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Next Frontier in Physics—Space as a Complex Tension Field

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ABSTRACT

We hypothesize that 100% of the energy of our cosmic system is held by a physically real Complex Tension Field (CTF). We are using an old methodology of thinking used by our forefather engineers long before the advent of modern scientific thinking. We call it Interaction Process Mapping Epistemology or IPM-E. We apply this IPM-E on to the prevailing Measurable Data Modeling Epistemology or MDM-E. This approach helped us analyze the "Measurement Problem", recognized during the rise of quantum mechanics (QM), and helped us recover a universal property of all linear waves, that they do not interact, or interfere, with each other. This Non-Interaction of Waves, or the NIW-property, should be obvious through daily observations and through the Huygens-Fresnel diffraction integral and through critical evaluation of contradictory hypotheses we have been assigning to photons through ages. This implicates that the time-frequency Fourier theorem, although mathematically correct, and is used universally in all branches of science; does not map the real physical interaction processes for most optical phenomena. Accordingly, we present the necessary modifications for a few selected phenomena in classical and quantum optics to validate the NIW-property. In the process we find that accepting photons as non-interacting, but diffractively propagating linear wave packets crossing the entire cosmic space, requires CTF as a physical medium. Then we develop logical arguments in support of stable elementary particles as nonlinear but resonant vortex-like undulations of this same CTF. These vortex-like particles impose various secondary potential gradients around themselves giving rise to the four forces we know. Thus, CTF can serve as the cosmic substrate to develop a unified field theory without the need of dark matter and dark energy. In the process, we demonstrate a path to add ontologic thinking on our biologically successful epistemic thinking.

Keywords: Non-Interaction of Waves; Cosmic Tension Field; Dark Energy and Matter; Platform for Unified Field Theory

1. Introduction

The paper establishes that photons are non-interacting classical wave packets. This requires the cosmic vacuum to be a real physical Complex Tension Field (CTF) to sustain and facilitate such linear waves to propagate across the entire cosmic volume. We then postulate that CTF holds 100% of the cosmic energy. Then we accommodate particles as vortex-like nonlinear space-finite oscillations. The oscillations are self-resonant for their stability giving rise to the quantumness in the micro universe. Our approach is to "stand on the shoulders of the giants", a la Newton, who is rightly considered as the father of modern physics. However, our novel approach helps remove a large number of ad hoc hypotheses from many of the modern theories. That the foundational hypotheses behind the working theories of physics need to be re-visited is obvious from a large number of recent books and papers [1-13]. We hope our effort in this paper will add further impetus to put vigorous efforts in developing unified field theories in many new ways by questioning the foundational hypotheses of the current working theories [8,9,12-14]. Accordingly, we have put efforts to differentiate between epistemic and ontologic thinking [13,15] by tracing back to our evolutionary successes.

Sustainably evolving within the bounds of the laws of nature is being successfully practiced by all single and multi-cellular species, including humans, since ancient times. We are the first species to accelerate our rate of evolution, better than the others, by being able to articulate and pass on to the following generations such understandings in various forms, instead of relying only upon genomic transfer and genetic mutations available to all other species. Human ambitions have now been extended, beyond survival, to understand meanings, purposes and roles we can play in the vast cosmic system, beyond the earthly biosphere. A critical review of the records of human understandings, validated through quantitative ex-

perimentations, reveal that all the *physical processes* behind cosmological and biospheric phenomena, can be modeled (theorized) *fairly closely* as long as our fundamental assumption is that all the laws behind the cosmological evolution are *perfectly logical*, rather than ordained ad hoc by some spiritual force. Unfortunately, we do not have direct access to the *cosmic logics*. So, through ages, we have refined our theorizing approach as an *iteratively advancing process*, which can continue through ages. We have been first developing a set of *hypothesis logics* to bring conceptual continuity among a diverse set of related observations by imposing some logical congruence; and then structure them into a rigorous theory by imposing on them even more restrictive set of human-invented *mathematical logics* [11] with the explicit *desire* to capture the real set of operational *cosmic logics*. Even though microbes and ancient humans did not understand the cosmic logics directly, they have remained close to them by virtue of their intuitive capacity (or, un-articulated biological intelligence) to emulate the nature-allowed *physical processes* in modified forms to better adapt to their environment. We humans have identified this emulation of nature allowed *physical processes* as technology invention, which is now accelerating at almost an exponential rate as we have entered the Knowledge Age, leveraging the Internet empowered communication technologies.

The point is that our primitive forefather human engineers, inspite of not being scientists in the modern sense of the word, have successfully assured our sustainable evolution by *emulating nature allowed processes*. They could not visualize the physical process of tilted earth spinning on its axis and revolving around the Sun, yet they succeeded in developing the fundamentals of seasonally dependent agricultural technologies, critical for us being here today in such large numbers. Life-long meticulous recording of data on the positions of planets and stars by Tyco Brahe and Johannes Kepler, followed by empirical formulation of the planetary laws of motion by Kepler, finally inspired Newton, the discoverer of differential calculus, to enunciate the *universal* inverse square law of gravitational attraction. Today, we can mentally or digitally visualize the planetary motions, even though the Voyager (now traveling beyond the solar system) has not recorded and sent back time-lapsed videos of the planetary motions around the Sun!

