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Chapter 11

The NIW-property requires a complex tension field (CTF)

Relevant Quote

"That one body may act upon another at a distance through a vacuum, without the mediation of anything else . . . is to me so great an absurdity that I believe no man, who has in philosophical matters a competent faculty of thinking, can ever fall into it." Sir Isaac Newton.

Abstract

We propose a model that assumes the entire space to be a physical field, Complex tension Field (CTF); which should be considered as the final frontier of physics; instead of thinking whatever appears to be somewhat like *ether*, must be rejected. We are assuming that perpetually propagating EM waves are emergent sinusoidal undulations of this CTF. Particles are localized emergent complex self-looped, and hence resonant undulations of the same CTF. The quantumness in our micro world emerges out of this multiple stable resonant states of different entities. They all leverage diverse embedded physical characteristics of CTF that are evident from Maxwell's wave equation, $c^2 = \varepsilon_0^{-1} / \mu_0$, and from the fine structure constant α for particles. This approach is a significant improvement over the older *ether* hypothesis of the nineteenth century. The strength of our model derives from the fact that it harmoniously integrates our existing phenomenological knowledge of physics, while removing a good number of non-causal hypotheses developed during the last two hundred years. Once we accept that photons are EM wave packets and they do not interact (interfere) by themselves (the NIW-property, elaborated in the earlier chapters), and look for other causal hypothesis, the CTF postulate becomes a natural new direction of investigation in physics. It is natural for us to find the observable universe, from femto to micro to macro domains, to be persistently elusive because all the observable physical transformations are different kinds of newer emergent properties built out of interactions between diverse entities, themselves being emergent properties of the same CTF, held by the inseparable cosmic space. All the forces correspond to diverse kinds of potential gradients of CTF induced by the self-looped localized oscillations of CTF. CTF, thus, provides the platform to build a unified field theory, the dream of many physicists since Einstein initiated the concept.

11.1. Introduction

Since ancient times, optical physics have been playing the key role in triggering new concepts and theories in modeling diverse observations in nature. Up to Ch.10, this book has been essentially devoted to explain the impacts of a very broad phenomenon, the NIW-property of waves, in basic classical and quantum optics, which was not explicitly recognized during the entire period of emergence and development of modern physics. This chapter ventures in proposing several potentially far-reaching concepts to bring back hard causality in physics by leveraging the causal model for photon developed in the last Ch.10. We simply logically extend the consequences of the universal NIW-property of EM waves [2.1].

Our causal model for photons is a diffractively propagating classical wave packet, which also conform to all the basic demands of classical and quantum physics. It is also well established that the photons travel at the highest possible velocity through space, traversing the universe in every possible directions. And this velocity is never imparted by the photon-emitting atoms or molecules. Thus, we need a tension field to support the generation of EM wave packets and then their perpetual propagation. Further, the velocity of the emitter does not introduce any change in the velocity of the wave packet; it introduces only Doppler frequency shift, very much like classical waves supported by material based tension fields. An example would, a tuning fork generating sound waves leveraging the pressure tension in air. QM formalism, validated by ample measurements, clearly indicates that an atomic downward transition always creates a wave packet with a frequency exactly ν_{QM} as per its prediction. However, the atom's Maxwellian velocity in the cosmic *vacuum*, be it inside a discharge tube, or in a distant star, makes the ν_{QM} evolve into a new Doppler shifted frequency $\nu_{QM} \pm \delta\nu_{Dplr.}$. An atomic detector resonant at ν_{QM} can perceive the approaching wave packet of frequency $\nu_{QM} \pm \delta\nu_{Dplr.}$ as ν_{QM} only if it can nullify $\pm\delta\nu_{Dplr.}$ by emulating the identical *vectorial velocity* that the emitting atom was executing during emission. In other words, the detecting atom needs to achieve *zero relative velocity* with respect to the emitter and to perceive the wave packet with zero Doppler shift. Only then the approaching wave packet with frequency $\nu_{QM} \pm \delta\nu_{Dplr.}$ would appear to be as ν_{QM} . Thus, the Doppler shifts, in *emission* and *detection*, are two distinctly different physical processes requiring the space to be a stationary tension field capable of sustaining propagating EM waves .We are calling this cosmic filed a complex tension field (CTF) [1.8].

