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Essay competition on: **What Is “Fundamental”?**

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The concept of “fundamental” must keep evolving

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Abstract

Physicists have been searching for the fundamental building blocks and the fundamental laws that govern the universe since ancient times. I will define those sets of building blocks and those sets of laws of interactions as fundamental, which are minimum in number and yet models and explains the maximum number of observable phenomena. We have not found such minimal sets. Because we face a permanent information retrieval problem. No finite set of experiment can extract complete information about any particular object. In our evidence (data) gathering experiments, we study an unknown object by letting it interact with a “known” object. We never know any object completely. So we are forced to approximate, assume, etc. We can keep refining our knowledge through diverse iterations. Mathematical theory is immensely helpful. However, Gödel’s Incompleteness Theorem gives us another limiting block. **Hence, our search for fundamental building blocks and fundamental laws of interactions must keep evolving.**

How to guide this evolution? A working theory, based upon human created postulates and human invented mathematical theories do not automatically guarantee that we can grasp the ontological reality of the universe. We need to adopt the system engineering thinking to keep us grounded to nature’s ontological reality. If an instrument works, then the working rules behind it are allowed by nature. This is not always true for working mathematical theories.

I give an example on how the system engineering thinking, or Interaction Process Mapping Epistemology (IPM-E) applied to mathematical Superposition Principle vs. experimentally observable Superposition Effect, helped me re-discover Non-Interaction of Wave in the absence of interacting media. This has led me to appreciate that space is a Complex Tension Field (CTF), since it allows both the EM waves and particles to emerge as diverse kinds of its oscillations. CTF is the fundamental field that generates the observable universe.

I. INTRODUCTION

Definition of “fundamental”

One of the acceptable ways to define “fundamental”, whether a universal building block, or universal laws of operations behind the incessant cosmic evolution, is, that which will minimize the number of independent postulates necessary to build a unified field theory to cover all observable phenomena. Such a definition will help us understand and appreciate that the universe, after all, is one comprehensible system.

Identification of various limits to the prevailing search for the “fundamental”

We now have too many disjointed theories. Note that all of our most successful theories, from Maxwell's Electromagnetism, to General Relativity, to Quantum Field Theories -- all indicate that the universe is emergent out of some complex field. Historically, we have a set of independent theories built at different times with different cultural modes of thinking, and using independent sets of postulates. We are trying to force fit these theories into a unified *fundamental* theory, without first developing a new coherent set of fundamental postulates to accommodate the emergence of all the particles and the EM waves. We should start all the way back from Newtonian mechanics to the latest particle and cosmology theories. We will explain the existence such a potential field, which we are neglecting to recognize because we have the inherent tendency to follow the success-rut built by our successful, but independent, theories.

To remain objective, explorations must be guided by a well-defined purpose

The prevailing physics thinking behind the successful evidence based science has remained stuck in the success rut of Measurable Data Modeling Epistemology (**MDM-E**). Physics thinking needs to be anchored to the *purpose* of successful human evolution in our biosphere, beyond present Global Warming and in our cosmo-sphere, beyond the demise of the Sun as a red-giant, several billions years from now. Only such a concerted approach will keep physics anchored to seeking out ontological reality of the universe and help us ultimately discover the *fundamental substance* and the *fundamental laws* of operation behind the evolving cosmic system. For that, we need to focus on visualizing the invisible *interaction processes* that are governing the biospheric and the cosmo-spheric evolutionary *processes*. *We need to tie physics thinking with the pragmatic system engineering thinking*. We need to incorporate Interaction Process Mapping Epistemology (**IPM-E**) over and above the immensely successful MDM-E [1]. Focus on understanding the *ontological processes* will lead us to find the cosmic origin of ontological, meaning, real and *fundamental* building block and the *fundamental* laws of operation.

Evidence based science does not provide us with complete information about any objects under analysis.

Obviously, such a search for *fundamental building block* and the *fundamental laws of operation* will have to keep on evolving. The reason is that we are forever challenged to extract complete information about any object, or any entity under study through experiments that create evidential data. We never know complete information about anything in this universe. Therefore, we must use our imaginations to create some rational postulates to close the information gap. Logically self-consistent mathematical theories cannot also guarantee that it will help us extract ontological realities. *Gödel's Incompleteness Theorem* validates this assertion. No working theory is complete. No knowledge is final knowledge.

