & -h_x & 0 \end{pmatrix} \quad (33)$$

Since \mathbf{L} is proportional to r , Eqs(32) and (33) manifest inverse square law of \mathbf{h} and \mathbf{M} . \mathbf{h} is called the *rotational field*, and \mathbf{M} the *dynamic field tensor*.

It can be shown [4] that

$$\oiint_s \mathbf{M} \cdot d\boldsymbol{\sigma} = -\frac{8\pi G}{3c} \mathbf{p} \quad (34)$$

where $\mathbf{p} = m\mathbf{v}$ is the linear momentum of the mass m .

Eq(34) is called *Wang's Law*, which is the dynamic counterpart of the static Gauss' Law. It says that the closed integration of the dynamic field tensor \mathbf{M} is a constant proportional to the linear momentum of the moving mass. Wang's Law is therefore a statement that the total linear momentum transmitted through the gravitational field is conserved. The discovery of Wang's Law together with Gauss' law show that the inverse square law is as accurate as the surface area of a sphere is proportional to the square of its radius.

The differential form of Wang's law is

$$\nabla \cdot \mathbf{M} = -\frac{8\pi G}{3c} \mathbf{j} \quad (35)$$

where

$$\mathbf{j} = \rho\mathbf{v} = \frac{\mathbf{p}}{V} \quad (36)$$

is the *momentum density*, i.e., the momentum per unit volume. \mathbf{p} is the total momentum of the mass contained in the volume V . \mathbf{j} is also the *current density* (current per unit area).

Since $\nabla \cdot \mathbf{M} = -\nabla \times \mathbf{h}$, we have

$$\nabla \times \mathbf{h} = \frac{8\pi G}{3c} \mathbf{j} \quad (37)$$

It is straightforward to check that the divergence of \mathbf{h} is zero:

$$\nabla \cdot \mathbf{h} = -\nabla \cdot \left(\frac{Gm}{cr^2} \mathbf{v} \times \hat{r} \right) = 0 \quad (38)$$

For the static field \mathbf{f} , we have

$$\nabla \cdot \mathbf{f} = \nabla \cdot \mathbf{g} - \boldsymbol{\beta}' \cdot (\nabla \times \mathbf{h}) = -4\pi G \left(\rho + \frac{2}{3c} \boldsymbol{\beta}' \cdot \mathbf{j} \right) \quad (39)$$

It can be shown [4] that

$$\nabla \cdot \mathbf{M} = -\nabla \times \mathbf{h} = -\frac{1}{c} \frac{\partial \mathbf{g}}{\partial t} \quad (40)$$

Eq(40) gives the divergence of \mathbf{M} when the point of interest is not at the origin, namely, $r \neq 0$

At the origin where the source of gravitation m is located, $r = 0$, the divergence of \mathbf{M} is given by Eqs(35). The general formula for the divergence of \mathbf{M} (or curl of \mathbf{h}) is:

$$-\nabla \cdot \mathbf{M} = \nabla \times \mathbf{h} = \frac{1}{c} \frac{\partial \mathbf{g}}{\partial t} + \frac{8\pi G}{3c} \mathbf{j} \quad (41)$$

The total gravitational field \mathbf{f} is related to the static field \mathbf{g} :

$$\mathbf{f} = \mathbf{g} + \mathbf{M} \cdot \boldsymbol{\beta}' = \mathbf{g} + \boldsymbol{\beta}' \times \mathbf{h} = \mathbf{g} + \boldsymbol{\beta}' \times (\boldsymbol{\beta}' \times \mathbf{g}) \quad (42)$$

The time derivative of \mathbf{f} is

$$\frac{\partial \mathbf{f}}{\partial t} = \frac{\partial \mathbf{g}}{\partial t} + \boldsymbol{\beta}' \times \left(\boldsymbol{\beta}' \times \frac{\partial \mathbf{g}}{\partial t} \right) \quad (43)$$

For most heavenly bodies and the objects on the earth, both $\boldsymbol{\beta}'$ and $\boldsymbol{\beta}$ are negligibly small, the second term of Eq(43) can be dropped. Namely,

$$\frac{\partial \mathbf{f}}{\partial t} = \frac{\partial \mathbf{g}}{\partial t} \quad (44)$$

Eq(41) can be written as:

$$\nabla \times \mathbf{h} = \frac{1}{c} \frac{\partial \mathbf{f}}{\partial t} + \frac{8\pi G}{3c} \mathbf{j} \quad (45)$$

It can be shown [4] that

$$\nabla \times \mathbf{f} = -\frac{1}{c} \frac{\partial \mathbf{h}}{\partial t} \quad (46)$$

Eq (46) is the differential form of Faraday's law in electrodynamics.