But, today's advanced technology behind precision Doppler velocimetry shows that further the stars are from the center of any galaxy, more their velocity deviate from Newton's law of gravity; so it cannot be all that *universal*! Neither Newton's law of gravity, nor Einstein's General Relativity (GR), models such velocity variation data without ad hoc modifications [16]. Further, it is getting closer to almost a century that we have been trying to develop a unified field theory, first initiated by Einstein, to understand and visualize the evolution of the entire cosmic system; but we have not succeeded yet. We believe that this is because *we are extremely reluctant to accept space as a real physical field*, even though most of the successful working mathematical theories indicate that space is full of physical properties. 1) Gravitational law [17] requires that space has gravity related property G as in $G{\cdot}mM/r^2$; 2) Maxwell's wave equation demands the same space to have electric and magnetic properties, ε_0 and μ_0, because the velocity of light [18] in *free space* is always $c=\left(\varepsilon_0\mu_0\right)^{-1/2}$; 3) General Relativity defines gravitational force as a *curvature of the space*; 4) all versions of quantum mechanics find space to be full of "*zero point energy*", "*quantum foam*", "*background fluctuations*", etc. Further, the recent discovery of Higgs' Boson has not really succeeded in bringing uniform confidence that the prevailing epistemology of physics is in the right direction [19]. Yet, we have been religiously reluctant to renew our efforts to develop theories from the new foundation that space constitutes a real physical field! Instead, we have been successfully imposing around the globe the view that the foundation of the edifice of physics has already been laid and they must not be challenged any further! This directly contradicts our long trend of historical evolution of scientific theories. Classical theories were consecutively challenged by Relativity Theories (RT) and Quantum Mechanics (QM) and they have eventually prevailed. Over almost a century, these theories have provided us with enormously useful and practical guidance. Today our knowledge behind the workings of the micro and the macro universe is undeniably impressive. Yet, we have become collectively reluctant to accept the fundamental tenet of scientific thinking: We are not yet wise enough to ask the ultimate questions about the universe and construct the final theory! Hence, all theories must be iteratively corrected and enhanced as our measurement technologies keep on advancing and makes us wiser. Any and all human organized bodies of knowledge are *necessarily incomplete*, because they have been constructed based upon *insufficient knowledge and understanding* of the deeply interrelated and inseparable cosmic system.

Serious human epistemology should be guided by the enduring need for consciously constructing an evolving path for our sustainable and collective evolution. So the purpose of successful theory building should be explicitly directed towards visualizing the invisible interaction processes behind all phenomena. This will facilitate all engineers to become more inventive towards our continued future technological needs. *Science cannot continue to flourish without consciously being aware of its responsibility to directly facilitate our sustainable evolution*, *while working with the engineers hand in hand.*

Let us define the necessary approach [13] as the Interaction Process Mapping Epistemology (IPM-E), which should be added on to our currently successful approach, defined here as the Measurable Data Modeling Epistemology (MDM-E). Our biological brains have evolved as epistemic thinking tools. So, forcing ourselves to consciously visualize the invisible but ontological processes should train us to become better ontologic thinkers. RT and QM are enormously successful in validating wide ranges of measurable data. But both fail to provide us with visualizable maps for the interaction processes in macro and micro domains [10,20], even though they are successful in predicting the measurable data. In fact, the Copenhagen Interpretation explicitly advices us not to waste time in trying to visualize precise paths of electrons in stable atoms [21,22]. As a result, more than a century after indivisible photon hypothesis and more than 80 years of continued successes of QM, we are still living with diverse and self-contradictory metaphysical explanations for single photon and single particle interference [22]. Yet, we still have not succeeded in mathematically localizing indivisible photons. The photon as a Fourier mode of the vacuum is inconsistent with our observations and classical model for ultra-short laser pulses [23,24]. Besides, Fourier summation of wave amplitudes is inconsistent with the universal property of waves in the linear domain—they do not interact (or interfere) with each other to create new field energy distribution in the absence of some interacting medium. We call this Non-Interaction of Waves as the NIW-property [25-27], which we have been neglecting to explicitly recognize for centuries because MDM-E has kept us satisfied without enquiring any deeper about the invisible interaction processes between the superposed waves and the detector.

It is the recognition of this hitherto neglected NIW-property that has inspired us to explore the shortcoming of the prevailing scientific epistemology, *which we have characterized as MDM-E.* Our attempts to map the potential physical processes behind the NIW-property has helped us to reduce the number of ad hoc hypotheses, a la Occam's razor, necessary to explain a wide range of classical and quantum optical phenomena wherever the superposition effects play key roles [27].

2. "Measurement Problem" as an "Information Retrieval Problem"

Data we record through instruments are complex emergent phenomena [8], essentially invisible to direct viewing. This is not a simple measurement problem to be solved by elegant mathematical theorems [29-31].

1) Measurables as transformations: We can measure only physical transformations in an instrument.

2) Preceded by energy exchange: There are no transformations without energy exchange.

3) Guided by forces of interaction: Energy exchange, and consequent transformations, must be guided by some allowed force(s) of interaction.

4) Must experience physical superposition: Interactants must be within each other's sphere of physical influence to be able to interact under the guidance of an allowed force to exchange energy and undergo transformations. Thus, all interaction produced transformations must be *local* in the sense that the interactants must be within each other's sphere of physical influence.

5) Through some physical interaction process: Although invisible, all transformations are preceded by some real physical interaction process. Our conscious and systematic attempts to understand & visualize these invisible interaction processes provide us with some extra referent logical tools to explore cosmic logics (reality). IPM-E is a key tool that can connect our biological epistemic thinking with the necessary ontologic thinking.

6) Always requires a finite duration: Transformations in the interactants from one specific state into another requires a "compatibility sensing period" [32] between them before the interactants can acknowledge the force of interaction and then exchange energy and then undergo the measurable transformation (transition).

7) Perpetual information retrieval problem: How do we gather quantitative and accurate information regarding the transformations experienced by our chosen set of interactants in an experiment? We interpret. But, there are four fundamental limitations that always deprive us from gathering complete information about any entities we are studying. a) First, we have not succeeded in constructing any data registering instrument that has 100% fidelity in acquiring all the quantitative data (information) it generates through secondary transformations induced by the primary transformations experienced by our chosen interactants; b) Second, we have never succeeded in setting up an experiment where the interactants experience all the four forces that could introduce various measurable transformations in them, even though all material particles are subject to all of them under different circumstances; c) All interactants are incessantly perturbed by omnipresent cosmic rays and background EM radiations of all frequencies. These effects we usually burry under quantum statistics $\langle \psi^* \psi \rangle$. d) Finally, it is the human mind that provides the interpretations based upon whatever incomplete data we gather. And, since human minds have evolved for interpreting information for biological and socio-cultural survival first, our interpretations are subjective and vary from person to person and from culture to culture. Recall that Bohr-Einstein debate lasted for decades without resolution. We still do not know what an elementary particle

is made out of!

Physics has never formalized any force of interaction between linear waves. It is the light-matter *interaction process* that triggers the transformation we register as interference fringes. So, interference of waves is a misguided, yet well perpetuated concept, in most books and literature. This Non-Interaction of Waves, or the NIW-property is known [25-27] but we ignore it. We could not be enjoying music or visual sights unless all the necessary waves were reaching our sensors without being perturbed by other crossing waves.

