Could space be considered as the inertial rest frame?

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========= Slide #1 ========

Abstract

We take the postulate of Special Relativity, that the cosmic rules observable through physical phenomena, are the same for all stars in all galaxies. We have deliberately avoided using the phrase; "in all inertial frames of reference" to avoid conceptual mathematical debate in defining what such frames of references are [1-4]. Then, accepting the universal validity of light velocity defined by Maxwell's wave equation, $c^2 = 1/(\varepsilon_0 \mu_0)$; we revive the old ether concept with physically descriptive phrase that space is a continuous Complex Tension Field (CTF). This is strengthened by the fact that all non-dissipative tension fields allow for perpetual propagation of waves when excited within its linear restoration capability. We accommodate the particles as localized self-phase-looped resonant oscillations of the same CTF; thus integrating particles as another kind of excited states of the same CTF [5]. Further, all tension fields allow co-propagation and cross-propagation of multiple waves (preservation of wave properties and the respective Poynting vectors) through the same physical volume (linear Superposition Principle) in the absence of perturbing resonant detectors within the volume of superposition. We have re-named this universal property of all waves as Non-Interaction of Waves [6,7]. Thus, Doppler shifted waves from different stars and galaxies can cross through each other unperturbed while bringing to us the signatures of the properties of their parent stars. Now, if these light signals are waving of CTF, the optical Doppler effects must also be, as for sound waves in air pressure tension field, discernable into two different frequency shifts: as due to (i) source velocity (distant stars) and (ii) detector velocity (that of the earth) [8,9]. In other words, we are proposing that CTF (modified old ether) is the stationary cosmic rest frame. Since we have been routinely assuming that quantum phenomena are same in all stars; we strengthen our position by analyzing the origin of absorption lines in distant stars as the same energy level transition phenomenon as we observe on earth and well-modeled by precision spectrometry and validated by QM formalism. The analysis also reveals that Cosmological (Hubble) Redshift cannot be due to optical Doppler Effect; since the Doppler Effect is determined by the velocities of the source-atoms within the star coronas. We have also proposed a satellite based one-way light propagation measurement; which could identify the absolute velocity of the satellite and validate that CTF is the stationary rest frame for our observable universe.

Key words: Inertial reference frame; Ether as Complex Tension Field (CTF); Stationary Complex Tension Field; Velocities of source and detector in optical Doppler Effect; Cosmological Redshift; Hubble Shift not Doppler Effect

========= Slide #2 ========

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======== **Slide #3** ========

Ambitious vision with persistent humility is the key virtue to frame, re-frame, and re-frame enquiring questions to understand nature!
Framing the question determines the answer. But the questions are always subject to individual's overall culture driven upbringing, thinking and conscious/sub-conscious purpose!

"I do not know what I may appear to the world; but to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me."

"If I have seen further than other men, it is by standing on the shoulders of giants."

- ❖ Today we are both fortunate and confused. Our guiding giants, individually, have discovered many realities of nature, but they are not merging seamlessly into one harmonious "picture".
- ❖ We need to initiate a collective and collaborative approach to re-visit and re-construct the foundational hypotheses behind the most successful theories.
- ❖ We need an iterative approach to enhance the theories by incorporating *Evolution Process Congruent Thinking (EPC-T)* over and above the currently successful approach of Measurable Data Modeling Epistemology (MDM-E) [10].

Nature has been telling us, through all successful theories of physics, that the "empty space" is full of rich physical properties

➢ Electro-statics: Electric tension ε_0^{-1}

➢ Magneto-statics: Magnetic (restorative) tension μ_0

➢ Electromagnetism: Part of a Complex Tension Field, allowing light velocity $c^2 = (\varepsilon_0^{-1} / \mu_0)$

  Compare this with guitar string wave velocity $V^2 = (T / \sigma)$

➢ General Relativity: Gravity as the "Curvature of space " [potential gradient in some Complex Tension Field, or CTF]

➢ QM, QED, QCD, String theory: "Zero point energy", "Background fluctuations", "Quantum Foam", etc., etc.

There is a fundamental problem for a theory that validates only measurable data and ignores how to map the underlying physical interaction processes that give birth to the data. We can only measure some physical transformation due to some energy exchange between the interactants; not the preceding stimulations preparing them to undergo transformations! What are the differences between a stimulating force and the exchange-able energy units? What is the physical origin of statistical fluctuations? What fluctuates? What really foams? Is not physics supposed to explain the interaction processes that facilitate the measurable transformations?

It does not make sense to describe cosmic space as a real vacuum and negate that it is some form of a Complex Tension Field (CTF); the old ether with modified properties.

