

The Local-Ether Model and Quantum Electromagnetics Theory of Prof. Ching-Chuan Su

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Abstract - This paper is intended to promote the work of the late Prof. Ching-Chuan Su of the National Tsing Hua University in Hsinchu, Taiwan. Between 2000 and 2006, he published a series of papers proposing a novel theory he called the Local-Ether Model along with a corollary theory he called Quantum Electromagnetics. Together, they present a unified qualitative and quantitative description of the fundamental phenomena of electromagnetic, gravitational, and quantum physics founded on the classical principles of absolute time and three dimensional Euclidean space. The Local-Ether Model postulates an ether model with unique properties which accounts for a comprehensive scope of the fundamental phenomena of the propagation of electromagnetic waves. This includes accounting for the apparently null results of Michelson-Morley type experiments. Electromagnetism is formulated to be invariant under Galilean relativity. The Quantum Electromagnetics theory presents a quantum mechanical approach to account for additional phenomena under the framework and principles of the Local-Ether Model. It incorporates the electrostatic and gravitational potentials with an equation that defines the behavior of microparticles and their associated de Broglie matter waves. The equation is applied to show that phenomena that are commonly cited as support for Einstein's Relativity are actually due to the quantum nature of microparticles and their interaction with electromagnetic and gravitational fields. They include the dependence of mass on speed, the dependence of atomic clock rate on speed and gravitational potential, gravitational lensing, gravitational redshift, and the Shapiro delay. The equation is also applied to phenomena related to the interaction of microparticles, electromagnetic waves, and matter waves including the Ives-Stilwell and Davisson-Germer experiments. The Compton Effect and neutron interferometry are also addressed. This paper references the papers that comprise Prof. Su's work including their abstracts and URL links. It also references his magnum opus: *Quantum Electromagnetics: A Local-Ether Wave Equation Unifying Quantum Mechanics, Electromagnetics, and Gravitation*.

Introduction and General Comments

This paper is intended to promote the work of the late Prof. Ching-Chuan Su of the National Tsing Hua University in Hsinchu, Taiwan. Between 2000 and 2006, he published a series of papers proposing a novel theory he called the Local-Ether Model along with a corollary theory he called Quantum Electromagnetics. Together, they represent a unified qualitative and quantitative description of electromagnetic, gravitational, and quantum phenomena founded on the classical principles of absolute time and three dimensional Euclidean space.

The Local-Ether Model

The Local-Ether Model postulates that electromagnetic waves propagate classically in a medium called the Local-Ether. The novel properties of the Local-ether are shown to account for a comprehensive scope

of fundamental phenomena related to the propagation of electromagnetic waves including Michelson-Morley type experiments. It formulates electromagnetism to be invariant under Galilean relativity. It provides a fully developed alternative to Einstein's postulated principle of relativity for electromagnetism and the Lorentz transformation.

The Local-Ether Model postulates the following: Electromagnetic waves propagate classically via a medium called the local-ether. However, the properties of this medium are significantly different than the commonly assumed "universal" ether models made "superfluous" by Einstein in 1905. Prof. Su proposed that each celestial body is surrounded by a substantive, variable density medium for propagating electromagnetic waves called its local-ether. It is associated with and at rest with the gravitational potential field of the celestial body which implies that it is carried with but (crucially) does not rotate with the body. It can be visualized as a roughly spherical "halo" which is densest at the surface, and decreases in density with altitude $\propto 1/r$. This implies it is at rest with the Earth Centered Inertial reference frame (the ECI) for the Earth and the heliocentric inertial reference frame for the Sun/Solar System. Therefore a local-ether forms the unique "preferred" reference frame for electromagnetic wave propagation within its sphere of influence. This sphere of influence extends out to where the gravitational field of a more massive celestial body becomes dominant. For example, the radius of the Earth's local-ether "halo" is on the order of 1,000,000 km. Beyond this distance, the unique preferred reference frame for electromagnetic wave propagation transitions to the heliocentric inertial reference frame (the local-ether of the Sun/Solar System). The radius of the local-ether of the Sun/Solar System is on the order of two light years. Beyond that, the local-ether of the Milky Way Galaxy becomes the preferred reference frame and so on. There is a hierarchy of local-ethers surrounded by ever larger local-ethers generated by more massive celestial bodies.

Electromagnetic waves propagate at a constant characteristic speed with respect to the unique preferred reference frame of the local-ether they propagate within. The propagation is independent of the motion of a source and also (crucially) independent of the motion of a receiver.

A trivial "thought experiment" demonstrates the "classical" propagation of waves in a medium: Consider a quiet circular pond 20 meters in diameter with a soccer ball attached to a string located 5 meters from the center - the "receiver". If you throw a second soccer ball on a string - the "source" - into the center, the waves propagate from the center at its characteristic speed. They are not affected if you pull it back toward the shore (i.e. the second postulate of Special Relativity is trivially true). If the "receiver" is pulled toward the shore while the waves are propagating toward it, the wave propagation is also not affected. However, the leading crest will have to travel farther and (therefore) take longer to reach the "receiver" making the effective propagation speed measured by the "receiver" appear to be lower than if not moved. This is the simple, intuitive explanation of the Sagnac Effect. It is the motion of the receiver with respect to the local-ether that causes the phase shift in a rotating Sagnac loop interferometer. Note that rotation is not fundamental to the Sagnac Effect as is commonly assumed.