Cosmo-spheric and biospheric evolutions are dialectical to allow for continuous cycling and re-cycling

Galaxies are formed slowly through gravitational accumulation of thin gaseous particles. Then the condensed gas creates enormous pressure in its core, igniting a prolong set of nuclear reactions. A star is born. The nuclear reaction then evolves in different directions, eventually creating the demise of the stars through supernova explosions, or through prolong states of red giant. Should we try to re-construct the concept of forces such that they are fundamentally dialectical? This approach may eventually direct us to develop fundamental laws that directs us to understand better whether the universe is *fundamentally* a cyclic system, or evolving towards an equilibrium, or towards a death!

The concept of "fundamental" must keep evolving

Our neural logic system has evolved to assure our comfort and survival within the prevailing scientific enterprise. Our culture trains us to conform to the prevailing working rules and theories. Hence, our enquiring minds have the dominant tendency to create new theories that build upon the prevailing working theories. This is very similar to biological evolution. Add new DNA coding on to the existing system to overcome only the new stressful condition. Biology cannot afford to re-build life more efficiently, from the foundation up, using the past knowledge and future projection, and create a more efficient system. However, the independent thinking human mind can rebuild theories fresh and anew from a more congruent new set of coherent postulates, while comparing with the centuries' of past mistakes and future anticipations. For this, we need our physics thinking to be guided by system engineering thinking and scenario playing, while adopting IPM-E, over and above the prevailing MDM-E.

II. Examples of applying IPM-E to seek fundamental substance and fundamental laws

IIa. We have neglected fundamental rule of Non-Interaction of Wave (NIW) of nature in the linear domain

Experimental astrophysics relies on reproducible data on the characteristic properties of light coming out from stars in all the galaxies. They include spectral energy distribution (corroborating Planck's radiation law), discrete emission and absorption line spectra (corroborating quantum mechanical rules as observed on earth), etc. All these light from every individual distant stars and galaxies are passing through the radiation emitted by all those stars that are nearer to us compared to the distant ones. It is obvious that light radiation propagate through each other in the free space without altering (interfering or interacting with) each other's fundamental characteristics, in the absence of interaction facilitating materials. Otherwise, Astrophysical observations could not have been re-producible! This property of light was experimentally underscored by Alhazen a thousand years ago [2], and formally postulated by Huygens in his book [3] almost 350 years ago. Huygens' postulate of non-interacting secondary wavelets is the key foundation behind the Huygens-Fresnel diffraction integral. Modern optical science and engineering could not have been continuing to evolve un-interrupted since 1817 without the mathematical structure given to Huygens' Principle by Fresnel. This Non-Interaction of Wave (NIW) amplitude that is built into this diffraction integral; even though we do not call it out in books [but see ref.1]. In reality, NIW is a generic property of all waves that propagate riding on some tension field. For EM waves, we call this parent tension field a Complex Tension Field (CTF). For, sound waves, it is the pressure tension field held by air. For water waves, it is the surface tension field. For guitar or piano waves, it is the mechanical stretch tension field held by material wires. A careful examination of the second order differential wave equation and its solutions reveal that all waves are linear excitation of the parent tension field. That is why the wave equation accepts the linear superposition (summation) of any linear combination of linear waves. This is the mathematical *foundation* behind the Superposition Principle (SP). So, the physical meaning of SP is that multiple waves can propagate through each other within the same spatial volume provided that the sum total peak amplitude due to all the local waves does not exceed the local effective "Young's Modulus" to preserve the restoration capability of the linear tension field. Fringes that emerge in our detectors as Superposition Effect (SE), is the outcome of a non-linear quadratic *process*.

Detectors execute the square modulus process when stimulated by multiple phase-stable wave packets. This is built into our mathematics. However, lack of implementing IPM-E, we assume that the field amplitudes, by themselves, have created the energy re-distribution. This mistaken assumption has generated the phrase, wave-particle duality. We have now formalized this concept into a *fundamental*

property of waves, even though “duality” implies lack of our knowledge. Neglect of NIW has also forced us to develop a series of non-causal postulates like single-particle interference, delayed choice, etc.

What better physics can we extract using the knowledge of NIW?

IIb. The observable universe consists of various emergent oscillations of the fundamental Complex Tension Field (CTF).