Elementary school experiment tells us that the space between two annular magnets, facing with same polarity, is not empty; the space holds at least two different fields –magnetic and gravity!
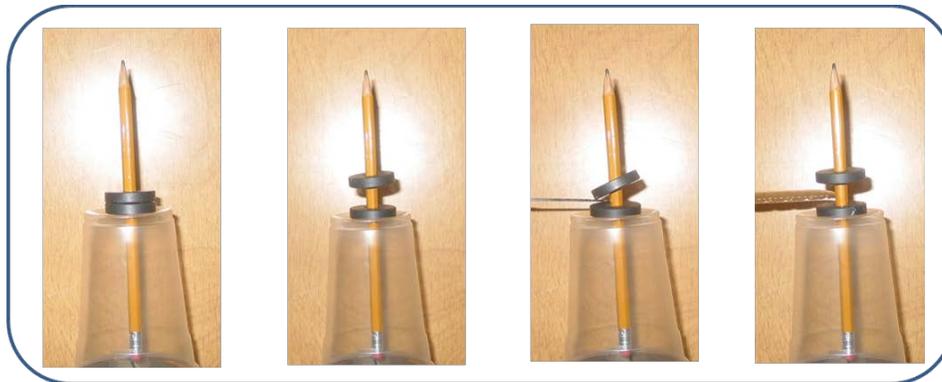
Annular magnets with opposite polarity attracts each other.	Annular magnets with same polarity repels each other. Space between them has "magnetic tension" that helps the upper magnet floating against gravitational tension.	A still blade changes the "magnetic tension" from repulsive to attractive by creating opposite polarities on its two sides.	An wooden blade, being "non-magnetic" does not alter the "magnetic tension" of the space.

The key postulates:

1. **CTF:** Space holds 100% of the energy of the universe as a stationary Complex Tension Field (CTF)
2. **Waves:** EM waves are perpetually propagating oscillations of the CTF as its oscillatory gradients triggered by some **linear excitations** by various material dipoles.
3. **Particles:** Particles are localized and resonant (quantized) self-looped ("smoke-ring", "doughnut"?) oscillations of the CTF triggered by some **non-linear excitations**.
4. **CTF Stationary:** The various primary, secondary and tertiary tension gradients, change in space and in time; not the macro body of the CTF.

Consequences:
1. Linear oscillation propagates perpetually as EM waves (radio waves to Gamma rays)
2. The localized non-linear resonant oscillations, or their assemblies (particles, atoms and molecules, etc., moves (acquires velocities) with respect to the stationary CTF due to the different spatial gradients generated by them. These represent various forces.
3. The quantum properties (behavior) of quantum particles, atoms and molecules, remain identical, whether they are in inter- or intra-galactic dust, or in the stars, or on the planets.
4. Spectral properties (emission and absorption) are invariant across the galaxies. Local physical conditions influence local behaviors.
5. Most of our experimental knowledge about cosmology comes from spectral studies and are correlate-able with earth-based spectrometry. This validates assertions #3 and #4.
6. The very foundation of Quantum Mechanics was also triggered by spectrometric measurements (Ritz-Rydberg formula, Planck's Blackbody radiation, Bohr's Hydrogen atom, modern QED, etc.
7. Measurable Doppler spectral shifts (actual due to source movement; apparent due to detector movement) are separately due to local velocities of emitters and detectors with respect to the stationary CTF. This is a new assertion; bringing back Doppler's original assertion.
8. Only a fraction of the Cosmological Redshift could be due to Doppler Effect! Most of the Redshift is acquired by the background white light during its long journey across the universe. Another new assertion that raises doubt about the conclusion of "Expanding Universe" based upon Hubble's Doppler Shift.
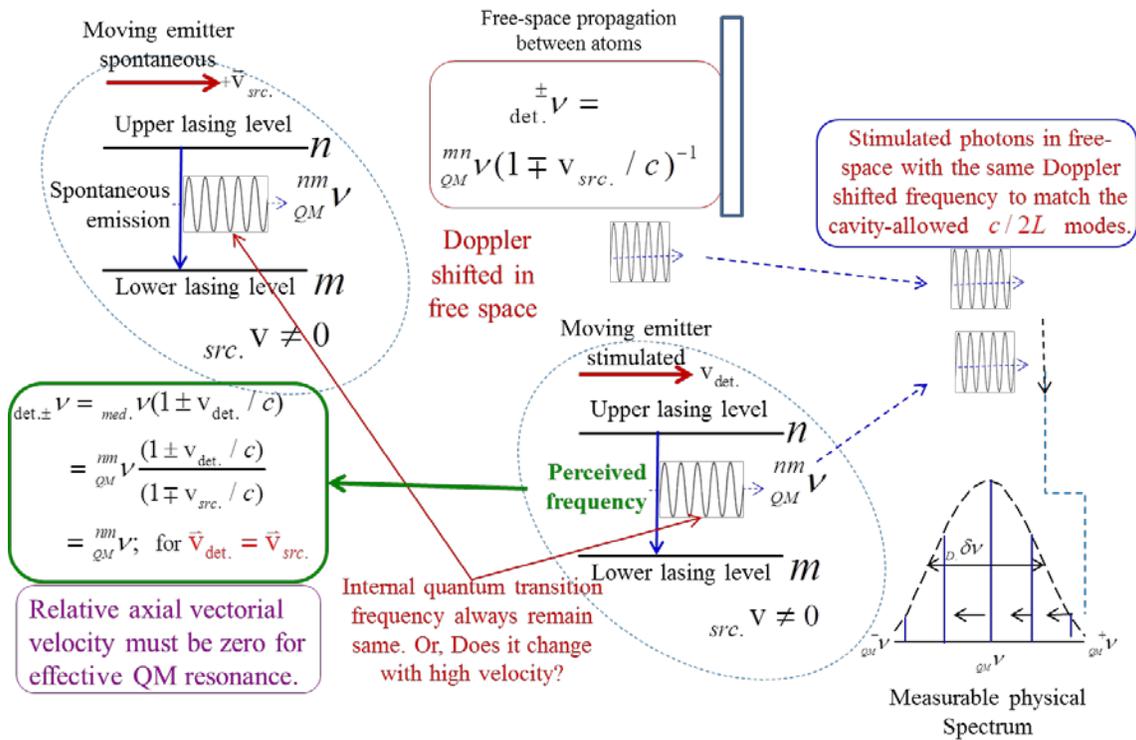
I. The separability of Doppler effects due to source and detector velocities; hence the star's "local" velocity as identifiable through clever experiments.