3. Empowering Mathematical Logics [11] Using IPM-E

It is instructive to find out why our MDM-E using current representation of the superposition effects perfectly validate the measured data and allows for diverse subjective interpretations like: photons and particles 1) display *wave-particle duality*; 2) display self-interfere and 3) the superposition effects are *nonlocal phenomena*; etc.

We never *see* light. We can interpret the presence of EM wave only by inferring from electric *current pulses* in our detector consisting of *billions of electrons*. A silicon-based visible light detector fails to alert us about the presence of X-rays even though they possess more energy! It is the quantum mechanically allowed physical transformation in a detector, which becomes our measured data. So the mathematical equation representing light detection must first model the light-matter interaction process. Material molecules are modeled as oscillating dipoles in the presence of EM waves by both classical physics and QM. If we superpose N coherent waves $E_n = a_n \exp\left[\mathrm{i}2\pi\nu\left(t+n\tau\right)\right]$ with a periodic phase delay $n\tau$ on a detecting dipole, the total stimulated dipolar undulations can be represented by, using χ as the first order polarizability:

$$\begin{aligned}\Psi(\tau) \equiv \sum_n \psi_n &= \sum_n \chi E_n \\ &= \chi \sum_n E_n\end{aligned} \tag{1}$$

When χ is a constant for a narrow band of frequencies, the mathematical rule allows us to take it out of the sum-symbol as a common factor. Now the physical meaning of the last two mathematical expressions in Equation (1) can be interpreted dramatically differently. The expression in the second line of Equation (1) dominates the prevailing physics: EM fields interact with each other and sum themselves to create a new resultant field distribution; χ is no more than a *mere* detector constant! However, the expression in the first line of Equation (1) tells us that the fields are non-interacting, but the detecting dipole executes the joint stimulations imposed on it by all the simultaneously present fields. Thus the superposition effect is a local phenomenon [10,32] carried out by localized detectors. The recipe for the energy exchange has been given correctly by both the classical and the quantum physics; it is the square modulus of the total complex amplitudes. If we consider the special case of a two-beam Michelson or Mach-Zehnder interferometer, we get:

$$\begin{aligned}\Psi^*(\tau)\Psi(\tau) &= \chi^2 \left| a_1 \mathrm{e}^{\mathrm{i}2\pi\nu t} + a_2 \mathrm{e}^{\mathrm{i}2\pi\nu(t+\tau)} \right|^2 \\ &= \chi^2 \left[a_1^2 + a_2^2 + 2a_1 a_2 \cos 2\pi\nu\tau \right] \\ &= 2\chi^2 a^2 \left(1+\cos 2\pi\nu\tau\right); \text{ for } a = a_1 = a_2\end{aligned} \tag{2}$$

Note that in the real world it is very difficult to experimentally arrange absolutely correctly $a_1 = a_2$. So a detector registers an oscillatory energy absorption $2\chi^2 a_1 a_2 \cos 2\pi\nu\tau$ riding on a DC bias of $\chi^2 a_1^2 + \chi^2 a_2^2$. Our mathematics tells us that the detector absorbs energy proportional to the product $a_1 a_2$ to display fringe oscillation. The hypothesis "*photons interfere only with itself*", prevails only because we stay focused exclusively on the *oscillatory parameter*, $\cos 2\pi\nu\tau$, while ignoring the contribution of energy by both the beams indicated by the factors a_1 and a_2.

We need to stay alert that the algebraic symbols represent actual physical parameters of the entities under study and the operating symbols represent nature allowed interaction process guided by an appropriate force. Consider again Equation (1). $\psi_n = \chi E_n$ represents E_n induced physical dipole undulations allowed by the electromagnetic force of interaction between the EM wave and the material dipole. So ψ_n is not just an abstract mathematical probability amplitude; it is the physical dipolar undulation amplitude. *We can eliminate Born's interpretation for* ψ *and make QM represent more reality.* Summing χE_n implies that we are visualizing a critical physical process: First, the dipole executes a resultant undulation by summing all the individual stimulations and then executes the square-modulus recipe to absorb energy from all the fields, proportional to the individual intensities a_n^2. All the prevailing non-causal interpretations regarding superposition effects and ad hoc hypotheses regarding photons, become unnecessary, including wave-particle duality. Very similar logics apply to superposition phenomena registered by using particle beams [33].

Wave-particle duality implies lack of our knowledge about both particles and waves. If we treat *lack-of-knowledge* as an acceptable part of a working theory, we are formalizing *lack-of-knowledge* as *real-knowledge*! In the process, we are discouraging critical enquiry of nature any further at the cost of imposing brakes on the scientific evolution of our minds. Fortunately, no engineers try to propagate indivisible photons, whether designing a radio-telescopes or an X-ray telescope; they use

century old Huygens-Fresnel (HF) diffraction integral. We should not impose wave-particle duality interpretation on the highly successful HF integral. HF integral tells us that the far-field divergence angle of all EM waves reaches an asymptotic maximum and is inversely proportional to the frequency of the wave. This accommodates why gamma-rays behave more like particles than all the other lower frequency waves. Note that e^+, e^- pair production can happen only when γ interacts with some nucleus. Direct $\gamma-\gamma$ interaction in vacuum has remained elusive even today.

4. Improving Classical & Quantum Optics Using NIW-Property and IPM-E

In this section we demonstrate that recognition of the universal NIW-property of waves helps us remove several more unnecessary ad hoc hypotheses to explain optical phenomena, while bringing stringent causality back within the framework of existing theories. We also present causally valid and QM-transition consistent model of photons as non-interacting classical wave packets and hence *the QM definition of photon as a Fourier mode of the vacuum is unnecessary.*

4.1. Improving Classical Optics

1) Spectrometry: Classical theory of spectrometry has been formulated based upon propagating a Fourier monochromatic frequency through passive linear spectrometer (grating, Fabry-Perot, etc.), which match up with most observed data. Unfortunately, Fourier monochromatic wave is a non-causal proposition as it exists in all space and hence violates the principle of conservation of energy. So, we have developed a causal theory by propagating the carrier frequency of a time-finite pulse [34].