Many of the properties of a Local-Ether are similar to the gravitational potential field surrounding a celestial body. It is carried with its celestial body and its orientation is fixed with respect to the distant galaxies and quasars - like its generated gravitational potential field. This implies (crucially) that a Local-Ether does **not** rotate with its embedded celestial body. And like the gravitational potential, the Earth's Local-Ether is at rest with the Earth Centered Inertial reference frame (the ECI) (also called the geocentric inertial frame). The Sun's/Solar System's Local-Ether is at rest with the heliocentric inertial frame.

This implies that a point on a rotating body's surface has a velocity with respect to its local-ether "halo". Its speed is constant and equal to $\omega r \cos\theta$ (ω is the rotation rate, r is the radius and θ is the latitude). For example for the Earth, it is approximately 360 meters per second at 40 degrees latitude. Its direction is also constant: west-to-east. This is the long sought "ether-wind".

And this explains why Michelson-Morley type experiments have failed to unambiguously detect an "ether-wind": its magnitude is much smaller than expected by "universal" ether models. The "universal" ether model assumes that the ether has the same properties everywhere in the universe, is unaffected by matter, and is at rest with a universal reference frame. Until the mid 20th century, this universal reference frame was assumed to be at rest with the Solar System which implied an "ether-wind" speed of at least 30,000 meters/sec due to the Earth's orbital velocity. The discovery of the CMBR dipole in 1969 implied that the Solar System is moving ~ 370 km/s with respect to a universal reference frame at rest with the CMBR. Also, both the direction and apparent magnitude of a velocity signal due to either "universal" ether model would vary throughout a sidereal day. The original Michelson-Morley experiment in 1887 was designed to be sensitive enough to detect a signal due to a 30,000 m/s velocity but didn't detect a signal that could be distinguished from noise. Note that, according to the Local-Ether Model, the Earth's local-ether "halo" blocks any "ether-wind" due to the Earth's motion with respect to the Solar system, the Galaxy, or the CMBR in the vicinity of the Earth (which is in accord with experiments).

The magnitude of the signal due to the "ether-wind" predicted by the Local-Ether Model for an Earth based Michelson Interferometer is less than 1/7000th of the magnitude of the signal (phase or frequency shift) expected for a 30,000 m/s "ether-wind" because the predicted signal is proportional to velocity squared $(360/30000)^2$. Before 1979, Michelson interferometers were incapable of detecting such a small value. Modern Michelson-Morley experiments using lasers and optical cavity resonators might be barely sensitive enough but have processed their data expecting a diurnal variation in compass direction and magnitude which would suppress an "ether-wind" signal with a constant magnitude and east-to-west direction.

One experiment in 1979 probably did detect a signal consistent with the Local-Ether model but the paper's authors declared it to be "persistent" and "spurious" [32,33]. See also section 6.2 of [3]. However, a Michelson interferometer on a spacecraft in low Earth orbit could unambiguously detect the "ether-wind" implied by the Local-Ether Model because it is due to the orbital velocity of the spacecraft with respect to the ECI (approximately 7500 m/s at an orbital altitude of 500 km). This implies the signal would be over 400 times greater than for an equivalent Earth based interferometer $(7500/360)^2$. The signal would be approximately 7000 times greater for an interferometer in solar orbit compared to Earth based due to the spacecraft's orbital speed of ~ 30000 m/s with respect to the heliocentric inertial reference frame.

Another proposed property of a Local-Ether is that it has a variable density proportional to the absolute magnitude of the gravitational potential field. This means its density is highest at the surface of a celestial body and decreases inversely proportional with distance from its center (like the gravitational potential field: $\phi(r) = GM/r$) until the local-ether of another celestial body becomes dominant. Further, the characteristic propagation speed of electromagnetic waves is a function of the Local-Ether density/gravitational potential: the higher the density, the slower the propagation speed. This effect on the propagation speed is analogous to the index of refraction of a transparent material. It is, in effect, a gravitational index of refraction, $n_g = (1 + 2GM/rc^2)$. This accounts in a simple, intuitive way for

phenomena including gravitational lensing and the Shapiro Delay. The Quantum Electromagnetics theory provides a quantitative derivation of these phenomena. This is a physical alternative to the purely mathematical concept of curved space-time of General Relativity.

Prof. Su shows that, based on the concepts of the Local-Ether model, the equations of electromagnetic potentials, fields, and forces can be formulated so that they are compliant with Galilean relativity - i.e. they are invariant under the Galilean transformation. Further, he shows quantitatively how this classical version of electrodynamics accounts for the Fizeau experiment and several other fundamental propagation phenomena.

The “universal” ether model is assumed by almost everyone when contemplating a medium for the propagation of electromagnetic waves. When Einstein proposed his Special Theory in 1905, he declared the ether to be “superfluous”; he was implicitly referring to the “universal” ether model. It is equally valid to postulate an ether based on the Local-Ether Model but until the 1970's, the technology did not exist to detect evidence for a Local-Ether model (unless you count the Sagnac Effect).

Quantum Electromagnetics

The Local-Ether Model encompasses a corollary theory called Quantum Electromagnetics which complies with the framework and principles of the Local-Ether Model. The Quantum Electromagnetics theory presents a quantum mechanical approach to unify electromagnetism, gravity, and the quantum nature of microparticles and their associated de Broglie matter waves. It is based on an equation defined by Prof. Su which he calls the Local-Ether Wave Equation. This equation incorporates the electrostatic and gravitational potentials with an equation that describes the quantum behavior of microparticles and de Broglie matter waves. It leads to a time evolution equation similar to Schrödinger's equation.