1. We have been assuming, without supporting logics, that spectral properties (emission and absorption) are invariant across the galaxies. It turns out to be a correct assumption! The physical laws are same in all stars.
2. The spectral properties of atoms in a discharge tube on earth are the same as in the corona of a star in a distant galaxy – atoms are local oscillations of the same stationary universal CTF, but at different statistically-averaged local temperatures, whether in a discharge tube on earth or inside the corona of a distant star. The properties of the inter-atomic space (CTF) are the same, whether we consider the case of a laboratory discharge tube here or the corona of a distant star.
3. The next slide analyzes how an excited atom in a laser can produce a stimulated emission with a matching frequency with the stimulating wave frequency. They must have "absolute" and identical vectorial velocity (or zero relative velocity) with respect to each other. Understanding the detailed **physical processes** behind a laser function reveals a lot more realities of the atomic world than the original theories have postulated. In 1917 Einstein (in his paper on stimulated emission) could not have anticipated longitudinal laser modes in an in-homogeneously broadened gas laser cavity.
4. A similar attempt to understand and compare the physical processes behind the generation of the characteristics of absorption spectra from earth-based discharge tube and star-based corona discharge

atmosphere, reveals that the absorptions lines that we measure sitting on earth were fully formed at the outer corona of a star due to absorption of white light generated at the inner corona of the same star. A dark spectral absorption line represents absence of physical signal (light) in a particular frequency interval. The intrinsic properties of a "dark line' cannot be altered as it is not a physical signal. So, the Cosmological Redshift suffered by the absorption line center happens during long distance propagation of the white light due to properties of CTF and its contents along the way. The entire frequency band of white light undergoes redshift. Hence, the position of the dark line shifts. But, the absorption line width remains unchanged. So, cosmological redshift is not a Doppler Effect! (See slide #11).

========= **Slide #9** =======

The physical processes behind the spontaneous & the stimulated emissions tell us that source & detector velocities are discernible for actual & apparent Doppler Shifts!
Optical Doppler Effect is not determined by the source-detector relative velocity alone, albeit mathematically correct, after approximations!

Moving emitter spontaneous

Upper lasing level n

Spontaneous emission $\quad {}_{QM}^{nm}v$

Lower lasing level m

${}_{src.}v \neq 0$

Free-space propagation between atoms

$${}_{det.}^{\pm}v = {}_{QM}^{mn}v(1 \mp v_{src.}/c)^{-1}$$

Doppler shifted in free space

Moving emitter stimulated $\quad v_{det.}$

Upper lasing level n

Perceived frequency $\quad {}_{QM}^{nm}v$

Lower lasing level m

${}_{src.}v \neq 0$

Stimulated photons in free-space with the same Doppler shifted frequency to match the cavity-allowed $c/2L$ modes.

$$\begin{aligned} {}_{det.\pm}v &= {}_{med.}v(1 \pm v_{det.}/c) \\ &= {}_{QM}^{nm}v \frac{(1 \pm v_{det.}/c)}{(1 \mp v_{src.}/c)} \\ &= {}_{QM}^{nm}v; \text{ for } \vec{v}_{det.} = \vec{v}_{src.} \end{aligned}$$

Relative axial vectorial velocity must be zero for effective QM resonance.

Internal quantum transition frequency always remain same. Or, Does it change with high velocity?