Mathematically derived wave equations tell us that propagating waves are simply a group of harmonic undulations of a normally *stationary tension field*. The wave packet, once generated through external compatible stimulation and deposition of some energy, persistently gets pushed away by the parent tension field to bring back its original local stationary state. All classical waves, generated in some physical medium-based tension field, also follow the principle of diffraction modeled by Huygens-Fresnel's diffraction integral. This model works because it automatically incorporates the NIW-property (see Ch.4). *Then, the cosmic space must also consist of some form of complex tension field* (CTF)*, which accepts the generation of the EM wave packet and then facilitates its propagation anywhere across the entire cosmic space because it is a CTF.* This is very much like we are trying to revive the old ether theory [11.1] of the nineteenth century, even though the prevailing belief is that modern physics has decisively established space to be empty vacuum. This was also originally promoted by the special theory of relativity and the quantum mechanical model of photon as indivisible quanta (no field is necessary for its propagation). However, unlike ether theory as some novel substance, we are presenting CTF as a stationary physical field that sustains not only the EM waves, but also all the particles as some form of stable and resonant localized self-looped 3D harmonic undulations. Particles are produced through some high-energy excitations (yet to be modeled), in contrast to linear stimulations by material dipoles, which generate perpetually propagating EM wave packets. This CTF represents the next frontier for deeper exploration of nature's marvelous engineering. In this context, it is worth consulting a recent paper [11.2] on how communications between Einstein and Schrodinger, through their publications, led towards the identification of space as having some tension field-like properties. But the concept was not followed through.

An explicit recognition of space as a physical tension field opens up many new approaches to construct possible unified field theories [11.3]. This chapter will show that CTF postulate allows us to understand physical processes behind many light-matter interaction phenomena while reducing the number of diverse ad hoc hypotheses, which we have been using for a couple of centuries (see Ch.12, section xx). CTF postulate also helps us to eliminate the non-causal and non-informative hypothesis of *wave-particle-duality* we use to explain superposition effects due to EM waves and particle beams.

The validity of Maxwell's wave equation for EM waves in 3D requires them to have the characteristics of some linear, transverse, sinusoidal harmonic undulations of a physical tension field. Maxwell's wave equation explicitly identifies that this tension field must possess the properties ε_0^{-1} and μ_0 to propel the EM waves as linear undulations with the perpetual velocity $c^2 = (\varepsilon_0^{-1} / \mu_0)$ across the entire universe (see section 4.5). This also allows the light beams from billions of different stars in every direction, albeit crossing through each other, to deliver the original parental information unperturbed (due to NIW-property) to us through our imaging telescopes. The implication is that we should revive the old ether-concept, however, not as some novel *substance*, but as a physical complex tension field that holds physical attributes like ε_0^{-1} and μ_0 and more to accommodate the existence of particles as localized vortex-like undulations.

The key aspect of our enquiring methodology behind this book has been to search for *physical processes* behind recordable data or observable phenomena. Accordingly, let us apply this approach to Einstein's key postulate behind his theories of relativities, that the velocity of light c is constant for all observers (all frames of references). This postulate has been holding up remarkably well due to validation of measured data gathered through wide variety of experiments. Unfortunately, in spite of the elegance of the statement "c is constant for all observers" that appears though mathematical theories, it does not provide any serious guidance to appreciate, or visualize the physical processes in nature that accounts for this measured fact and make it to be the final ontological reality of nature [11.4]. CTF provides us with a physical substrate that allows the physical processes take place. The purpose of Physics should be to help us appreciate the physical processes going on in nature.