Maxwell’s theory supported the old ether with the physical properties, ϵ_0 and μ_0 since $c = (1/\epsilon_0\mu_0)^{1/2}$. However, Michelson-Morley Experiments (MMX) have conclusively proved that material bodies do not drag old ether. System engineering thinking tells us that a negative experimental result, the absence of “ether drag”, does not validate the absence of the field itself. All it says is that the material particles, or their assemblies, do not drag the “ether” field. This is where we introduce a new physical postulate. The basic elementary particles (electrons, protons, neutrons, etc.) are some form of localized complex EM waves, executing harmonic oscillations, but in the shape of a doughnut or similar vortex-like stable structure. The stability of these *field-particles* comes from their *resonant or in-phase* self-looped oscillations. Note that these are oscillations of different gradient properties generated in CTF. CTF itself is not oscillating. The rate of loss of in-phase motion dictates the finite life of particles. Such a *field-particle*, being an excited state of the parent tension field (fluid), its translational movement through the CTF will not require any physical movement, or drag, of the CTF itself. This accommodates all MMX observations. The energy of the self-looped oscillation is always held by the CTF, just as it is true for the energy of the propagating EM waves. [The same holds true for water waves, sound waves, etc.]. However, inducing translation motion on these *field-particles* will cause resistance by the CTF giving rise to the mass-like inertial property to the *field-particles*, $m_{inertia} = E/c^2 = hf_{in.}/c^2$, where $f_{in.}$ is the internal self-looped frequency of oscillation [Ch.11 in ref.1]. There are no “material” substance in this universe. However, these *field-particles* conform to Newton’s laws of motion for classical particles through its mass-like inertia, $m_{inertia} = hf_{in.}/c^2$. Many people are now developing mathematical framework to model electron, etc., as *field-particles* [4].

Conceptually, the key difference from that of the Einstein’s attempted approach to a unified field theory is that the *field-particles* do not exist separately from the field itself. Both the perpetually propagating EM waves (~25% of the cosmic energy pool) and the totality of *field-particles* (~5% of the cosmic energy pool), are different kinds of excited states of the same CTF. About ~70% of the energy appears to be remaining un-manifest to provide the stability to the dynamically evolving platform of the universe. However, 100% of the energy of the universe always resides in the CTF as its tension energy. The excited state energies of CTF in the form of EM waves and the *field-particles* cannot be arbitrarily assimilated by the CTF itself. This provides the rationale for the observed universal law of conservation of energy. Guided by the cosmic *dialectical rules of interaction forces*, the EM waves and *field-particles* keeps on interacting to create and re-create themselves, through miniscule to macroscopic structures -- generating, vanishing and re-appearing as stars and galaxies. CTF provides the dancing platform of its tension field, which is, otherwise stable and stationary.

IIc. CTF automatically accommodates the effects of the two postulates of Special Relativity, satisfying one key definition of what “fundamental” is:

Accommodating the 1st postulate of SR:

The velocity of light, $c = (1/\epsilon_0\mu_0)^{1/2}$, is the same in all inertial frames of references. We enhance this postulate further as follows. There exists only one physically stationary *inertial* frame of reference in this universe, which is the stationary CTF. Most galaxies, stars and planets exist through their diverse accelerated motions (axial spin and orbital rotations, etc.) under the confluence of mutual gravitational forces. Therefore, only the stationary CTF is the cosmic stationary reference frame with the necessary electric tension and magnetic restoring forces, allowing the EM waves to propagate at the universally constant velocity c . Within a given material medium, closely spaced assembly of *field-particles*, the effective value of $\epsilon\mu$ increases, thereby reducing the velocity of EM waves to $c_{med.} = (1/\epsilon\mu)^{1/2}$ within this assembly. This velocity will suffer from small longitudinal and transverse Fresnel drags, when it is in motion with respect to the CTF [5,6].

Accommodating the 2nd postulate of SR:

The laws of physics are the same in all inertial frames of references. It is true in our CTF model automatically since it is, by definition, the stationary inertial frame of reference for the entire universe. However, it gives us extra physical rationales. The laws of physics are same everywhere in this universe, first, because the specific *field-particles* are same kind of oscillations of the same stationary CTF everywhere in the universe. Further, the space-properties surrounding any atom anywhere in the universe, is the same stationary CTF whether they are within a discharge tube on earth or in the corona of a star. This why the basic laws of quantum mechanics we are finding on earth and our solar system, appear to be systematically valid for all the stars in all the galaxies. Additionally, the basic laws of nature on all earth-like platforms around diverse stars (on which advanced biological species can carry out any experiments) would remain valid as long as the absolute velocities of these *accelerated platforms* (axial and orbital rotation) are very small compared to the velocity of light. All present Astrophysical data validate this assumption.