${}_{QM}^{-}v \qquad {}_{QM}v \qquad {}_{QM}^{+}v$

Measurable physical Spectrum

Use Doppler shift spectrometry to determine the absolute vectorial velocity of the Sun with respect to the stationary CTF

Send a rocket with a spectrometer at an elliptical orbit around the Sun that will have widely varying velocity during its orbiting. Slowly rotate the calibrated spectrometer on-board and keep recording a selected strong spectral line whose Doppler-free line center is well-known. When the spectrometer exactly registers this line center without any Doppler shift, the vectorial velocity of the rocket at that moment is identical to that of the absolute *vectorial velocity* of the Sun with respect to the stationary CTF.
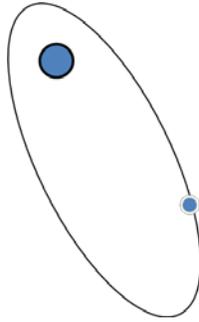
$$_{det.\pm}\nu = {}_{med.}\nu(1 \pm v_{det.}/c)$$

$$= {}_{QM}^{nm}\nu\frac{(1 \pm v_{det.}/c)}{(1 \mp v_{src.}/c)}$$

$$= {}_{QM}^{nm}\nu; \text{ for } \vec{v}_{det.} = \vec{v}_{src.}$$

$\vec{v}_{rocket} = \vec{v}_{Sun}$ when the spectral line center registers ${}_{QM}^{nm}\nu$.

Is it possible to determine the absolute vectorial velocity of a distant galaxy?

➤ The same technique as that proposed for the Sun can be applied in principle for any distant galaxies. Unfortunately, our rocket technology and signal retrieval techniques are too primitive to validate this idea by sending a rocket to a distant galaxy. But:

➤ A similar but steeper elliptical solar orbital rocket can be utilized, using a good sensitive spectrometer and a large telescope directed towards the desired galaxy:

$\vec{v}_{rocket} = \vec{v}_{galaxy}$ when the spectral line center registers ${}_{QM}^{nm}\nu$ [See the slide #8 for the formula; left lower box]

Understanding the physical processes behind the Doppler shift induced line broadening implies Cosmological Hubble Redshift is not due to Doppler Effect.
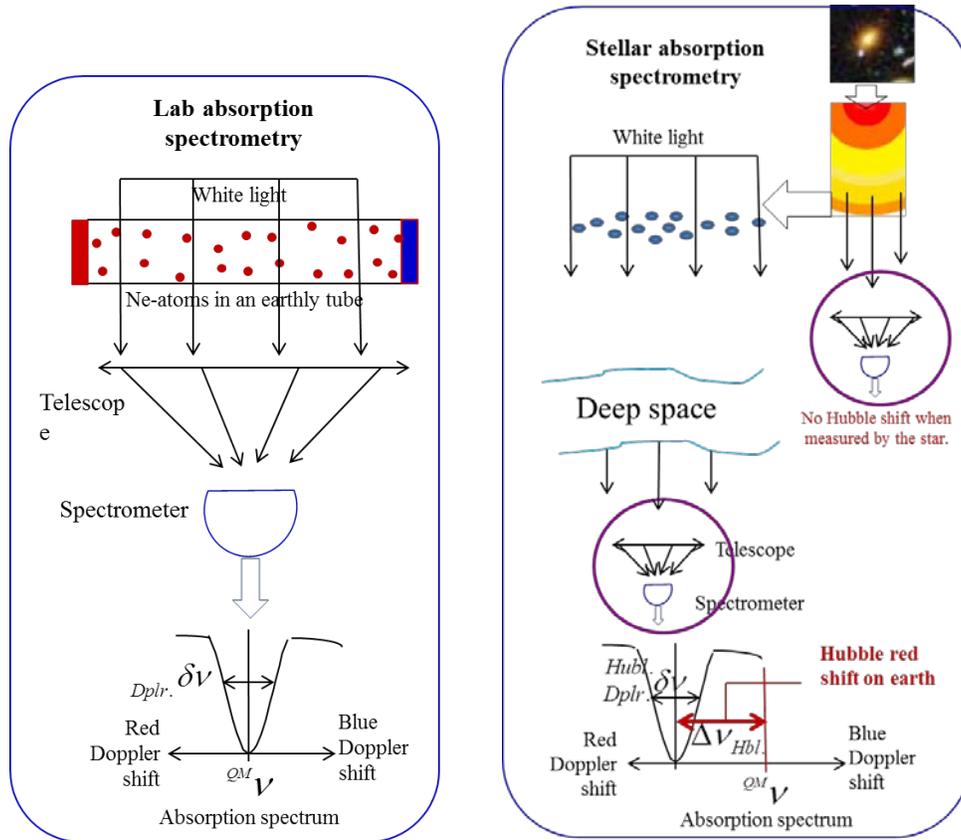
Do the atoms move with respect to the "star-frame", or the "earth-frame", or the "lab-frame" or the "vacuum-frame" (CTF)?

We posit that it is the "Vacuum-rest frame" (CTF), which is stationary everywhere!

The emission linewidth is determined by the velocity of the emitting atoms with respect to the stationary vacuum (CTF), whether in a discharge tube on earth; or in the outer corona of a star.

 # As in the case for the stimulated emission frequency, the absorption freq. is also determined by the velocity of the "detector-atom" only!