One of the key reasons behind dropping the ether-hypothesis has been the absence of *ether-drag* by material particles, planets and stars. Michelson-Morley (M-M) experiments *essentially* demonstrated that such a drag is not detectable [11.5-11.8]. To resolve this problem we propose that stable elementary particles are some form of localized vortex-like [1.8,11.9,11.10] self-looped resonant (and hence stable) undulations of this same CTF triggered by some non-linear perturbation. Emergence of vortex like phenomena in classical and quantum physics are abundant [11.11a,b,c]. To sustain vortex like particles, the CTF must also possess the intrinsic properties required for particle formation, $\alpha = (e^2 / 2h)(\varepsilon_0^{-1} \mu_0)^{1/2}$, where α is the well-known fine structure constant for particles. It has already been found that the particles are some sort of energy resonances [11.12] such that if one multiplies the ratio of the energy of a particle to that of an electron by 2α , one gets an integral number: $(E_{prtcl.} / E_{elec.})2\alpha = z$. *These stable self-looped localized oscillations of CTF can move through the CTF but does not drag CTF; just like the propagating wave group does not drag the sustaining parent tension field with it.* This provides a conceptually powerful unifying view that both EM waves and particles, which constitute our entire *observable* universe, are simply different kinds of harmonic undulations of the same cosmic tension field, CTF. The concept of self-looped resonance then explains the root of quantumness in the micro universe, where the exchange of energy must be of discrete amount to maintain the resonant stability. This is in contrast to continuous energy exchange between emergent macro assemblies where the resonant states have become continuum. The only difference between Classical Physics and Quantum Physics is determined by the continuous versus the discrete-resonant energy exchange processes. It is not the physical size of the objects that differentiate between Classical and Quantum world. Planck's law underscored this reality. The quantum mechanical behavior of Planck's radiation law, derived by using data from macro *Blackbody Cavity*, is the best example. Radiating and absorbing characteristics of the assemblies of atoms and molecules on the surface of the macro *Blackbody Cavity* are still dictated by quantum mechanical transitions in the various resonant but discrete energy states.

If particles are resonant oscillations of the CTF, then we are simply complex assemblies of diverse resonant undulations. The elementary particles form atoms; atoms form molecules; and molecules form our cells and hence biological bodies! We may consider the biological body as a classical system; but its life-giving basic functions are driven by quantum chemistry between harmonically vibrating molecules, assisted by electro-chemistry. Physically, it is not possible for us to perceive directly the CTF in which we are just assemblies of diverse oscillations and our thinking is some form of complex emergent property of some sub-assemblies of neural cells. We will have to think *outside the box* as to how to construct some experiments such that interactions between some oscillatory *entities*, and consequent transformations in them, could reveal that CTF lies behind the entire observable universe. If the CTF-postulate can be validated, then we do not need to separately find dark energy [11.13-11.15], and perhaps even the dark matter [11.16], to account for the total energy of the universe.

All the 100% of the cosmic energy is held by the CTF, which includes all the energy corresponding to the manifest undulations (observable universe) as different kinds of *excitations (undulations)* of the CTF. If the CTF itself does not participate in accepting any energy (as a sink) out of its oscillatory interacting entities, while they undergo transformations through energy exchange between themselves; then the universal rule of conservation of energy become understandable as a causal rule. But, if the CTF also functions as weak but energy recycling sink; then cosmological and particle physics may have to accommodate explicit form of energy recycling process through the CTF that violates our current form of the law of *Conservation of Energy*. We should not accept *energy-time uncertainty* as a law of nature without understanding and substantiating the physical process (es) behind it.