The Local-Ether Wave Equation is applied to derive alternative explanations for fundamental phenomena that are commonly cited as support for Einstein's Relativity. Instead, they are shown to be due to the quantum nature of microparticles and their matter waves and their interaction with electrostatic and gravitational potentials. They include the dependence of mass and atomic clock rates on speed with respect to a local ether. They also include dependence of atomic clock rates on gravitational potential (i.e. altitude of a satellite). Further, they include the dependence of the speed of propagation of electromagnetic waves on gravitational potential (the Shapiro Delay), the phenomena of gravitational lensing (the bending of starlight grazing the Sun, a galaxy, or a galaxy cluster), and gravitational redshift (the Pound-Rebka experiment).

The Local-Ether Wave Equation is applied to derive a quantum property of a microparticle that its effective inertial mass increases as its speed with respect to a Local-Ether increases; the resulting relation between mass and speed is identical to the Lorentz mass variation factor (also known as gamma, γ). It is further applied to show that the energy and frequency of electromagnetic waves emitted by the quantum transitions of electrons bound in atoms is reduced due to their speed with respect to a local-ether. And this leads to a decrease in the frequency/"tic rate" of atomic clocks as observed on GPS spacecraft. In other words, it is shown that these phenomena are a real physical consequence of the quantum nature of atoms and their interaction with the electrostatic potential. This is an alternative explanation to the purely mathematical concept of time dilation.

Further, the Local-Ether Wave Equation is applied to show that a decrease in the absolute magnitude of the local gravitational potential leads to an increase in the energy and frequency of the quantum states of atoms. This leads to an increase in the frequency of electromagnetic waves emitted and absorbed by atoms due to the modified quantum transitions of electrons bound in atoms. And this accounts for the increase in the frequency/"tic rate" of atomic clocks with altitude as observed on GPS spacecraft. Thus the phenomenon is actually a physical consequence of the quantum nature of atoms and their interaction with the gravitational potential. It is not due to a purely mathematical concept derived from General Relativity related to the curvature of space-time.

Additionally, the Local-Ether Wave Equation is applied to phenomena related to the interaction and interference of microparticles, electromagnetic waves, and matter waves. This includes emission and absorption of electromagnetic waves by fast moving microparticles in experiments including Ives-Stilwell, Davisson-Germer, and neutron interferometry. The Compton Effect is also shown to be a consequence of the interference of electromagnetic waves and de Broglie matter waves in a separate paper [19] not covered in *Quantum Electromagnetics*.

Prof. Su initially presented his Local-Ether Model and Quantum Electromagnetics theory in a series of papers published between 2000 and 2006. They are referenced below with their abstracts, URL links, and Digital Object Identifiers (DOI). This is intended to demonstrate the comprehensive scope of his work.

In 2006, Prof. Su compiled the content of most of his papers into his magnum opus, *Quantum Electromagnetics*. The book is the result of his "...efforts to make the formulations more rigorous and compact, the arguments stricter, and the descriptions more precise...":

Quantum Electromagnetics: A Local-Ether Wave Equation Unifying Quantum Mechanics, Electromagnetics, and Gravitation [1].

For an alternative theory to be accepted, it must be able to account for known phenomena. But one should not expect a presentation by a single individual to address every phenomenon. *Quantum Electromagnetics*, however, presents a unified account of a comprehensive scope of the most fundamental physical phenomena. This includes the realms of electromagnetic, gravitational, and quantum physics:

The Local-Ether Model.

- The Sagnac effect
 - In the global positioning system (GPS),
 - In the intercontinental microwave link,
 - In Sagnac type rotating loop interferometers,
 - In the Michelson-Gale experiment and ring lasers.
- The round-trip Sagnac effect in the interplanetary radar.
- The apparently null effect in the Michelson-Morley experiment.
- The constancy of the speed of light with a moving source.
- The spatial isotropy with phase stability
 - In the Kennedy-Thorndike experiment.

- In the one-way fiber-link experiment.
- The Doppler effect and spatial anisotropy
 - In Roemer's observations
 - In the cosmic microwave background radiation (CMBR);
- Galilean Invariant electromagnetism.
 - Modified Lorentz force law;
 - Modified Maxwell equations.
 - The effects of a moving dielectric medium
 - In Fizeau's experiment,
 - In the Sagnac loop interferometry;
 - Barnett's experiment.
 - Railgun theory.

Quantum Electromagnetics.