Spectrometers functionally replicate an incident pulse into a train of *N*-identical pulses, *N* being the grating slit number (or the finesses number for a Fabry-Perot), with a characteristic periodic temporal step delay $\tau=\Delta/c=m/\nu$; where Δ is the physical step delay, and *m* is the order of interference. So, all spectrometers have a characteristics time constant $\tau_0=N\tau$ (**Figure 1**) is required to generate the entire train of *N* pulses. This physical property of spectrometers has not been formally recognized by classical spectrometry [35]. The resultant time varying dipolar stimulation of a detector placed at the exit plane of the spectrometer due to an incident pulse $a(t)\exp(\mathrm{i}2\pi\nu t)$ is:

$$i_{\text{out}}(t)=\sum_{n=0}^{N-1}(\chi/N)\,a(t-n\tau)\cdot\exp\left[\mathrm{i}2\pi\nu(t-n\tau)\right] \quad (3)$$

The temporal rate of energy that can be absorbable is:

$$\left|i_{\text{out}}(t)\right|^2=\left|\sum_{n=0}^{N-1}(\chi/N)\,a(t-n\tau)\cdot\exp\left[\mathrm{i}2\pi\nu(t-n\tau)\right]\right|^2 \quad (4)$$

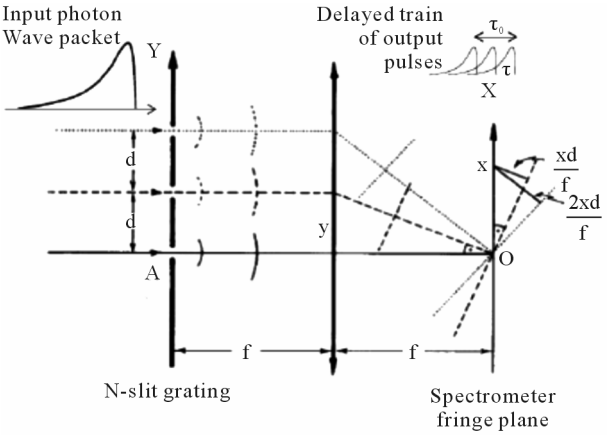

Figure 1. Pulse replication by grating and their temporally delayed superposition by a lens *L* in on a detector at the measurement plane.

We integrate this for the entire duration of *N*-pulses and get the registered fringe width centered on ν:

$$I_{\text{pls}}(\nu,\tau)=\frac{\chi^2}{N}+\frac{2\chi^2}{N^2}\sum_{p=1}^{N-1}(N-p)\,\gamma(p\tau)\cos\left[2\pi p\nu\tau\right] \quad (5)$$

where, $\gamma(p\tau)=\int \mathrm{d}(t-n\tau)\,\mathrm{d}(t-m\tau)\,\mathrm{d}t\Big/\int \mathrm{d}^2(t)\,\mathrm{d}t$

Equation (5) yields the classical CW result for a long pulse:

$$\begin{aligned}\underset{\delta t\geq\tau_0}{Lt.}\, I_{\text{pls}}(\nu,\tau)&=\frac{\chi^2}{N}+\frac{2\chi^2}{N^2}\sum_{p=1}^{N-1}(N-p)\cos\left[2\pi p\nu\tau\right]\\&\equiv\frac{\chi^2}{N^2}\frac{\sin^2\pi N\nu\tau}{\sin^2\pi\nu\tau}\equiv I_{cw}(\nu,\tau)\end{aligned} \quad (6)$$

Application of Parseval's energy conservation theorem on the time integrated Equation (4) can also be expressed as:

$$I_{\text{pls}}(\nu,\tau)\approx\int_{-\infty}^{\infty}\left|i_{\text{out}}(t)\right|^2\mathrm{d}t=I_{cw}(\nu)\otimes\tilde{A}(\nu) \quad (7)$$

The fringe broadening given by Equation (5) is not due to the physical presence of the Fourier frequencies, which is mathematically obtainable from the pulse envelope. It is due to the partial superposition of the translated stimulating pulses on the detector. Diffraction and reflections are almost instantaneous and linear response of gratings and mirrors. They do not have the physical capacity to carry out Fourier algorithms and then respond to the Fourier frequencies. Thus, *we are proposing a fundamentally important conceptual change in interpreting* "*what is a spectrum*" *due to a pulse.*

Notice that our theory of spectrometry (Equations (3)-(7)), has also derived the key classical results under special conditions, which helps remove classical misconceptions. In the limit of long pulse, $\delta t>\tau_0$, Equation (5) becomes Equation (6) that is equivalent to classical CW

derivation. This is because the N-replicated pulses are now effectively almost fully superposed giving $\gamma(p\tau) \to 1$. Next, classical spectrometry assumes that the measured fringe broadening due to a pulse $a(t)$ is the convolution between its Fourier intensity spectrum $\tilde{A}(\nu)$ and the CW response function $I_{cw}(\nu)$. We have derived this in Equation (7). *The concept of the physical reality of Fourier frequency is a wrong hypothesis* perpetuated due to this a mathematical coincidence, supported by the conservation of energy, but only when the entire pulse train is integrated by the detector. The "spectral fringe" due to a nano second pulse through a spectrometer registered by a pico second streak camera will show time varying fringe broadening (Equation (4)). This also implies that the Fourier indeterminacy relation $\delta\nu\delta t \geq 1$ is not a real resolution limit in our physical world. During quantitative spectrometry, Equation (5) should be treated as the *pulse impulse function* for the instrument and it should be deconvolved from the recorded fringe function to achieve *super resolution*. One can also use heterodyne spectrometry [36] using a known reference frequency to determine the unknown carrier frequency ν.

2) Diffraction: Diffraction theory is a unique example where it started with IPM-E in mind by Huygens, but once mathematically formulated by Fresnel, the physical model and its implications got lost. Propagation process of waves imply as if every point on the wave front generates a new forward moving spherical wave front with a $\cos\theta$ reduction in its amplitude from the forward direction. So the total field amplitude $U(P_0)$ at a point P_0 with a distance r_{01} due to a field distribution on an aperture plane is the sum of all the secondary spherical wave fronts arriving at P_0.

$$U(P_0) = \frac{\mathrm{i}}{\lambda}\iint_{\Sigma} U(P)_1 \frac{\exp(\mathrm{i}kr_{01})}{r_{01}}\cos\theta \,\mathrm{d}s \tag{8}$$

The complex amplitude $U(P_0)$ at any near or any far distance r_{01} is given by the same set of *evolving* spherical wave fronts. This clearly implies that the secondary wavelets propagate through each other while evolving, without interacting (or interfering) with each other. Thus Huygens-Fresnel diffraction principle works because the NIW-property is automatically built into it [37]. The integral allows one to find the sum of the resultant amplitude and corresponding intensity but only at the plane of observation by placing some suitable detector; in between they are not interacting. It is a subtle but very important point to recognize.