Thus, we have accommodated the two postulates of SR as *direct causal derivatives* of the stationary CTF, rather than as independent postulates.

IId. Potential experiments to validate the existence of stationary CTF on a satellite or inside a super vacuum chamber.

Stationarity of CTF (with lateral pulse displacement): We can fix a pulsed diode laser and a precision position-sensing detector at the two ends of a rigid *bar*, keeping the space between them empty for light propagation. The light pulse is propagating in the free space (in CTF). If the *bar-vector*, and hence the light *Poynting-vector*, are collinear with the satellite *velocity-vector*, the light pulse will arrive at the center of the detector array [see Fig 1a on the very last page, “endnote”]. If we make the *bar-vector* and the satellite *velocity-vector* orthogonal to each other, the light pulse will arrive at a laterally displaced location because the Poynting vector of the light pulse will always follows the stationary CTF medium [see Fig 1b and c on the very last page, “endnote”]. We can quantify this from the length of the rigid-bar, the velocity of the satellite and that of light [7].

Stationarity of CTF (with no lateral pulse displacement): In the second instrument, the rigid bar is a glass rod and the pulsed diode laser and the detector are rigidly fixed at its two ends. The light propagates through the glass rod. In this set up, irrespective of whether the glass-rod-vector is orthogonal or parallel to the velocity-vector of the satellite, the light pulse will always arrive at the same central spot of the detector, fixed on the other end. Only the arrival time will be delayed due to the reduced velocity of the

light c/n . The glass rod, not the CTF, now dictates the direction of the Poynting vector, or the propagation of the light pulse. One can quantify the miniscule longitudinal and transverse Fresnel Drags for the moving glass rod (satellite velocity) using electromagnetic theory [5,6].

Significance of the proposed experiments:

(i) Stationarity of the CTF will change the very *foundation of physics thinking*. (i) Stationary CTF will justify the cause as to why the laws of physics (Astrophysics) are the same for all galaxies. Since all planets spin and rotate, no planet-based laboratories should be considered as an inertial frame of reference for physics experiments. (ii) The new models for the elementary particles must be developed without the need for Dark Matter and Dark Energy. (iii) Since the two basic postulates of the SR are automatically accommodated within the stationary CTF, 3-D space will be restored for advancing physics through a single CTF field. (iv) Since the expanding CTF would continuously change the physics of elementary particles (self-looped oscillations), the model of the Expanding Universe have to be re-visited. (v) Stationary CTF also implies the dominant portion of the Cosmological Redshift simply cannot be due to Doppler Shift [7]. (vi) Etc., Etc.

Ile. Application of our fundamental epistemology to Cosmology

Redshift is due to weak energy dissipation of EM waves in the CTF

At present, the dominant explanation behind the Cosmological Redshift is due to Expanding Universe (expansion of the space) [8]. Since we universally accept $c = (1/\epsilon_0\mu_0)^{1/2}$, ϵ_0 and μ_0 are the intrinsic physical properties of the space. These values will change with the expansion of the space causing change in the velocity of light. Astrophysics has never accepted or reported any variation of c in the free space.

We do not think that the cause of Cosmological Redshift is completely due to Doppler Effect either. We know that the physical properties of a medium completely determines the velocity of light. Velocity of the light emitting atom or the molecules has no contribution to the velocity of the emitted light. However, the effective velocity of light emitting atoms or molecules with respect to the stationary CTF determines the resultant Doppler Frequency Shift. This is the real physical frequency shift since this shift continues forever through the CTF. The Expanding Universe model does not consider that the distant galaxies are having absolute relative very high velocity with respect to the stationary space. They are apparent velocities due to expansion of the space. Accordingly, the atoms and molecules in these distant galaxies are not physically experiencing these enormous velocities. Hence, the observed redshift cannot be due to the Doppler Effect. Since the measured effect has been validated for over a century, they are real. We suggest that it is due to linear distant dependent energy dissipation property of EM waves. We have used Hubble's relation and have back calculated this energy dissipation factor, using Hubble's relation. The dissipation, of course, is proportional to the Hubble constant ($2.5 \times 10^{-18} \text{ sec}^{-1}$) [9].