- Alternative explanations for phenomena commonly cited as evidence supporting Einstein's Relativity.
- The Local-Ether Wave Equation.
 - Unification of electromagnetism, gravity, and de Broglie matter waves.
 - Derivation of a time evolution equation similar to Schrödinger's equation.
- The origin and the identity of inertial and gravitational mass.
- The dependence of the propagation speed of electromagnetic waves on gravitational potential.
 - Gravitational lensing (including the gravitational deflection of light by the Sun).
 - In interplanetary radar echo time (the Shapiro delay);
- The gravitational redshift (including the Pound-Rebka experiment);
- The dependence of inertial mass on speed with respect to a local-ether.
 - Derivation of the Lorentz mass variation factor as a quantum property of microparticles.
- The dependence of the frequency of atomic clocks on speed with respect to a local-ether.
 - In the Hafele-Keating experiment,
 - In GPS,
 - In the interplanetary spacecraft microwave links.
- The dependence of atomic clock frequency/tic rate on gravitational potential.
 - In the Hafele-Keating experiment,
 - In GPS,
 - In interplanetary spacecraft microwave links;
- The spatial isotropy with frequency stability
 - In the Hughes-Drever experiment,
 - In the cavity heterodyne experiment.
- The emission and absorption of electromagnetic waves by microparticles
 - In the Ives-Stilwell experiment,
 - In the ammonia-maser experiment,
 - In the Mossbauer rotor experiment,
 - In the two-photon absorption (TPA) heterodyne experiment.
- The Bragg reflection of matter-waves in the Davisson-Germer experiment.
- The Sagnac effect in neutron loop interferometry.
- The effects of earth's rotation and gravity in the neutron-wave loop interferometry.

- The reinterpretation of the Compton Effect based on the interference of electromagnetic waves and matter waves.

An important additional feature of an alternative theory is to make predictions and propose experiments to test the theory. *Quantum Electromagnetics* includes several experimental proposals. In this author's opinion, the most crucial experiment would be to perform a Michelson-Morley experiment in low Earth orbit or (better) solar orbit.

It is hoped that the scope and quality of Prof. Su's work will convince others that it is worthy of serious consideration and that some will be inspired to perform the proposed experimental tests. It is further hoped that some will be inspired to extend his work to additional phenomena.

Many have suggested that progress in physics has stalled and needs a new direction. In particular, the goal of unifying electromagnetic, gravitational, and quantum physics has remained elusive. This author asserts that the primary reason has been the stubborn reluctance to question Einstein's Relativity. Einstein's Relativity and Quantum Mechanics have separately accounted for a wide scope of phenomena. However, Prof. Su's Local-Ether Model together with the Quantum Electromagnetics theory accounts for the same phenomena equally well without violating the common sense, classical principles of absolute time and Euclidean space. In addition, it achieves the goal of unification.

This author suggests that Prof. Su's work represents the needed new direction.

The following sections list the papers that comprise the Local-Ether Model and Quantum Electromagnetics. Some of the papers are supplementary - not covered in the book; some provide general support for the theory; and some are superseded by other papers and are included for reference purposes only. They are listed with their abstracts under chapter in *Quantum Electromagnetics* that they are related to.

Finally, this author's comments are intended to inspire others to study Prof. Su's work; they are not meant to be a substitute for it.

Introduction to the theory of Quantum Electromagnetics:

"Quantum Electromagnetics – A Local-Ether Wave Equation Unifying Quantum Mechanics, Electromagnetics, and Gravitation" [2].

Abstract - The theory of *Quantum Electromagnetics* presents a wave equation which is constructed, in compliance with Galilean transformations, for electromagnetic and matter waves. A fundamental feature entirely different from the principle of relativity is that the wave equation is referred specifically to the proposed local-ether frame. For electromagnetic waves, the local-ether wave equation accounts for a wide variety of experiments on propagation and interference. For matter waves, the wave equation leads to modifications of Schrödinger's wave equation which in turn lead to a unified quantum theory of electromagnetic and gravitational forces in conjunction

with the origin and the identity of inertial and gravitational mass. Further, it leads to modifications of the Lorentz force law and of Maxwell's equations. Moreover, the wave equation leads to the dispersion of matter waves, from which the speed-dependence in the mass of a particle and in the wavelength, angular frequency, and quantum energy of a matter wave can be derived. The consequences of the wave equation are in accord with a wide variety of experiments that are commonly ascribed to the special relativity, the general relativity, the Lorentz mass-variation law, or to the de Broglie matter wave. Thereby, the local-ether wave equation unifies quantum mechanics, electromagnetics, and gravitation.

Chapter 1: Local-Ether Model of Wave Propagation

This paper describes the local-ether concept and focuses on phenomena related to the propagation of electromagnetic waves in the local-ether medium:

“A local-ether model of propagation of electromagnetic wave” [3].

Abstract - It is pointed out that the classical propagation model can be in accord with the Sagnac effect due to earth's rotational and orbital motions in the high-precision GPS (global positioning system) and interplanetary radar if the reference frame of the classical propagation medium is endowed with a switchability according to the location of the wave. Accordingly, it is postulated that, as in the obsolete theory, electromagnetic waves propagate via a medium like the ether. However, the ether is not universal. It is proposed that in the region under sufficient influence of the gravity due to the earth, the sun, or another celestial body, there forms a local ether, which in turn is stationary with respect to the gravitational potential of the respective body. For earthbound and interplanetary propagation, the medium is stationary in a geocentric and a heliocentric inertial frame, respectively. An electromagnetic wave propagates at a constant speed with respect to the associated local ether, independent of the motions of source and receiver. Based on this local-ether model of wave propagation, a wide variety of earthbound, interplanetary, and interstellar propagation phenomena are accounted for. Strong evidence of this new classical model is its consistent account of the Sagnac effect due to earth's motions among GPS, the intercontinental microwave link, and the interplanetary radar. Moreover, as examined within the present precision, this model is still in accord with the Michelson–Morley experiment. To test the local-ether propagation model, a one-way-link rotor experiment is proposed.