Absorption lines represent absence of real signal. They cannot undergo physical changes (Doppler Shift)! It is the white light, generated in the inner star-corona, develops the absorption dark line while emerging out of the outer corona. These broad white light frequencies undergo uniform *Cosmological Redshift* during their long journey through the *cosmic space*. Hence, the "absence-of-signal" dark lines appear to be shifted under our spectrometric display on the earth. The width of the original absorption lines remains determined by the average temperature of the outer corona.
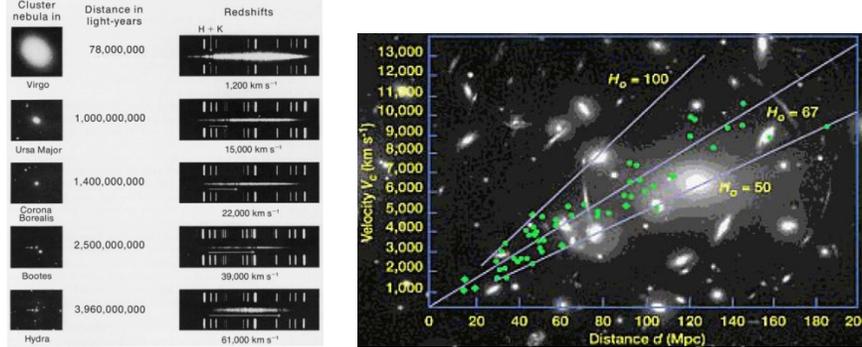

Sources: http://astro.wku.edu/astr106/H_K_redshift.jpg

Ongoing exoplanet detection by Doppler shift measurement due to relative velocity

The measurement approach relies upon measurement of differential Doppler frequency shift equating with the differential relative velocity

$$\delta \nu = {}_{QM}^{nm}\nu(\delta \mathrm{v} / c) \tag{1}$$

The key assumption is that the quantum transition frequency ${}_{QM}^{nm}\nu$ is same in all galaxies!
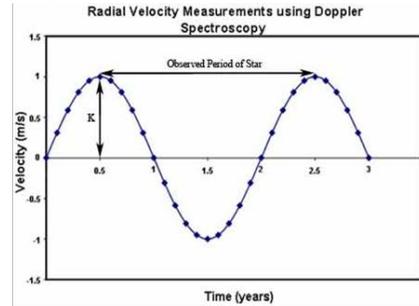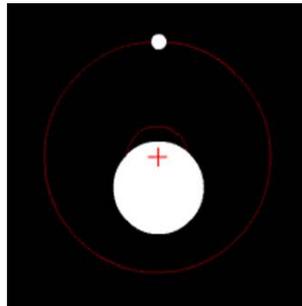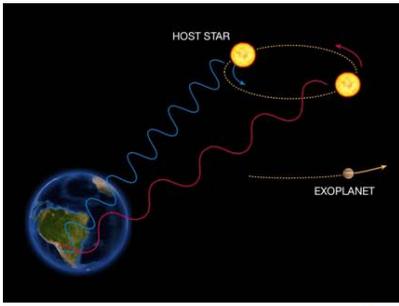
https://en.wikipedia.org/wiki/Doppler_spectroscopy

The total effective Doppler shift experienced by a moving detector, when the source is also moving, would be given by Eq.2. Here the subscripts have been changed to reflect optical emission and detection. However, this formula is identical to the one for the case of sound – source and detector are both moving with respect to stationary air [16]; in our case, the CTF is stationary.

$$\text{det.}_{\pm}\nu = {}_{QM}^{nm}\nu \frac{(c \pm \mathrm{v}_{\text{det.}})}{(c \mp \mathrm{v}_{src.})} \tag{2}$$

$$\text{det.}_{\pm}\nu = {}_{QM}^{nm}\nu\left(1 + \delta\mathrm{v}/c\right); \text{ for } \mathrm{v} \ll c \tag{3}$$

$$\delta\nu = {}_{QM}^{nm}\nu(\delta\mathrm{v}/c) \tag{4}$$

Eq. 1 is identical to Eq.4. It is derived by approximating "sound wave" Doppler shift formula re-cast for spontaneous emission frequency emitted by atoms having an "absolute source velocity" and the spectrometer having its own "absolute detector velocity" with respect to the stationary CTF. By taking the approximations and measuring only the differential frequency, we are losing the opportunity discover the capability to measure the absolute velocity of stars and earth. We need to set up our spectrometers to measure absolute frequency.

======== **Slide #15** ========

Atomic clocks "zero" the Doppler shift by zeroing the absolute velocity to achieve super stable Invariant Clock

➢ Consider the invariant atomic clock at absolute zero temperature [17].
➢ Zero Doppler shift of the emitted EM wave frequency when the source is maintained at the zero degree absolute. The natural line width is an artifact of our measurements. [See ref.11, Proc. SPIE Vol.9570-31 (2015)]
➢ The satiability of the atomic clock remains same on the Earth suffering from five different velocity vectors. In a satellite, the atomic clock is suffering from seven, two more velocity vectors, its own spin and its orbital velocity w.r.t. earth.
➢ So, the quantum transition energy and the frequency are invariant at absolute zero irrespective of the macro velocities of the macro container. The atoms are at rest w.r.t to the absolute space, vacuum or CTF; even though the encasing container is moving. *It makes sense to hypothesize elementary particles as self-looped vortices of a universally stationary CTF.*

======== **Slide #16** ========

M-M and ether "drag" experiments can be explained by considering EM waves and particles as diverse types of oscillations of the "vacuum", treated as a stationary Complex Tension Field.