Wave Equation

We now have a set of equations, Eqs(38), (39), (45) and (46), that allows us to understand the propagation of gravitational wave. In a free space where $\rho = 0$ and $\mathbf{j} = 0$, these equations take more simple and symmetric form:

$$\nabla \cdot \mathbf{f} = 0 \quad (47)$$

$$\nabla \cdot \mathbf{h} = 0 \quad (48)$$

$$\nabla \times \mathbf{h} = \frac{1}{c} \frac{\partial \mathbf{f}}{\partial t} \quad (49)$$

$$\nabla \times \mathbf{f} = -\frac{1}{c} \frac{\partial \mathbf{h}}{\partial t} \quad (50)$$

With these equations, it is trivial to obtain a wave equation:

$$\nabla^2 \mathbf{f} - \frac{1}{c^2} \frac{\partial^2 \mathbf{f}}{\partial t^2} = 0 \quad (51)$$

Eq(51) is the gravitational wave equation rigorously derived first time ever from our unification theory. The physics community is led to believe that Einstein's general relativity predicted the gravitational wave. It is simply not true. The gravitational wave equation is manufactured with linear approximation of Einstein's field equation and a few *ad hoc* hypotheses. The most important hypotheses are: 1) The space is a vacuum so the stress-energy tensor $T_{\beta\delta} = 0$; 2) The cosmological constant is zero; 3) The field is weak and the metric tensor can be approximated as nearly Minkowski. With these hypotheses and other mathematically invalid tricks, a wave equation was then manufactured to take the following form [6]:

$$\frac{\partial^2 h_{\beta\delta}}{\partial x^2} + \frac{\partial^2 h_{\beta\delta}}{\partial y^2} + \frac{\partial^2 h_{\beta\delta}}{\partial z^2} - \frac{\partial^2 h_{\beta\delta}}{c^2 \partial t^2} = 0 \quad (52)$$

Now let us examine these *ad hoc* hypotheses needed to yield Eq(52). The first two hypotheses are in direct conflict with the current mainstream cosmology which claims that the cosmological constant is mainly responsible for the dark energy, and the universe is filled with dark energy and dark matter that count 97% of the total mass of the universe. The third hypothesis is invalid near the black holes because that is where the metric tensor goes to infinity, not anything like Minkowski metric.

Apparently, the gravitational wave equation is not "derived" from Einstein's field equation, but manufactured with a number of invalid *ad hoc* hypotheses. The true derivation of gravitational wave equation is given first time ever by our unification theory published in 2018.

Unification of Gravitational and Electromagnetic Fields

The discussions above show that the gravitational force and the electromagnetic force can be described by exactly the same set of equations. The only difference here is that the mass m in the gravitational theory is replaced by the electric charge q in the electromagnetic theory. The different constants G and k are merely the indicators of strength of the interacting forces. As a matter of fact, we can combine the gravitational and electromagnetic forces into a unified equation:

$$\mathbf{F} = (k_1 q q' - G m m') \frac{1}{r^2} \left[\hat{r} + \frac{1}{c^2} \mathbf{v}' \times (\mathbf{v} \times \hat{r}) \right] \quad (53)$$

It is amazing that the force equation alone is sufficient to derive all the relevant laws governing the electromagnetic and gravitational interactions. It is a testimony of the consistency of our unification theory and Ether Dynamics.

Unification of gravitational and electromagnetic forces has been a century long dream of the physics community. Early attempts were made by Hermann Weyl, Arthur Eddington, Theodor Kaluza and Albert Einstein [7-10]. Their unification theories are considered "classical unification theories", all failed without exception. After the 1930s, few scientists worked on classical unification, due to failures of these theories as well as the emergence of quantum field theory.

The Standard Model of particle physics seems to be successful in unifying the electromagnetic and the weak nuclear forces [11-15]. The physics community hoped that further development of quantum field theory might eventually include the strong nuclear force in a unification theory, so-called Grand Unification Theory (GUT), and eventually include the gravitation in a final Theory-

of-Everything (TOE) [16]. Unfortunately, chances for unifying these forces under the framework of Standard Model are extremely slim. The major problem with GUT is that the energy needed to test these theories is in the order of 10^{16} GeV, way beyond what the current technology could reach. It needs an accelerator bigger than the solar system, which is absolutely impossible. Moreover, some of the predictions by GUT contradict the experimental findings. For example, GUT theories predict that the proton would decay, but the experiments show that the lifetime of the proton is at least 10^{35} years, which is 24 orders of magnitude longer than the lifetime of the universe predicted by the Big Bang cosmology. It is a significant failure.

The unification of gravitational force with other forces is much harder. An unsurmountable obstacle is that the gravitational field is not renormalizable, which means that any unification theory including the gravitational force in the framework of the Standard Model is a divergent theory. Divergent theories do not make any sense. It is now generally realized that general relativity is not compatible with quantum field theory. Theory of Everything requires an energy scale of the Planck energy (1019 GeV). It is 1000 times higher than the energy scale of the Grand Unification Theory, far beyond the reach of modern accelerators.

All in all, the unification along the approaches of general relativity or the standard model of quantum field theory has been a sure failure. Many other fundamental problems with General Relativity and the Standard Model of particle physics are analyzed by Wang in two review articles [17,18]. Our unification theory is immune of all these problems, and it is amazingly rigorous and beautifully simple. A physics or engineering student who has mastered fluid dynamics and electrodynamics should be able to understand our Ether Dynamics and Unification theory.