Chapter 2: Modifications of Lorentz Force Law

“Modifications of the Lorentz Force Law Complying with Galilean Transformations and the Local-Ether Propagation Model” [4]. This paper includes most of the content of Chapter 2: :

Abstract - It is generally expected from intuition that the electromagnetic force exerted on a charged particle should remain unchanged when observed in different reference frames in uniform translational motion. In the special relativity, this invariance is achieved by invoking the

Lorentz transformation of space and time. In this investigation an entirely different interpretation of the invariance of force is presented. We propose a new model of the electromagnetic force given in terms of the augmented potentials, which are derived from the electric scalar potential by incorporating a velocity difference between involved particles. The propagation of the potentials is supposed to follow the local-ether model. All of the position vectors, time derivatives, and velocities involved in the proposed potentials and force law are referred specifically to their respective frames. By virtue of this feature, the electromagnetic force is independent of the reference frame simply based on Galilean transformations. The proposed model looks quite different from the Lorentz force law, except the electrostatic force. However, under the common low-speed condition where the mobile charged particles forming the current drift very slowly in a neutralizing matrix, it is shown that the proposed model reduces to the Lorentz force law, if the latter is observed in the matrix frame as done tacitly in common practice.

The following papers are related to the modified Lorentz force law but are not covered in the book:

“Reexamination of Barnett's Experiment Based on the Modified Lorentz Force Law” [5].

Abstract – Barnett's experiment demonstrates that the induction on a stationary cylindrical capacitor in the presence of a rotating magnet or solenoid is zero. In this investigation, based on the modified Lorentz force law, which complies with Galilean transformations and depends on relative velocities, the induction on the capacitor is reexamined. When the rotating solenoid is long and the capacitor is placed inside the solenoid, it is seen that the induction actually vanishes as observed in Barnett's experiment. However, when the capacitor is placed outside the solenoid or when the solenoid is short, it is shown that the induction can depart from zero. This prediction provides a means to test the validity of the modified Lorentz force law.

“An Ignored Mechanism for the Longitudinal Recoil Force in Railguns and Revitalization of the Riemann Force Law” [6].

Abstract – The electric induction force due to a time-varying current is used to account for the longitudinal recoil force exerted on the rails of railgun accelerators. As observed in the experiments, this induction force is longitudinal to the rails and can be the strongest at the heads of the rails. Besides, for the force due to a closed circuit, it is shown that the Riemann force law, which is based on a potential energy depending on a relative speed and is in accord with Newton's law of action and reaction, can reduce to the Lorentz force law.

“Mechanisms for the longitudinal recoil force in railguns based on the Lorentz force law” [7].

Abstract - In this paper, the electric induction force due to a time-varying current is used to account for the longitudinal recoil force exerted on the rails of railgun accelerators. The analysis is based on the Lorentz force law. The paper shows that the induction force is longitudinal to the rails, and that its magnitude depends on the location, speed, and acceleration of the armature, and can be the strongest at the heads of the rails as observed in experiments.

“Connections Between the Riemann and the Lorentz Force Laws” [8].

Abstract - It is known that for the magnetic force due to a closed circuit, the Weber force law can be identical to the Lorentz force law. In this investigation it is shown that for both the electric and the magnetic force of the quasi-static case, the Riemann force law can be identical to the Lorentz force law, while the former is based on a potential energy depending on a relative speed and is in accord with Newton's law of action and reaction.

Chapter 3: Modifications of Maxwell's Equations

"In Chapter 1 we have presented the local-ether model, whereby the propagation of earthbound waves is supposed to be referred uniquely to a geocentric inertial frame. Further, in Chapter 2, in compliance with Galilean transformations and the local-ether propagation model, the modified Lorentz force law is developed, which is formulated in terms of the potentials originating from the net charge density and the neutralized current density. The relationships between the potentials and the electromagnetic fields are also derived. In this chapter, the corresponding wave equations for the potentials and the fields along with the corresponding continuity equation and Lorenz gauge are derived. Then the phase speed of electromagnetic waves in a moving dielectric or magnetic medium is derived. After the Sagnac effect due to the movement of the transmission path is taken into consideration, it is shown that the local-ether wave equation for the electric field can account for various precision interference experiments in a consistent way, including the one-way-link experiment with a geostationary fiber, the Sagnac rotating-loop experiments with a comoving or a geostationary dielectric medium, and Fizeau's experiment with a moving dielectric medium in a geostationary interferometer. These experiments together then provide support for the local-ether wave equation. Meanwhile, some other phenomena are predicted, which provide a means to test its validity. Thereafter, we derive the divergence and the curl relations for the electric and magnetic fields, which represent modifications of Maxwell's equations complying with Galilean transformations." From abstract for Chapter 3 in [31].

"Modifications of Maxwell's Equations Invariant under Galilean Transformations" [9].

Abstract: In the special relativity, Maxwell's equations and the Lorentz force law are invariant under the Lorentz transformation. In this investigation, based on the modified Lorentz force law and the local-ether model of wave propagation recently developed, the Galilean-invariant counterparts of the wave equations of potential, the continuity equation, and of the Lorenz gauge are derived. Thereby, we derive the divergence and the curl relations of electric and magnetic fields. These relations have a unique feature of being Galilean invariant and present modifications of Maxwell's equations.