Ilf. Application of our fundamental epistemology to Quantum Mechanics

Removal of wave-particle duality by differentiating Mathematical Superposition Principle (SP) from the Observable Superposition Effect (SE):

We have already underscored that there are no material substance in this universe, in the Newtonian sense. The intrinsic *rest-energy* for field-particles, in terms of its self-looped frequency, is given by $E_{rest} = hf_{in}$, where f_{in} is the intrinsic harmonic frequency. This is easily corroborated by Schrodinger's "wave"

representation for any free particle, $\psi = \exp(i2\pi f_{in}t)$, which is at the foundation of successful Quantum Mechanics (QM). $\psi = \exp(i2\pi f_{in}t)$ does not exclusively represent a “plane wave”. It can also be a localized harmonic oscillator function. Even classical mechanical pendulums and electrical LCR oscillatory circuits are modeled and analyzed by using similar harmonic functions. We do not require wave-particle duality to explain observed Superposition Effects. It is always the detector and its dipolar quantum properties that dictate the observability of the superposition effects. Let us represent the two linear amplitudes of stimulations of the same detecting dipole by $\psi_{1,2} = \chi_1 a_{1,2} \exp[i\phi_{1,2}(t)]$, where χ_1 is the linear polarizability of the detecting dipole for the allowed quantum transition induced by two incident phase-stable signals. We express the Superposition Principle (SP) as the ongoing joint amplitude stimulations of the same detecting particle as, $\psi_1 + \psi_2$. However, SP is not an observable phenomenon; it only represents the excited state of the detecting dipole. We correctly represent the observable fringes due to energy exchange, and consequent physical transformation of the detector as the square modulus of the joint stimulation, $\{sq.mod.(\psi_1 + \psi_2)\}$. *Causality does not allow a single stable elementary particle to carry more than one physical value for the same physical parameter.* Therefore, we need to acknowledge that the amplitudes $a_1 \exp[i2\pi vt]$ and $a_2 \exp[i2\pi v(t+\tau)]$ represent two in-phase EM waves of same frequency, or two particles of same velocity. That the simultaneous presence of two independent optical signals from the two opposite sides of the beam-combiner of a Mach-Zehnder interferometer are a critical requirement to observe SE for EM waves, has been demonstrated [10]. To establish that the same causality holds for particle in SP and SE experiments, the same paper has also proposed a double-slit interference experiment using mono-energetic beam of Rb-atoms. The fringes of superposition should be recorded on a thick photographic emulsion of Ag-Halide crystallites. After development of the photographic plate, a white light illumination will show the expected two-slit dark and bright interference fringes. However, if the plate is illuminated by a coherent Rb-resonance radiation at an angle, the glow of the resonance radiation will closely resemble a Gaussian-like intensity distribution (arrival of scattered Rb atoms) [Ch.11.5.2 in ref.1]. Note that particles are localized oscillators. They possess two kinds of oscillations. One is doughnut-like internal oscillation for its very existence, $E_{rest} = hf_{in}$. The other second harmonic oscillation is a velocity dependent kinetic energy, $E_{kin.} = hf_{kin.}$. This “kinetic frequency” approach is congruent with the origin of particles in our model of CTF. It also removes the “infinity problem” in de Broglie’s assumption about particles that at rest, $v = 0$, they have infinitely long Broglie-wavelength, as implied by $\lambda = h/mv$.

For both the cases of superposition experiments, whether using light beams or particle beams, the dark fringes are generated due to the absence of physical stimulations. *This is not*, as is historically assumed, *due to non-arrival of “photons” or particles at these dark-fringe locations.* The dark-fringe locations are also active sites. However, here the two out-of-phase stimulating signals arrive simultaneously on the same detecting element, *suppressing its possible excitation.* Hence, these un-excited elements cannot absorb energy, representing “dark fringe” in our record.

III. Conclusion & Comment

To the question, “What is “fundamental?””, we have given a broad definition that should satisfy most physicists – that approach which minimizes the number of necessary postulates and maximizes the number of observed phenomena covered. However, we then focused elaborating the various reasons as to why our quest for fundamental building blocks and fundamental laws of the universe are still wandering around, still in question. We have then underscored that this quest must always keep on evolving since

we cannot create a complete theory given that we always have to start from a platform of partial knowledge at every step. Experimentally, we will always suffer from information retrieval problem. Mathematically, we will always suffer from Gödel's Incompleteness Theorem. However, to anchor our quest to access nature's ontological reality in incremental and evolutionary steps, we must adopt the system engineering thinking, guided by the proposed tool of Interaction Process Mapping Epistemology (IPM-E), over and above the prevailing Measurable Data Modeling Epistemology (MDM-E). We have concluded that our search for fundamental substance and the fundamental laws must keep on evolving, just as our mind keeps evolving with the acquisition of newer knowledge by us.