11.2. Most successful theories implicate space possessing some physical properties

11.2.1. Gravitational field

It is interesting to note that we routinely use the phrase *Gravitational field*, but are reluctant to accept that free space has the physical attributes required by G and embedded in CTF implied by the expression for the gravitational force GmM / r^2. Gravitation is the first of the four forces that we have come to discover in physics. This was formally expressed as an inverse square law by Newton during late seventeenth century. The other three forces are electromagnetic force and strong and weak nuclear forces, recognized during nineteenth and twentieth centuries. We also have secondary forces like van der Wall force, etc. The mathematical success of the gravitational inverse square law was simply overwhelming. Through simple mathematical formalism, Newton explained all the three planetary laws constructed earlier by Kepler based upon the organization of data for planetary movements gather through life-long work of himself and Tycho Brahe. However, because of the vast distances between the Sun and its different planets, Newton and his contemporaries were seriously bothered by the necessity of accepting the concept of *action at a distance* (as noted in the abstract above). The purpose of physics in those days was still supposed to explain the *physical processes* behind all the different natural phenomena. Yet, the successes of mathematics and their validation through observed data softened up the enquiry for the physical process behind the *action-at-a-distance*. In 1915, Einstein removed this problem of *action-at-a-distance* with his theory of general relativity by reframing the *gravitational force* as the *curvature of space*; which can also be viewed as the classical potential gradient ($1/r$) to the Newtonian force ($1/r^2$). If the space can be *curved*, then it has to have some physical property, which can assume some spatial gradient over a very large spatial range. We can eliminate the need for the hypothesis, *action-at-a-distance*, if we assume that the gravity is an extended potential gradient induced in the CTF by the localized oscillations of CTF (or their assembly). But General Relativity itself does not explicitly posit any such property onto space; otherwise, it would have re-kindled the ether hypothesis.

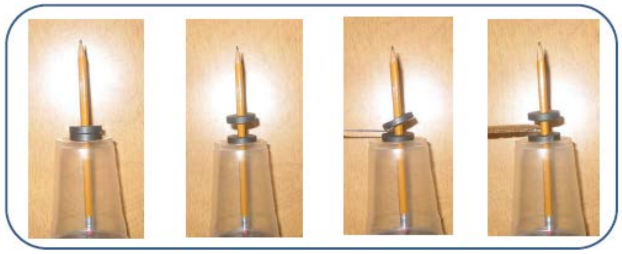
11.2.2. Space-time four dimensionality of Relativity

Almost all people, even without any formal exposure to physics, *know* that our universe is at least *four-dimensional*. If it is correct physics, then four-dimensionality should imply that free space and time must possess some intrinsic physical properties that could make them physically interconnected according to the theories of relativity. We have had to accept this four-dimensionality through decades of cultural training, rather than succeeding in figuring out how they are physically interconnected. In terms of modeling data with theory, the theories of relativity are in *reasonable* shape. Unfortunately, even Einstein underscored that it is the theory that determines what we can measure. This underscores that congruency between the predictions of a theory and the measured data, does not make the theory as the *final law* of nature (see the quotations in the beginning of Ch.12). Consider the various physical processes that are behind how we measure space (length or volume) and time. One can take a standard meter scale and measure out the length. We can extend our hands and get a sense of the space. We walk on earth; we travel to moon and we a get a physical sense of space. Can we get a similar sense or a physical appreciation of time? No! Our experience does underscore that everything in this universe apparently has a finite period of life, like about hundred years for humans and 4 to 8 billion years for the stars. However, each one of these life-period (or, time-interval) datum is dictated by different sets of physical parameters and their very complex interactions. None of these life-period represents a simple analytically definable parameter, which can be called *running time*. What we really measure is the precisely definable and reproducible frequency f of some kind of an oscillator, like a watch, or an atomic clock. We invert the frequency to derive the *period* of oscillation, or a *time-interval*, $\delta t = (1/f)$, and we have also figured out how to measure longer and longer time-interval by counting the frequency many times, $(\Delta t)_n = n\delta t$, which gives us a means of keeping track of *running-time*. From the standpoint of physics, one might use classical thermodynamics that entropy always increases and defines an *arrow of time* [11.17,11.18]. However, on the cosmic scale, we are already observing that the play between the long-range gravitational force and the short-range nuclear forces, along with the participation of the electromagnetic force, the cosmic gases, spewed out by some supernova explosions, organizes new stars and the cycle goes on. Astrophysics cannot convincingly claim that the cosmic system also suffers from the *arrow-of-time*. Even if it does, we have not yet learnt how to make a practical clock out of this cosmic *arrow-of-time*. Accordingly, while this book favors the acceptance of space as a rich tension field, CTF, time is not considered as a primary physical parameter of anything. The time is, of course, an essential *secondary parameter* to formulate the dynamics of interaction between particles and EM waves, which are behind the persistent evolution of all terrestrial and cosmic phenomena. We should be cautious from assigning the status of a *primary physical parameter* to *time* through the assumption that the four-dimensionality of nature is the final theory of physics. So far, we have learnt to physically manipulate the frequencies of diverse oscillators, and hence *time-intervals*; but that has not empowered us technologically (physically) to alter the *running-time* or the *arrow-of-time*. Diverse physical properties of CTF directly influence in determining the frequency of all the oscillating entities it supports; but the consequent secondary parameter, the period $\delta t = (1/f)$, contrived by human logics (concepts and theories), do not provide any physical mechanism that could make the *running time* t as an intrinsic and primary physical property of CTF.