3) Coherence: Coherence theory is normally presented as normalized mathematical autocorrelation $\gamma_t(\tau)$ between a pair of replicated and superposed pulses, which also turn out to be equivalent to the measurable fringe visibility [38] $V(\tau)$:

$$\begin{aligned} V(\tau) = \gamma_t(\tau) &= \frac{\int_0^T a_1(t)a_2(t-\tau)\,\mathrm{d}t}{\left|\int_0^T |a_1(t)|^2\,\mathrm{d}t\right|^{1/2}\left|\int_0^T |a_2(t-\tau)|^2\,\mathrm{d}t\right|^{1/2}} \\ &= \frac{\int_0^T \chi a_1(t)\,\chi a_2(t-\tau)\,\mathrm{d}t}{\left|\int_0^T |\chi a_1(t)|^2\,\mathrm{d}t\right|^{1/2}\left|\int_0^T |\chi a_2(t-\tau)|^2\,\mathrm{d}t\right|^{1/2}} \end{aligned} \tag{9}$$

By virtue of the NIW-property, fields cannot correlate with each other. So, the first line in Equation (9) does not represent any physical process. Yet, measured $V(\tau) = \gamma_t(\tau)$ is well validated. MDM-E works, but why? The second line has incorporated IPM-E by converting all the field amplitudes into a detector's dipolar amplitude stimulations by inserting the multiplying factor χ, which is behind the real measurable transformation. Since, mathematical rule allows us to cancel the common factor χ from the numerator and the denominator; the two expressions in Equation (9) are mathematically identical, as far as MDM-E is concerned. However, as per IPM-E, they represent different physics. The first line represents wrong physics since field-field correlation cannot exist. The second line represents correct physics, because dipole-dipole correlation represents real detection process. This correlation also depends upon the duration of integration (intrinsic and circuit imposed). If we can invent an atto second detector with complementary time resolved fringe registration system, any and all light will give very high visibility fringes. So, *light*, *by itself*, *is neither coherent nor incoherent*. Note that even quantum coherence theory is, unfortunately, built upon the assumption of field-field correlation, rather than the correlation of the same dipole stimulated by two different fields. So, we have re-defined coherence as correlation properties of detectors, albeit dictated by specific characteristics of light [39] as follows: a) *Spectral correlation* (light with a frequency variation); b) *Temporal correlation* (light with temporal amplitude variation); c) *Spatial correlation* (light with independent multiple emitters); And d) *Complex correlation* (mixture of the above cases).

4) Polarization: Consider that we are working with a two-beam Mach-Zehnder interferometer which can generate and combine two different coherent beams of different states of linear polarizations. Then the detector will be simultaneously stimulated by two different E-vectors at an angle φ. Then the standard two-beam cosine fringes $\cos 2\pi\nu\tau$ will be multiplied by a visibility degrading factor $\cos\varphi$:

$$\begin{aligned} D(\tau) &= \left|\boldsymbol{\chi}_1 a\mathrm{e}^{\mathrm{i}2\pi\nu t} + \boldsymbol{\chi}_2 a\mathrm{e}^{\mathrm{i}2\pi\nu(t+\tau)}\right|^2 \\ &= 2\chi^2 a^2\left[1+\cos\varphi\cos 2\pi\nu\tau\right];\ \ \boldsymbol{\chi}_1\cdot\boldsymbol{\chi}_2 = \chi^2\cos\varphi \end{aligned} \tag{10}$$

For the case of $\varphi = \pi/2$, the fringe visibility will be zero. This is well known in physics and we tend to explain

it by using an ad hoc hypothesis that orthogonally polarized light beams are incoherent to each other. IPM-E now guides us to extract, so far, un-articulated physical process—that *detecting dipoles cannot simultaneously oscillate in two orthogonal directions* and hence fails to absorb energy from both the field simultaneously. Then, can it be true that the introduction of a precise phase delay between the two beams $2\pi\nu\tau = |2\pi| + 90^\circ$ will generate a circularly rotating polarized light, even though light beams do not interact with each other [40]?

5) Fourier transform spectrometry (FTS) and light beating spectrometry (LBS): These two methods of spectrometry experimentally give different information about the frequency content of the light being analyzed in different forms. Consider that we are analyzing the frequency content of a He-Ne laser, running in two frequencies, ν_1 and ν_2, using a Michelson's Fourier transform spectrometer where the relative delay τ between the two paths can be varied very slowly. If we use a very fast modern detector at the output, the photo current, normalized by the square of the detector polarizability factor, can be given by Equation (11).

$$\begin{aligned} & D(\tau)/\chi^2 \\ &= \left|\exp[\mathrm{i}2\pi\nu_1 t] + \exp[\mathrm{i}2\pi\nu_2 t]\right. \\ &\quad \left. + \exp[\mathrm{i}2\pi\nu_1(t+\tau)] + \exp[\mathrm{i}2\pi\nu_2(t+\tau)]\right|^2 \\ &= 4 + 2\cos 2\pi(\nu_1-\nu_2)t + 2\{\cos 2\pi(\nu_1-\nu_2)(t+\tau) \\ &\quad + \cos 2\pi[(\nu_1-\nu_2)t + \nu_1\tau] + \cos 2\pi[(\nu_1-\nu_2)t - \nu_2\tau] \\ &\quad + 2[\cos 2\pi\nu_1\tau + \cos 2\pi\nu_2\tau]. \end{aligned} \tag{11}$$

This photo current appears quite complex because of spatial and temporal beat signals between the modes and their replicated beams. All the time-dependent factors in Equation (11) will be reduced to zero if we use a very slow time-integrating detector. We will be left with terms

$$D(\tau)/\chi^2 = 4 + 2[\cos 2\pi\nu_1\tau + \cos 2\pi\nu_2\tau] \tag{12}$$

what a normal Fourier transform spectrometer will record, as shown in Equation (12). Note that the original assumption by Michelson was that different optical frequencies are *incoherent* and hence they do not *interfere*. It is a wrong hypothesis because EM waves never interfere. But his mathematical result was correct because he used long time integrating photographic plate for his quantitative work. Michelson recognized that the mathematical Fourier transform of the oscillatory component of the recorded fringes will give him the actual physical spectrum of the original signal. Then, from Equation (12) we have:

$$\begin{aligned} FT[D_{osc.}(\tau)] &\equiv FT[\cos 2\pi\nu_1\tau + \cos 2\pi\nu_2\tau] \\ &= \delta(\nu-\nu_1) + \delta(\nu-\nu_2) \end{aligned} \tag{13}$$

We have now eliminated another ad hoc hypothesis in optics, *non-interference of different frequencies*, and explicitly recognize a more important experimental process, the physical role of the integration time of detectors [32].