"Local-Ether Wave Equation of Electric Field and Interferometry Experiments with Moving Medium and Path" [34]:

Abstract: Recently, we have presented the local-ether model, whereby the propagation of earthbound waves is supposed to be referred uniquely to a geostationary inertial frame. Further, in order to comply with this propagation model, the modified Lorentz force law is developed. Thereby, the corresponding wave equations of potentials and fields are derived in this investigation. It is shown that the local-ether wave equation of electric field can account for various precision interferometry experiments in a consistent way, including the one-way-link

experiment with a geostationary fiber, the Sagnac rotating-loop experiment with a comoving or a geostationary dielectric medium, and Fizeau's experiment with a moving dielectric medium in a geostationary interferometer. These experiments together then provide a support for the local-ether wave equation. Meanwhile, some other phenomena are predicted, which provide a means to test its validity.

"Reinterpretation of Fizeau's experiment with moving medium in accord with the Sagnac effect due to earth's rotation" [29]:

Abstract - The famous Fizeau's interferometry experiment with flowing water is commonly cited as a demonstration of the velocity transformation in the special relativity. In this investigation, by taking into account the modification of the propagation velocity due to the motion of the dielectric medium and the modification of the propagation length due to the Sagnac effect, an entirely different interpretation of this experiment is presented. Physically, the influence of the medium velocity on the phase velocity is associated with an effect of the polarization current. Both the medium velocity and the Sagnac effect depend on earth's rotation, while its influence on the phase difference in Fizeau's experiment cancels out substantially.

Chapter 4: Modifications of Schrödinger's Equation

"A Local-Ether Wave Equation and the Consequent Electromagnetic Force Law" [10].

Abstract - The local-ether wave equation incorporating a natural frequency and the electric scalar potential is presented, from which the electrostatic force in conjunction with the inertial mass is derived. It is found that the inertial mass of a charged particle originates from the temporal variation of the associated matter wave. Further, the wave equation is extended by connecting the scalar potential to the augmentation operator which in turn is associated with the momentum operator and the velocity of source particles. From this local-ether wave equation, a first-order time evolution equation is derived, which in turn leads to the electromagnetic force law based on the augmented potentials. Under the low-speed condition, this law reduces to the modified Lorentz force law.

"...The evolution equation then represents modifications of Schrödinger's equation complying with Galilean transformations and the local-ether propagation model. The fundamental modification is that the position vector and the time derivative are referred specifically to the local-ether frame. Furthermore, the role of the vector potential in Schrödinger's equation is replaced by the augmentation operator connected with the scalar potential. The evolution equation looks quite different from Schrödinger's equation. However, under some ordinary conditions, it is shown that these two equations become substantially identical." From abstract for Chapter 4 in [31].

"Modifications of Schrödinger's Equation Complying with the Effect of Earth's Rotation on Quantum Energy in Atoms and with the Electromagnetic Force" [11].

Abstract - Recently, we have presented a local-ether wave equation incorporating a natural frequency and the electric scalar potential, from which the speed-dependences in the angular frequency and wavelength of matter waves, in the mass of a particle, and in the energy of quantum states are derived. These relations look like the postulates of de Broglie and the Lorentz mass-variation law, except that the particle speed is referred specifically to a geocentric inertial frame and hence incorporates earth's rotation for earthbound particles. Further, the wave equation is extended by connecting the scalar potential to the augmentation operator which is associated with a velocity difference between involved particles. Then the electromagnetic force law is derived, which under some ordinary conditions reduces to the modified Lorentz force law. In this investigation, the interaction of atoms with electromagnetic radiation is explored. Then it is shown that the time evolution equation derived from the wave equation is substantially identical to Schrödinger's equation incorporating the vector potential, if the latter is observed in the atom frame and if the source generating the vector potential is electrically neutralized, as in common practice.

Chapter 5: Unified Quantum Theory of Electromagnetic and Gravitational Forces

"In this Chapter, by incorporating the gravitational potential into the local-ether wave equation, the gravitational force together with the gravitational mass is also derived. Thereby, a unified quantum theory of electromagnetic and gravitational forces in conjunction with the origin and the identity of inertial and gravitational mass is presented. Meanwhile, for a particle bound in an atom, the gravitational potential is found to cause a decrease in the energy of each quantum state of the associated matter wave. The corresponding gravitation-dependence of the transition frequency is in accord with the experiments demonstrating the gravitational redshift. The local-ether wave equation also leads to the gravitation-dependence of the propagation speed of electromagnetic waves, which in turn leads to the deflection of light by the Sun and the increment of echo time in the interplanetary radar. Thereby, based on the wave equation complying with Galilean transformations, alternative interpretations of the evidence supporting the general theory of relativity are provided. However, the derived gravitational redshift originates from a quantum nature of the involved atoms and the gravitation-dependence can be different for different transitions. This discrepancy then provides a means to test the local-ether wave equation." From abstract for Chapter 5 in [31].

"A local-ether wave equation unifying gravitational and electromagnetic forces" [12].