1. The concept of "ether" has not been wiped out by MM experiments.
2. A moving mirror approaching an oncoming light pulse will reach it earlier than a stationary one. That is how we do all precision interferometric measurements.
3. Bring the pulse laser in an MM experiment. How far the vertical mirror should be so that a pico second pulse misses it? [See figures in slides #17 and #19]

Michelson-Morley null result does not invalidate the existence of"ether" [or, the Cosmic Tension Field (CTF)]
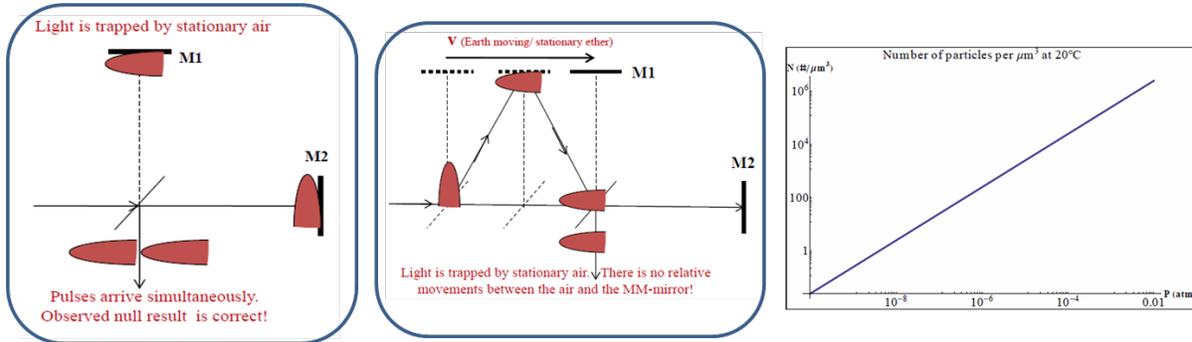

> ➤ A light pulse keeps traveling along its original Poynting vector direction. A light pulse does not try to follow the center of a transverse moving mirror as has been implied by "path delay" computation for M-M experiments. The vertical beam would go straight up in the lab frame and come straight down. If the lateral size of the mirror is not wide enough and it laterally moves far enough (during light pulse's vertical travel); the pulse may completely miss the mirror and never get reflected! [See figures in slides #17 and #19].
> ➤ M-M experiment measure relative phase difference between the returned beams. The set up does not directly measure light velocity. Drawing inference becomes complex because CTF, that sustains the EM waves, is stationary and even the air is stationary with respect to the interferometer!
> ➤ The vacuum machines of 19th and 20th century was not good enough to simulate pure vacuum (CTF), as in deep space. 100 particles per micron cube, giving 10<-6> atmosphere is still a physical medium for light. Light velocity will remain "trapped" by the refractive index of the thin air.
> ➤ Modified space experiment is suggested in the next slide.

(i). F. Selleri, "Noninvariant one-way speed of light and locally equivalent reference frames"; Found. Phys. Lett. 10, 73-83 (1997)
(ii). S.J.G. Gift, "Successful Search for Ether Drift in a Modified Michelson-Morley Experiment Using the GPS"; Applied Physics Research Vol. 4, No. 1; February 2012. www.ccsenet.org/apr

We need to measure the real velocity of light. M-M experiment tries to measure relative phase difference; not the real velocity!
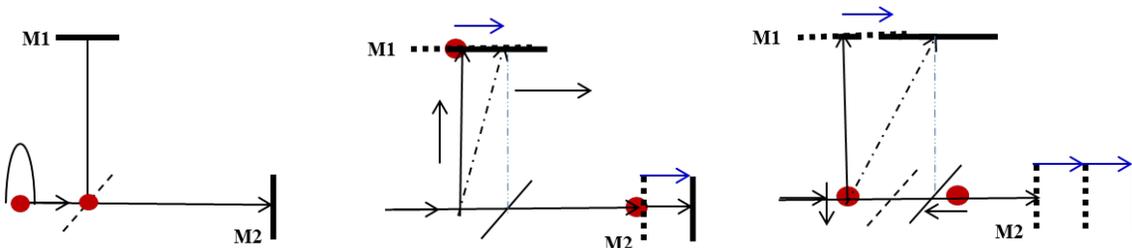
A short pulse of light illustrates the point. The M-M interferometer is immersed in stationary air and stationary CTF. Light travel direction is completely controlled by the Poynting vector on the wave front, not by the direction of the movement of the interferometer. So, the pulse on its vertical journey, on arrival, may just get reflected from the edge of the top mirror. On its return, it may not even encounter the beam splitter, if the interferometer vertical arm-length

is made very very long! Light does not travel along elongated triangular paths in M-M interferometer as are depicted in all papers and books. The top mirror may translate laterally; but the light travels straight vertically up and down; except for suffering transverse Fresnel Drag if the M-M interferometer moves with respect to the air. This transverse Fresnel Drag is positive, but negligible. No *interferometry* experiment can un-ambiguously discern the "ether problem" either in air or in the vacuum.