4.2. Improvements in Quantum Optics

In this paper, we will confine our discussions to those that are directly relevant to the NIW-property.

1) Are photons indivisible quanta or classical wave packets? One should note that Dirac's formulation [41] found photons as Fourier modes of the vacuum and they do not interact. This means that Dirac actually discovered the NIW-property; but to accommodate the mistaken classical assumption that light interferes, he proposed an un-necessary ad hoc hypothesis, "*a photon interferes only with itself*". We now know that it is the detector that generates the superposition effect absorbing energy from all the incident (superposed) waves. Regarding Dirac's "*Fourier mode*", we believe that it is an unphysical and non-causal assertion since a Fourier monochromatic mode has to extend over all space and time and would violate the principle of conservation of energy. Again, Dirac was most likely trying to accommodate QM predicted single frequency emission ν_{mn} in an atomic transition $\Delta E_{mn} = h\nu_{mn}$, with the classical assumption, that a single frequency (monochromatic) radiation must be a Fourier monochromatic mode.

We are proposing that the emission of the energy packet ΔE_{mn} by an atom, either through spontaneous or through stimulated emission process, evolves into a semi-exponential pulse [42] with the unique carrier frequency ν_{mn} (see **Figure 2**). Classical Lorentzian emission for a dipole radiation was derived to be an exponential pulse. Precision spectrometric measurement also found natural line width to be Lorentzian, which is a Fourier transform of an exponential pulse (recall Equation (7) for sperctrometry). Quantum mechanics also derived natural line width of atomic lines to be Lorentzian. Thus, our spectrometric theory implies that photon wave packets should be very much like an exponential pulse. But it should start from

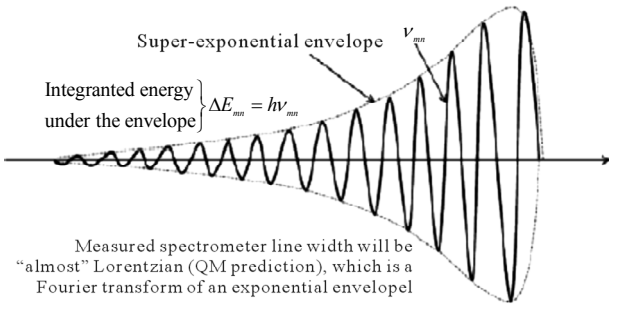

Figure 2. Photons are classical wave packets with a unique carrier frequency with a semi-exponentially decaying envelope. The model supports classical and QM observations.

zero value, and very quickly rise to its peak and then die exponentially, while containing the total energy $h\nu_{mn}$ to satisfy the needs of QM.

The next question is whether we can replace the 107 years old hypothesis, *indivisible quanta*, proposed by Einstein, by a better model based on interaction process. Let us first underscore that *QM does not demand that a quantum* entity can absorb the required quantum of energy only if it is delivered as a pre-quantized packet. Inside He-Ne laser discharge tubes, Ne-atoms can undergo transition to its upper lasing quantum level by accepting the desired amount of energy either 1) from a resonantly excited He-atom sharing an exact quantum of energy, or, 2) from an accelerated classical electron as the necessary fraction out of its total kinetic energy.

Next we need to appreciate that photo electron stimulation is a complex process. Einstein genius mind was the first one to recognize that there definitely was some quantumness behind the photoelectric data and the related interaction process. Being five years ahead of Bohr's heuristic quantum theory and 20 years ahead of modern QM, Einstein imposed the quantumness on the photon wave packets, instead of on the electrons. Otherwise, he would have invented QM, most likely in a different format than what we have today! He assumed that the quantum $h\nu$ was directly absorbed to provide for the binding energy φ, and the rest went to provide the kinetic energy to the emitted electron:

$$h\nu = (1/2)m\mathrm{v}^2 + \varphi(\text{work function}) \tag{14}$$

Today we know that electrons in materials are bound collectively to the matrix of atoms (molecules). Hence, their excitation would require the induction of some form of dipolar stimulations, whose allowed frequency band is set by the quantum mechanics. Equation (14) can be re-written in terms of dipolar stimulations induced simultaneously by many competing photon wave packets, followed by absorption of energy by the material matrix that facilitates the complete liberation of a photo electron, or its transfer from the valence to the conduction band ($m \to n$) as photo electric current to be drawn by external circuit:

$$\left|\sum_q \chi(\nu_q) a_q(\nu_q) \exp \mathrm{i}\left[2\pi\nu_q t + \phi_q\right]\right|^2 \overrightarrow{\text{gives}}\ \Delta E_{mn} = h\nu_{mn} \tag{15}$$

This re-formulation helps us better appreciate and model *the dependence of photo electron counting statistics on the fluctuating amplitudes and phases of simultaneously present multiple wave packets*, *besides the temporal energy fluctuations due to beat between different frequencies which fall within the allowed quantum band of frequencies.*

2) Relevancy of Bell's inequality theorem: Bell's theorem assumes photons are indivisible quanta and that single photons interfere by themselves. Since we have more confidence on our causal NIW-property, we believe that Bell's *no-go theorem* is irrelevant in experimental observation of superposition effects, which, in reality, is functionally determined by the detectors and not by the photons themselves!