11.2.3. Electromagnetic fields

Ancient Electrostatics taught us that the free-space has a physical property ε_0, we call dielectric constant**.** Magneto statics gave us the physical property of magnetic permeability of free-space μ_0. Electromagnetism, unified by Maxwell (1864) through his differential wave equation for EM wave, out of the empirical relations developed by Coulomb (1736-1806), Ampere (1775–1836), Faraday (1791-1867), etc., also begs for assigning rich properties to space, as already mentioned in the introduction. In fact, Maxwell did propose the ether theory. If light is a wave and it travels through *free space* with a unique velocity $c^2 = (\varepsilon_0^{-1} / \mu_0)$, then the space ought to have the physical attributes corresponding to ε_0^{-1} an μ_0, which ushered in the concept of ether but got rejected prematurely due to some null M-M experiments without deeper introspections.

Faraday was the first one who formalized the concept of the field and the density of field lines to explain electro static and magneto static forces and their remote influence on material bodies when they move relative to each other. His purpose was to remove the concept of *action-at-a-distance* through vacuum. The concept facilitated the invention of electric current generators and electric motors. Consider a simple experiment that we show in the primary schools to get the children interested in science and technologies. A pair of annular magnets, with the same polarity facing each other, helps defy the gravitational downward pull on the upper magnet (Fig.11.1). It is obvious that the space between the two ring magnets possesses both the *gravitational tension field* and the *magnetic tension field*. The gradients in these two tension fields, gravitational attraction and magnetic repulsion, must be balancing each other to keep the upper ring magnet floating over *empty space*! A human finger or a wooden blade, passing through the space between the two magnets, does not show any changes; the two fields remain unperturbed. But if we try to slide a steel blade through the space between the floating magnets, the two magnets snap together. Of course, we know that a steel blade, being a *magnetic material*, is capable of altering the gradient in the *magnetic tension field* around it; but our experience tells us that the *gravitational tension field* remains effectively unperturbed on the surface of the earth! Our point is that if we look at our everyday experience with open mind, we can appreciate that the *space* simply cannot be *empty*! The free space manifests diverse physical properties and hence it must be something physical to display them.



(a) (b) (c) (d)

Figure 11.1. Space is not empty. A kindergarten experiment to remind ourselves that the space between a pair of magnets, with same poles facing each other, floats and the space in between contains magnetic and gravitational fields. (a) With opposite polarities, the magnets snap together. (b) With same polarity, the upper magnets float defying gravitational pull. (c) A steel knife inserted between the floating magnets perturbs the magnetic field and brings the magnets together. (d) An wooden knife cannot perturb the magnetic field between the magnets; so they keep on floating.