<center>======== **Slide #19** =======</center>

The running time cannot be dilated (or contracted). Such a human-assigned physical property cannot be experienced by any physical object as it is not an alterable true physical parameter (variable) of any object.

- ➢ Diverse kinds of oscillatory *frequencies* of observable bodies are measurable and also alterable physical parameters.
- ➢ Human ingenuity has devised the technique of measuring the frequencies of such "material" oscillators. We then invert the frequency and define that as a brief "time period".
- ➢ We bring in the semblance of measuring the running time by counting a large number of frequencies (periods).
- ➢ The alteration (contraction or dilation) of physical frequencies can be effected by natural processes, or by crafty human experiments.
- ➢ Thus, running time is a secondary (derived) parameter in Homo sapiens invented theories. We need it, as time in intervals, to accommodate velocity of objects through the 3D space.
- ➢ The same logic is also applicable to another very important parameter, the *temperature*. It is a secondary parameter constructed by our theory out of average velocity of molecules in the air or in an enclosed box. We can affect the change in the secondary measurable parameter, temperature, but only by changing the primary parameter, the average velocity of the air molecules.
- ➢ To underscore the "primacy" of a physical parameter while modeling any natural phenomenon, let us cite another example. $\nu\lambda = c = (\varepsilon_0^{-1} / \mu_0)^{-1/2}$. $c = (\varepsilon_0^{-1} / \mu_0)^{-1/2}$ is clearly a derived parameter out of the tension parameters of the "free space" (CTF). Of ν and λ, ν is the primary parameter as it is (i) determined during emission by the intrinsic oscillatory property of the source and further, it remains constant while the light pulse is propagating through different media experiencing changes in λ due to changes in the effective tension field properties (refractive indices) of the medium, $c_{med} = (\varepsilon_{med}^{-1} / \mu_{med})^{-1/2}$. In fact, Planck underscored that he had to switch to using ν, instead of using λ, to succeed in correctly deriving the Blackbody radiation formula.
- ➢ We can certainly assign secondary or tertiary theoretically needed parameters the status of a mathematical dimension, like N-dimensional vector- or phase-space. But, nature is not obligated to become N-dimensional to accommodate our elegant "working" theories.
- ➢ **This is a vitally important issue to remember during constructing theories to model measurable (observable) natural phenomena.**
- ➢ **What do we measure? Does the measurable parameter directly reflect a transformable physical state of the object undergoing a specific physical state change?**

A satellite based one-way light propagation experiment is proposed to determine the absolute velocity of the satellite

$$\longrightarrow \delta x = v\delta t$$

(a)   (b)
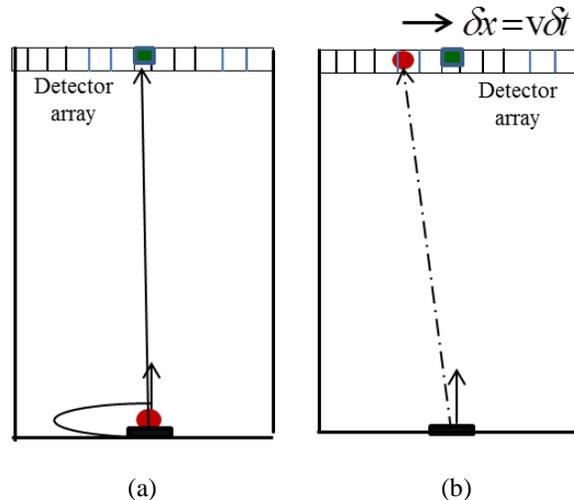
(a) When the evacuated box (on a satellite in deep space), assumed, does not move with respect to CTF (ether); light arrives at the central pixel. (b) When the evacuated box does move with a velocity v with respect to CTF (ether); light arrives at an off-axis pixel. Note that in (b) light will travel vertically up in the CTF once the optics is set up for vertical propagation; even when the box is moving laterally to the right (say) with a velocity v in free space. The light pulse will not traverse a tilted longer path (implied by the dashed line) compared to the vertical distance!

Measuring non-drift of ether (stationary CTF) in deep space. Or, one-way velocity of light!

➢ Send the above experiment on a geosynchronous orbit to achieve super vacuum (absence of air).
➢ Exploit earth's orbital velocity 30km/s by orienting the satellite along the right direction.
➢ Use "centering" detector array of pitch 100 micron.
➢ The necessary distance between the pico second pulsed diode and the detector array should be a minimum of 1meter for 1 pixel shift in the arrival of light.

We believe the postulate of the space as a Complex Tension Field will facilitate our desire to build a unified field theory of EM waves and stable particles.