Abstract - Recently, we have presented the local-ether model of propagation of electromagnetic wave. This new classical model accounts for a wide variety of propagation phenomena, including the gravitational effects associated with the deflection of light by the Sun and the increment in interplanetary radar echo time, which are commonly ascribed to general relativity. In this investigation, based on the local-ether model, a wave equation incorporating the gravitational potential, the electric scalar potential, and a natural frequency is proposed for the matter wave associated with a charged particle. The local-ether wave equation leads to a time evolution equation similar to Schrödinger's equation. Then both the gravitational and the electrostatic forces are derived in a quantum-mechanical approach. Furthermore, it is found that the gravitational mass and the inertial mass are identical to the natural frequency, aside from a common scaling

factor. Thus the identity of gravitational and inertial mass is also derived from the local-ether wave equation.

”A Wave-Propagation Model for Gravitational Effects On Light Deflection and Radar Echo Time” [13].

Abstract - The deflection of a light beam passing close to the Sun and the increment in interplanetary radar echo time are known as important consequences of the general theory of relativity. In this investigation, by endowing each celestial body with a unique local ether and by modifying the speed of light in a gravitational potential, a wave-propagation model is proposed to account for these phenomena in a classical way without invoking the space-time curvature.

“A local-ether wave equation and speed-dependent mass and quantum energy” [14]. This paper is also part of the content for Chapter 6. See abstract in next section.

Chapter 6: Speed-Dependent Mass and Quantum Energy

“A local-ether wave equation and speed-dependent mass and quantum energy” [14]. This paper also applies to Chapter 5 regarding the discussion of gravitational redshift.

Abstract - The east-west directional anisotropy in clock rate observed in the Hafele-Keating experiment with circumnavigation atomic clocks is commonly ascribed to the special relativity. In this investigation, based on the local-ether wave equation, an entirely different interpretation of this anisotropy is presented by showing that the clock-rate variation can originate from an intrinsic quantum property of the atom. For a harmonic-like wavefunction, the local-ether wave equation leads to a first-order time evolution equation similar to Schrödinger’s equation. However, the time derivative incorporates a speed-dependent factor similar to that in the Lorentz mass-variation law. Consequently, the quantum energy, the transition frequency, and hence the atomic clock rate decrease with the atom speed by this speed-dependent mass-variation factor. According to the local-ether model, the speed is referred specifically to a geocentric or heliocentric inertial frame for an earthbound or interplanetary clock, respectively. It is shown that this restriction on reference frame is actually in accord with the various experimental results of the anisotropy and the clock-rate difference in the Hafele-Keating experiment, the synchronism and the clock-rate adjustment in GPS (global positioning system), and of the spatial isotropy in the Hughes-Drever experiment. Moreover, the switching of the unique reference frame is in accord with the frequency-shift formulas adopted in earthbound and interplanetary spacecraft microwave links. Meanwhile, the local-ether model predicts a constant deviation in frequency shift from the calculated result reported in an interplanetary spacecraft link. This discrepancy then provides a means to test the local-ether wave equation.

Chapter 7: Resonant Absorption between Moving Atoms

“Resonant Absorption between Moving Atoms due to Doppler Frequency Shift and Quantum Energy Variation” [15].

Abstract - By taking both the Doppler frequency shift for electromagnetic waves and the quantum energy variation of matter wave into consideration, a resonant-absorption condition based on the local-ether wave equation is presented to account for a variety of phenomena consistently, including the Ives-Stilwell experiment, the output frequency from ammonia masers, and the Mössbauer rotor experiment. It is found that in the resonant-absorption condition, the major term associated with the laboratory velocity is a dot-product term between this velocity and that of the emitting or absorbing atom. This term appears both in the Doppler frequency shift and the transition frequency variation and then cancels out. Thereby, the experimental results can be independent of the laboratory velocity and hence comply with Galilean relativity, despite the restriction that the involved velocities are referred specifically to the local-ether frame. However, by examining the resonant-absorption condition in the Mössbauer rotor experiment to a higher order, it is found that Galilean relativity breaks down.

“Reinterpretation of the TPA Heterodyne Experiment Based on Doppler Frequency Shift and Quantum Energy Variation” [16] (supplementary - not covered in the book).

Abstract - Based on the local-ether wave equation, a resonant-absorption condition between moving atoms is derived by taking into account both the Doppler frequency shift for electromagnetic waves and the quantum energy variation of matter waves. As the dependence of quantum energy on mass and speed is considered, this approach is different from that based on the special relativity. Thereby we present a reinterpretation of the TPA (two-photon absorption) heterodyne experiment which is commonly ascribed to a consequence of the special relativity.

Chapter 8 Interference of Matter Wave

“Reinterpretation of Matter-Wave Interference Experiments Based on the Local-Ether Wave Equation”, [17]

Abstract - Based on the local-ether wave equation for a free particle, the dispersion of matter wave is examined. From the dispersion relation, the angular frequency and wavelength of matter waves are derived. These formulas look like the postulates of de Broglie in conjunction with the Lorentz mass-variation law. However, the fundamental difference is that for terrestrial particles their speeds are referred specifically to a geocentric inertial frame and hence incorporate the speed due to earth’s rotation. Thus the local-ether model predicts an east-west directional anisotropy both in mass and wavelength. Meanwhile, in spite of the restriction on reference frame, the local-ether model can account for the matter-wave interference experiments of the Bragg reflection and the Sagnac effect. For electron wave, the effects of earth’s rotation are negligible and the derived Bragg angle is actually in accord with the Davisson-Germer experiment, as examined within the present precision. On the other hand, the local-ether model leads to a directional anisotropy in the Bragg angle in neutron diffraction. The predicted anisotropy due to earth’s rotation then provide a means to test the local-ether wave equation.