Conclusions and Discussions

a) A few words are in order to justify the concept of ether. All Physicists believed that the electromagnetic waves were propagating through a medium ether before Einstein proposed his general relativity in 1915. It was unimaginable that any interaction could propagate without a medium. Einstein, however, believed that the propagation of electromagnetic wave was realized through field instead of ether. Physics community was then led to believe that the field is matter. However, Einstein was never able to disprove the existence of a universal medium ether. His believing of field as a "matter" was merely a subjective believing. It is now a common knowledge that the space is filled with interstellar and intergalactic materials. The cosmic microwave background is the experimental evidence of the existence of the interstellar and intergalactic materials. Such interstellar and intergalactic material was historically called ether, now a politically incorrect term.

We do challenge the concept that the field is matter. What is a field? The gravitational field is the force on unit mass, which is acceleration. To say that field is matter is to say that force is matter and acceleration is matter, which is absurd. Moreover, if field is matter, are the gravitational field and the electromagnetic field the same matter or different matters?

A mistake the early physicists made is to assume that ether was an absolutely static rigid medium, without regarding the possibility of ether being a fluid capable of local movements. The concept of an absolutely static ether run into a conflict with the null result of the famous Michelson-Morley's ether drift experiment. Wang has pointed out that if the local ether is rotating with the solar system,

the null result of both the first order ether drift experiment of Wang and the second order ether drift experiment of Michelson-Morley are naturally explained [19].

b) The experimental detection of the dynamic term is extremely difficult at the current level of technology. The relative strength of the dynamic term over the static term is at least a factor of (v^2/c^2) smaller at the most advantageous orientation of the velocities. The orbital velocity of the earth is about 30 km/s. The velocity of the sun relative to the center of mass of the solar system is less than 10⁻⁴ km/s. The dynamic term of the gravitational force is at least a factor of 3×10^{-14} smaller than the static term. No wonder the dynamic term of gravitation escaped detection by observational astronomers, and was missing in Kepler's laws and Newton's law of gravitation. It is our conviction that in the future the technology would be so advanced as to allow the detection of the dynamic term.

Lacking immediate new experimental evidence should not prevent us from accepting a new theory if it is logically consistent, rigorous and theoretically compelling. Historically, Newton's law of gravitation was published in 1687. No new experimental evidence was available at that time. One hundred and fifty years later, Urbain Le Verrier predicted the position of the then-undiscovered planet Neptune and its position based on Newton's theory of gravitation after analyzing perturbations in the orbit of Uranus. Subsequent observations of Neptune in the late 19th century led astronomers to speculate that Uranus's orbit was being disturbed by another planet besides Neptune, which was later discovered and named Pluto. These predictions came 150 years later. Newton's theory of gravitation was accepted long before the predictions on Neptune and Pluto. The main reason for the acceptance was the success of Newton's theory in explaining the then existing Kepler's empirical laws. Similarly, theoretical derivation of the empirical Biot-Savart law and Lorentz force based on our *Ether Dynamics* is as significant as Newton's derivation of Kepler's empirical laws of planetary movements. The theoretical derivation of the empirical Biot-Savart law and Lorentz force should serve as strong and convincing experimental evidences to support our Ether Dynamics and Unification Theory. The value of our Unification Theory and Ether Dynamics also rests on the detailed derivation of the dynamic term of gravitation, which is as significant as the discovery of Newton's static term of gravitation. In a sense, our Ether Dynamics and Unification Theory have completed and consummated the theory of gravitation started by Newton with a static term only.

c) A significant achievement of our theory is the newly discovered Wang's Law, which says that the total momentum transmitted into space is conserved, a discovery not known to physics community before. It adds credibility to our Unification Theory and Ether Dynamics.

d) The fact that our Ether Dynamics gives a theoretical derivation of the dynamic term of gravitation and the empirical Biot-Savart law and Lorentz force is a verdict that ether does exist, and it is a highly viscous incompressible fluid capable of local movements. Nowadays, the concept of a universal space medium is a common knowledge of physics community, the knowledge of such space medium as a highly viscous incompressible fluid is, however, a new discovery.

e) Now we can ask a natural question: can we apply Ether Dynamics and the newly discovered Unification Theory to unify

the nuclear forces?

The answer is yes, if we know the nuclear forces very well, but we do not. We do not even have a reliable formula of nuclear forces as a function of distance. The best speculation so far is the Yukawa potential, which is a static potential, not enough to revile the complexity of a dynamic nuclear force, it does not work well when it comes to the strong nuclear force. Unification to include the nuclear forces may be possible only after we have an accurate and complete formula of nuclear force as a function of distance.

f) Our unification theory shows that the unification of gravitational and electromagnetic forces could be beautifully done within classical framework without resorting to general relativity and quantum field theory. The simplicity, rigorousness and completeness of our unification theory are so compelling that it leaves no doubt on the consistency and correctness of the classical approach. It poses a serious question to the correctness of the paradigm and doctrine of the prevailing theoretical physics of 20th century.

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