➢ See references:
[5] Roychoudhuri, C., "Next frontier in physics – space as a complex tension field", J. Mod. Phys., Volume 3, Number 10, pp.1357-1368, (2012).
[7] Roychoudhuri, C., Ch.11 in "Causal Physics: Photon Model by Non-Interaction of Waves", Taylor and Francis, (2014)
➢ See also various papers in this conference the panel discussion, Proc. SPIE Vol.9570 (2015).

CONCLUSIONS

We propose affirmatively that space constitutes a stationary Complex Tension Field (CTF):

 (i) ***CTF is stationary and hence serves as the inertial reference frame*** for all observable physical phenomena in all galaxies.

(ii) ***Self-looped non-linearly*** excited oscillating gradients of CTF are our particles. Linearly excited waves are perpetually propagating EM waves.

(iii) The dynamics of the observable universe (forces) are due to simple and complex, primary and secondary, potential gradients, generated in the otherwise stationary CTF by the self-looped oscillations, we call particles. We thus ***need a new approach to formulate forces as diverse potential gradients***; which are emergent properties of CTF due self-looped particles and their assemblies.

(iv) ***CTF is three dimensional***, just as our common experience suggests. It cannot have running time as its 4th dimension because there are no physical object, to our knowledge, that has one influence-able physical parameter as the running time.

 (iv) ***CTF Holds 100% of the energy*** of the universe as various kinds of tension energy within the same volume. Dark Energy and Dark Matter postulates are unnecessary.

*(v) **We should learn to utilize the various embedded tension energies in CTF anywhere in space to become the true space faring species, without carrying enormous volumes of explosives!***

========= Slide #23 =======

Where from do the waves derive their propensity of moving perpetually from the site of origination?
Perpetual velocity of all propagating waves is an intrinsic property of the relevant tension field.

A uniform tension field tends to stay at its lowest energy state of unperturbed equilibrium. When external energy imparts any disturbance, the tension filed attempts to get rid of the disturbing energy, but all it can do is to push it away, which generates the perpetually moving wave packet. Uniform tension field gives uniform "push away" velocity and a gradient provides a "bending" of the wave front, since the propagation is a local and regional "collective phenomenon" that gives rise to the very existence of the wave packet.

Water waves – leverage surface tension and the gravitational tension in the water.
Sound waves – leverage the pressure tension in air (a result of gravitational force of the earth on air molecules).
**String waves -** leverage mechanical tension (stretching) applied on a string.
Etc. -

EM waves – leverage the Complex Tension Field (CTF), filling the entire cosmic space (19th century "ether" with modified physical properties).

========= Slide #24 =======

Derivation of Maxwell's wave equation, in analogy with mechanically stretched string wave equation, assuming ε_0^{-1} as the "electric tension" (source of charge generation) and μ_0 as the "magnetic restoring tension"
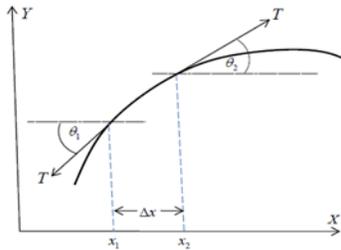
Classical string wave derivation; Ref.[13], Proc. SPIE Vol.8121, 81210P (2011)

The wave equation for a string under tension is derived by equating two balancing forces. Mass times the acceleration of an elemental string length equals the restoring tension force. Displacement of string position is "y".

$$ma = F \tag{5}$$

$$\sigma \Delta x \frac{\partial^2 y}{\partial t^2}(x,t) = \Delta_x (T \sin \theta) \approx T \Delta_x \left(\frac{\partial y}{\partial x}\right) \tag{6}$$

$$\sigma \Delta x \frac{\partial^2 y}{\partial t^2}(x,t) = T \Delta_x \frac{\partial y}{\partial x} \implies \frac{\partial^2 y}{\partial t^2}(x,t) = \frac{T}{\sigma}\frac{\partial}{\partial x}\frac{\partial y}{\partial x}(x,t) = v^2 \frac{\partial^2 y}{\partial x^2}(x,t) \tag{7}$$

$$\frac{\partial^2 y}{\partial t^2} = v^2 \frac{\partial^2 y}{\partial x^2}; \ v^2 = \frac{T}{\sigma} \tag{8}$$

Deriving classical Maxwell's wave equation for light in CTF as a tension field (ε_0^{-1}, μ_0, etc.)

We write Eq.9 by exactly emulating Eq.6 for a stretched string:

$$(\mu_0 \Delta x)\frac{\partial^2 E}{\partial t^2}(x,t) = T\Delta_x(\sin\theta) = \varepsilon^{-1}\Delta_x(\frac{\partial y}{\partial x}) \tag{9}$$

$$\frac{\partial^2 E}{\partial t^2}(x,t) = \frac{\varepsilon_0^{-1}}{\mu_0}\frac{\partial}{\partial x}\frac{\partial E}{\partial x}(x,t) = c^2\frac{\partial^2 E}{\partial x^2}(x,t); \quad c^2 = \frac{\varepsilon_0^{-1}}{\mu_0} \tag{10}$$

Thus, ε_0^{-1} ("electric tension") and μ_0 ("magnetic restoring tension") are two major tension components of the stationary CTF.