We have also applied IPM-E to underscore logically that our observable universe does consist of emergent oscillations in the stationary Complex Tension Field (CTF). We have been failing to properly identify CTF because of our prevailing physics thinking does not accommodate IPM-E, which is essential to keep our enquiring thinking towards ontological reality.

To support the existence of the stationary CTF, we have presented two very simple satellite-based experiments. The concept behind these experiments have been constructed accepting the validity of Michelson-Morley experiments that there is no drag of the CTF against moving material particles, which are assemblies of vortex-like oscillating *field-particles*. I have also proposed a double-slit Rb-atom diffraction experiment to validate that the postulate, wave-particle duality, is unnecessary when we realize that particles are vortex-like oscillation of the CTF.

I am eagerly looking forward to potential collaborators to carry out these proposed experiments by submitting joint proposals to appropriate agencies and/or organizations. I am also looking forward to major philanthropist donors who are willing to help organize and guide a new research institution that will focus on the development of theories that will stay focused on digging into ontological realities (fundamental substance and laws) utilizing IPM-E and system engineering thinking. I will request such people to recognize the following. If the presented and well-grounded postulate of CTF is correct, then 100% of the energy of the universe is in this universal CTF field. Then consider this possibility. One of the funded innovative system engineer succeeds in discovering how to "mine" this ubiquitous energy from anywhere and everywhere. Humankind will not have any more energy problem. Consider further that another engineer invents a spaceship engine, which can propel itself by re-cycling the space-energy wherever it is located in its journey into the deep space! We would not need to carry many "bus-loads" of explosives and create multiple stopping stations to re-fuel! Let us jointly organize such a far-sighted research foundation to understand the detailed properties of the ultimate fundamental field of the universe. All observable waves and particles are different kinds of emergent dances of CTF. Einstein's dream can be fulfilled finally!

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Proposed space experimnt to validate that the Complex Tension Filed (CTF) is the universal inertial refrence frame

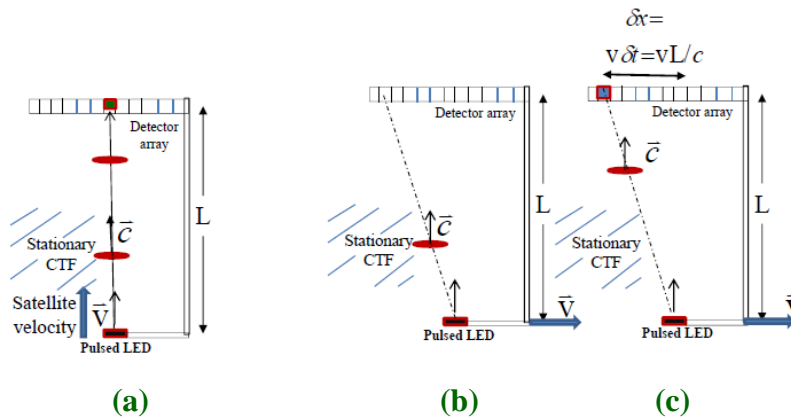


Figure 1. Two views of the proposed sensor on the satellite platform. **For (a):** When the velocity vectors for the light pulse and that of the satellite (thick blue arrow) are parallel to each other, the light always arrives at the calibrated center of the detector array. **For (b) and (c):** When the light velocity vector is orthogonal to the satellite velocity vector; the pulse Poynting vector continues “vertically” in a straight line in the frame of stationary Complex Tension Field (CTF), traveling the fixed vertical distance L . However, an observer sitting on the moving satellite platform, would perceive the light pulse propagating along the longer dashed line while the rigid structure of our sensor, attached to satellite, keeps moving to the right. So, the light pulse will arrive displaced to the left by $\delta x = v \delta t = v L / c = 78 \mu$, for a satellite velocity of 7.8km/sec. Note that the light pulse itself is not traveling a longer path implied by the tilted dashed line. Light propagation does not get influenced by an observer looking at the apparatus.