3) Can photons be entangled? If an isolated quantum entity emits a pair of photon wave packets, the quantum nature of the light emitting process will clearly impose all the necessary conservation laws and the emitted photon wave packets will acquire complementary properties during the emission process. So, one can describe them to be *entangled* during their birthing process as conjoined twins due to having, say, orthogonal polarizations. These two energy packets, after emission, keep on evolving as diffractively propagating and spreading wave packets as linear undulations of CTF. These spatially separated *linearly* undulating wave packets neither can interact, nor can influence each other [25-27]; even though they remain co-related as orthogonally polarized entities. In fact, if one folds one of the wave packets back on to the other, one using a mirror, they would not even perceive each other's presence because of the NIW-property. We believe that the use of the w*ord entangled* is unfortunate.

5. Space as a Complex Tension Field (CTF)

5.1. How Does EM Waves Move Perpetually through Free Space?

We know that emitting atoms or molecules do not add kinetic velocity to EM waves. To be self-consistent with our model for photon as a 1) classical wave packet, 2) which can traverse through the entire length and breadth of the cosmic system, 3) with the *same* staggeringly high velocity $c = (\varepsilon_0\mu_0)^{-1/2}$, 4) obeying HF integral and as a solution of Maxwell's wave equation, we need the space to be a tension field with intrinsic EM properties ε_0 and μ_0. This is similar to the ether of nineteenth century, but conceptually modified to be a massless physical tension filed, rather than some novel substance.

Let us very briefly review how waves propagate, which was visualized by Huygens some 300 years earlier. Sound waves are undulation of the pressure tension of air. Water waves are undulations of the surface and gravitational tensions of water. String waves are due to undulation of a string under mechanical tension. Within the linear domain, a perturbed point of a tension field tries to come back to its original state of equilibrium by pushing away the perturbation energy to its surroundings, which is then repeated by the consecutive disturbed points. This persistent restoration tendency of every point of the tension field is the root cause behind the perpetual sinusoidal movement of a perturbation as a group of linear sim-

ple harmonic wave. HF diffraction integral models this physical process very well and hence it is so successful in modeling diffractive propagation of all waves. One should carefully note that waves do not really "carry" energy. The group of propagating undulating waves makes the energy of the local tension field available, wherever the wave packets are, to be absorbed if a suitable absorber is present (resonance helps).

Let us now attempt to assign tension-field oriented physical meaning on to ε_0 and μ_0 of CTF, beyond just the traditional definition of dielectric permittivity and magnetic permeability of the free space. We reproduce the wave equation for a stretched string [43] and then rewrite Maxwell's wave equation, but in terms of the vector potential [44] A to accommodate both electric and magnetic potential in the same equation, while emulating the string equation and then compare the two.

$$\frac{\partial^2 y(z,t)}{\partial t^2} = \mathrm{v}^2 \frac{\partial^2 y(z,t)}{\partial z^2} = \frac{T}{\sigma}\frac{\partial^2 y(z,t)}{\partial z^2} \tag{16}$$

$$\frac{\partial^2 A(z,t)}{\partial t^2} = c^2 \frac{\partial^2 A(z,t)}{\partial z^2} = \frac{\varepsilon_0^{-1}}{\mu_0}\frac{\partial^2 A(z,t)}{\partial z^2} \tag{17}$$

We see that ε_0^{-1} can be treated as the potential electric tension triggered in the CTF, which then generates μ_0 as the restoring magnetic resistance.

In this simple model of undulations of CTF, photon wave packets, most likely, do not possess properties like spin, angular momentum etc. It is the detecting molecules while absorbing energy from one or more polarized superposed waves, display modifications in their own such properties that they possess. We should not assign response characteristics of atoms and molecules on to EM waves.

5.2. Accommodating Massless Localized Particles in CTF

CTF to be a valid physical hypothesis, it must also accommodate particles that form the material universe. So, let us now assume that CTF also possess some intrinsic dynamic properties that allows it to sustain localized vortex-like *nonlinear* but harmonic spinning undulations, some of which could acquire *resonant stability* within its surroundings giving rise to all the stable and semi-stable particles. We underscore this vortex motion as *nonlinear*, which is beyond the linear restoration capability of CTF. So, vortices are locally confined and cannot move automatically like the EM waves. Further, the *linear* perturbations, induced by dipoles, not only move perpetually away from its location of generation, they also pass through each other unperturbed as long as the sum total perturbations at any local point do not exceed the linear restoration capacity of CTF (the intrinsic NIW-property). In contrast, vortices being nonlinear in origin, they can neither move by themselves, nor can pass through each other. This is the root of solidness in the material world.

One can hypothesize that the spin quantization is one of the required properties to provide resonant stability to the vortex that will always have a preferred axis within the 3D CTF. Under the dynamic vortex-like motions of CTF, its intrinsic properties, ε_0^{-1} and μ_0, possibly become manifest as charge and magnetic moments, the critical properties of all particles [1,45] The resonant (long lived) and semi-resonant (short lived) particles should possess a set of quantized energy values defined by some of the intrinsic properties of CTF. In fact, the energy values of most of the particles have recently been actually found [46] to possess an integer relation Z which equals to the product of α, the fine structure constant, multiplied by two times the ratio of the particle-to-electron energy (not mass):

$$2\left(m/m_{\text{elctrn.}}\right)\alpha = Z;\quad \alpha = \left(e^2/2h\right)\left(\varepsilon_0/\mu_0\right)^{1/2} \tag{18}$$

This implies that the electronic charge e and the Planck's constant h are also two intrinsic properties of CTF under vortex-like undulation, which play key roles in bringing out the quantumness in the material universe. The unit of quantum h being "erg.sec", it supports the hypothesis that the energy and the undulation periods of vortex-like *resonant* oscillations are inseparably related

Our model of particles as vortex-like motion of the field CTF automatically implies that they cannot possess any Newtonian property like mass. *Thus we do not need to find how the particles acquire mass.* They are stable in the CTF as local vortices hence they should naturally display inertia against any attempt to move them. In other words, we need to hypothesize the origin of the forces between particles to move them.