"Reinterpretation of the effects of the Earth's rotation and gravity on the neutron-interferometry experiment" [18].

Abstract - The phase shift of matter waves due to the Earth's rotation and gravity has been demonstrated in the neutron-interferometry experiments where the Bragg reflection of the neutron wave from crystals is used to form a closed path. In the literature, the rotation induced phase shift is ascribed to an extra energy term associated with angular momentum in the Hamiltonian. In this investigation, based on a classical treatment of the collision of neutrons with the lattice planes, the modifications in the particle velocity due to the Earth's rotation as well as those due to gravity are calculated. Then, in conjunction with the relation between the particle velocity and the propagation vector of matter wave, it is shown that the corresponding phase shifts in matter wave are in accord with the interference experiments. Thereby, based on the velocity modification due to collision, a reinterpretation of the effects of the Earth's rotation and gravity on the neutron-wave interference is presented. Meanwhile, a null effect of the Earth's orbital motion is predicted.

"A Wave Interpretation of the Compton Effect As a Further Demonstration of the Postulates of de Broglie" [19] (supplementary - not covered in the book).

Abstract - The Compton effect is commonly cited as a demonstration of the particle feature of light, while the wave nature of matter has been proposed by de Broglie and demonstrated by Davisson and Germer with the Bragg diffraction of electron beams. In this investigation, we present an entirely different interpretation of the Compton effect based on the postulates of de Broglie and on an interaction between electromagnetic and matter waves. The speeds of interacting electrons in the Compton scattering are quite fast and its mechanism relies heavily on the mass variation. Thus, based on this wave interpretation, the Compton effect can be viewed as a further demonstration of the postulates of de Broglie for high-speed particles. In addition to the scattered wave, a direct radiation depending on the mass variation is predicted, which provides a means to test the wave interpretation.

Papers of general interest cited by and in support of the Quantum Electromagnetics theory

"An Explicit Second-Order Formula For Radar Echo Time" [20].

Abstract - In the radar ranging, the echo delay depends on the movements of the target and the transceiver during wave propagation. Thus, the exact formula for determining the radar echo time is implicit. In this investigation, the forward and the backward propagation times are expressed in terms of the separation distance of the target and the transceiver at the instant of wave emission. Thereby, an explicit second-order formula for the radar echo time is derived, which is helpful in high-precision radar, such as the interplanetary radar.

"Generalisation of Radar Doppler Shift for Target of Arbitrary Velocity Relative to Transceiver" [21].

Abstract - Based on the pseudorange correction adopted in GPS (global positioning system), the round-trip propagation range for a monostatic radar is derived. By treating the Doppler effect as the time rate of change of the propagation range, the radar Doppler shift is generalised to the case where the velocity of the target relative to the transceiver is arbitrary, thereby taking into account both the transverse component of the relative velocity and the acceleration.

“On the Singularity of the Static Green's Function and the Derivations of Equations Associated With Potentials” [22].

Abstract - The singularity of the static Green's function incurs mathematical difficulty. It is pointed out that this singularity is unnecessarily complicated and can be removed by a physically meaningful assumption which regularizes the static Green's function without substantially affecting the electromagnetic theory. Further, this regularization smooths the electric field in the close proximity of the source and leads to the result that the electrostatic force due to a charged particle exerted on itself is zero. Therefore, the Poisson equation of the regularized static Green's function can be obtained in a simple manner. Then the wave equations of the electric scalar potential and the magnetic vector potential are derived in a new approach. Furthermore, we derive the Lorenz gauge rather than assume it.

“Explicit Definitions of Electric and Magnetic Fields in Potentials and Derivation of Maxwell's Equations” [23].

Abstract - Based on the Lorentz force law given directly in terms of the scalar and the vector potentials, electric and magnetic fields are defined explicitly in terms of the potentials. These are in turn defined explicitly in terms of charge and current densities, respectively. The divergence and the curl relations of the two fields thus defined are just Maxwell's equations. The explicitness of the formulae provides a clearer way to understand the physical meanings of electric and magnetic fields.

Prof. Su passed away in approximately 2007 and a website he created (<http://qem.ee.nthu.edu.tw>) for the Local-Ether Model and Quantum Electromagnetics theory on the National Tsing Hua University website have been removed. However, most of the website can be accessed from the “Wayback Machine” at archive.org [31].

Papers superseded by other papers or are speculative

“A Local-Ether Model of Wave Propagation Complying with the Sagnac Correction in the Global Positioning System” [24], Covered in [3].

“On the Sagnac Effect in Wave Propagation” [25]. Covered in [3].

“Reinterpretation of the Michelson-Morley Experiment Based on the GPS Sagnac Correction” [26]. Covered in section 6.2 of [3]. Also note, the Brillet-Hall experiment of 1979 is not discussed.

“Modifications of the Lorentz Force Law Invariant under Galilean Transformations” [27]. Superseded by [4].

"A local-ether wave equation and the Galilean-invariant electromagnetic force law" [28]. Superseded by [10].

"A Proposed Mechanism for the Intrinsic Redshift and its Preferred Values Purportedly Found in Quasars Based on the Local-Ether Theory" [30]. This paper is somewhat speculative but contains some very interesting and novel ideas.

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- http://2-floor.dyndns.org/item_detail.php?pro_id=762760 for approximately \$81.00 US including shipping.
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