We hypothesize that the nonlinear vortex-like motion of CTF creates four different kinds of secondary potential gradients around themselves, so the stable vortices naturally fall into (or pushed away by) each other due to these potential gradients depending upon their mutual manifest properties. Gravitational force can be visualized as purely a *mechanical depression*, like negative potential gradient, imposed on the CTF around particles and their assemblies. So gravitation is universally attractive; where G is the intrinsic property of CTF that becomes manifest as the potential gradient. In contrast, the electromagnetic force, originating out as positive or negative potential gradients imposed on the CTF out of ε_0^{-1} and μ_0 properties. What kind of anti-symmetric motion in a vortex give rise to positive and negative charge-like gradients, still remains to be imagined and visualized. These two forces are long range and hence the gradients extend far out from the particle vortices. The two nuclear forces have been found to be very short range and quite com-

plex by Quantum Chromodynamics [1]. In this present heuristic paper, we will not venture into presenting any detailed map for these two forces. However, we think these forces are also emergent properties onto CTF. They are complex short range positive and negative gradients generated out of vortex-like churning of some of the intrinsic properties of the stationary CTF.

5.3. Resolving Wave-Particle Duality for Particles [33]

Albeit nonlinear, the harmonic undulation of the vortex of energy E has been captured by Schrodinger for a free particle as:

$$\exp\left(-\mathrm{i}Et/\hbar\right)=\exp\left(-\mathrm{i}2\pi ft\right);\ E=hf \tag{19}$$

If we assume the particle of energy E has vortex frequency f, then we have particles as nonlinear harmonic oscillators. We can now re-write the Equation (18), using Equation (19), in terms of rest-frequency ratio of particles-to-electrons as:

$$\left(f_{0,p}/f_{0,\mathrm{el}}\right)=Z/\left(2\alpha\right) \tag{20}$$

The rest frequency for an electron can be computed from $E=hf$ as $f_{0,\mathrm{el}}\approx 1.23\langle 20\rangle$. This also appears to be in the range of highest frequency gamma rays that can be converted into electron-positron pair while being scattered by some nucleon. For CTF, this appears to be the possible boundary between linearly push-able gamma- wave-frequency and localized nonlinear resonant vortex- like oscillations as electrons.

The rest frequency $f_{0,p}$ for any particle will increase to $f_{\mathrm{v},p}$ as the standard *rest-energy* have been found to follow when it is forced to move under some potential gradient (force) with a velocity v:

$$\frac{f_{\mathrm{v},p}}{f_{0,p}}=\frac{hf_{\mathrm{v},p}}{hf_{0,p}}=\frac{m_v}{m_0}=\left[1-\frac{\mathrm{v}^2}{c^2}\right]^{-1/2}=\left[1-\varepsilon_0\mu_0\mathrm{v}^2\right]^{-1/2} \tag{21}$$

We measure this excess energy as kinetic energy of the particle. *One can now appreciate that the heuristic concept of de Broglie wave or* "*pilot wave*" *is unnecessary*. But its internal vortex-like frequency has to increase to achieve higher velocity to overcome the inertial resistance due to ε_0^{-1} and μ_0 of CTF. It is better to refer to them rather than c to appreciate that we are dealing with physical properties of free space and they can be changed (as per General Relativity, through bending of star light by the Sun's gravity).

Since particle-particle interactions are also driven by two steps, phase sensitive complex field-field stimulations as ψ, followed by energy exchange through the recipe $\psi^*\psi$, we can now appreciate superposition effects due to particle beams as localized interactions between harmonically oscillating multiple particles simultaneously stimulating the same detecting molecule and trying to transfer some of their kinetic energy, which mathematically appear to be like wave-wave interactions [33,47]. Thus by imposing IPM-E to visualize particles as vortex-like undulations, we find that QM has more realities built into it than the Copenhagen Interpretation has allowed us to imagine [48]. *Thus*, *our hypothesis*, *particles as vortex-like localized oscillators*, *removes the wave-particle duality for particles.*

5.4. Time Dilatation and Ether (CTF) Drag

Does CTF need to be four dimensional? A deeper enquiry of the measurement process behind time [30,49-51] reveals that there are no physical objects that have t as one of its *real physical* parameters. What we really measure is the physical frequency f of some suitable oscillator. Then invert it to define an element of time interval, $\delta t=1/f$. We get longer measured duration $\Delta t=N\delta t$ by counting N times the number of oscillations. We should not assign any fundamental physical behavior on nature what is not a valid physical parameter of something in nature. Let us recognize that one can successfully model a small subset of a very large complex system by hypothesizing some rules, none of which may precisely coincide with the original fundamental rules behind the entire complex system.

What about observation of extended life time of muons? It is safe to hypothesize that the life time of an off-resonant vortex oscillation is enhanced due to its higher kinetic velocity, somewhat like the extra stability enjoyed by a speeding bike rider. Muon's internal physical oscillation frequency may have altered, but its clock has not changed, because it does not have one.

If CTF is a space filling 3D field, then the old "ether drag" question is brought out again. To propagating EM waves, CTF is stationary. Is it the same for vortex-like particles, or their assembly (planets and stars)? A high energy laser beams can be focused through a pinhole without distorting any of the fundamental properties of the beam. This implies that strong E-vector amplitude is not physically extended in 3D space. Then a stronger E-vector oscillation must be due to a stronger field gradient oscillation, rather than a spatial size of oscillation. If we extend this understanding to particles, vortex oscillations may also be purely temporal oscillatory gradients of different physical properties of CTF. Then the movement of particles under the influence of secondary gradients (forces) does not require dragging the CTF; only the complex set of gradients moves spatially. This is consistent with the following famous observations: 1) Bradley telescope parallax for stars due to earth's motion, 2) Michelson-Morley null experiments to detect earth's motion around the Sun. However, stationary CTF does

not explain 3) positive and null [12] Fresnel drag experiments for moving and non-moving medium, respectively, within an interferometer. Some people believe that Fresnel positive drag is an EM phenomenon within a moving medium [52] and that it is not due to ether drag. Hence, further research is called for and the author has initiated a project to study this.

6. Conclusions

We believe that our proposition of space as a physical Complex Tension Field (CTF), in some form or another, does represent a potentially viable new approach to develop a unified field theory, especially utilizing the postulate that all the four forces are different kinds of potential gradients imposed on the same CTF by the particles. The strength of CTF comes from its capability to accept most of the tenets of the existing theories, while at the same time; it helps clean up much confusion in current physics by simply eliminating the need for quite a few self-contradictory hypotheses, wave-particle duality being the most important one.

Most of the cited papers by this author can be found at this website [53].

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