11.2.4. Modern quantum theories

Starting from Schrodinger's *wave* equation [11.19], to the latest set of string theories [1.31] all show that the structure of the mathematical equations resembles some form of field or wave. Some of the theories have *discovered* the existence of *zero point energy, quantum foam, background fluctuations*, etc. If a theory is consistently validated though a wide variety of experiments, then we must accept that the theory has captured at least some of the ontological realities behind the transformational processes going on in nature, even while we accept that all theories are always *work in progress*, and are never final. So, the emergence of mathematical results implying the existence of *quantum foam*, etc., should be taken as a serious indication that space possesses rich physical properties. However, QM circumvents the problem of *action-at-a-distance* by modeling all the four forces as being mediated through appropriate exchange particles, various bosons and gravitons, without the need to assign any physical properties to the space itself. *This also implies as if the forces themselves are quantized; instead of accepting the reality that the quantity of energy exchanged between particles is quantized for need of their resonant structural stability as resonant oscillations of the CTF.*

11.3. Propagation of EM waves as undulations of the Complex Tension Field (CTF)

Our position is that waves should not be represented by Fourier monochromatic waves existing over all space and time as that violates the most extensively validated rule of conservation in nature, which is the conservation of energy. Infinitely extensive wave requires infinite energy, which is simply impossible in nature (see Fig.5.1). Waves should always be represented as a space and time finite packet propagating with a unique carrier frequency under a finite envelope, $a(t)\exp[-i2\pi\nu t]$. Further, waves propagate as a group phenomenon until they are perturbed by physical structures comparable and or smaller than their wavelengths. All of physical optics consists of propagation of waves through diverse optical components of sizes varying from macro to nano to pico meter material entities. That is why wave groups maintain their physical integrity even when they cross through each other as long as the medium is non-interacting. This has already been underscored in most of the previous chapters. Mathematical theories should always model the propagation of such wave packets conforming to conservative nature. Wave packets propagate as a *collaborative*, space and time extended, phenomenon. They are forced to perpetually propagate *away* from the site wherever they may be at any particular time, which is built into the first order, second derivative wave equation for a source-free space. Let us re-visit the comparison between the two wave equations copied from Ch.4, Eq.4.7 (for mechanical string waves; read from left to right) and Eq.4.8 (for EM waves; read from right to left):

$$\sigma\Delta x \frac{\partial^2 y(x,t)}{\partial t^2} = \Delta(T\sin\theta) \;\Rightarrow\; \sigma \frac{\partial^2 y(x,t)}{\partial t^2} \approx \frac{\Delta}{\Delta x}\left(T\frac{\partial y}{\partial x}\right) = T\frac{\partial^2 y}{\partial x^2} \;\Rightarrow\; \frac{\partial^2 y(x,t)}{\partial t^2} = \frac{T}{\sigma}\frac{\partial^2 y(x,t)}{\partial x^2} = \mathrm{v}^2 \frac{\partial^2 y(x,t)}{\partial x^2} \qquad (4.7)$$

$$\mu_0\Delta x \frac{\partial^2 E(x,t)}{\partial t^2} = \Delta(\varepsilon_0^{-1}\sin\theta) \;\Leftarrow\; \mu_0 \frac{\partial^2 E(x,t)}{\partial t^2} \approx \frac{\Delta}{\Delta x}\left(\varepsilon_0^{-1}\frac{\partial y}{\partial x}\right) = \varepsilon_0^{-1}\frac{\partial^2 y}{\partial x^2} \;\Leftarrow\; \frac{\partial^2 E(x,t)}{\partial t^2} = \frac{\varepsilon_0^{-1}}{\mu_0}\frac{\partial^2 E(x,t)}{\partial x^2} \cancel{= c^2 \frac{\partial^2 E(x,t)}{\partial x^2}} \qquad (4.8)$$

We are underscoring the mathematical similarity between the wave equations, one modeling waves on a string under mechanical tension T and the other modeling EM waves in CTF under electrical tension ε_0^{-1}. When the string experiences an unbalanced force $\Delta(T\sin\theta)$ induced by mechanically delivered energy by an external agent on the string, its disturbed segment then intrinsically responds to restore itself by generating a linear restoration force, given by Newton's force law, as the product of its elemental inertial mass $\sigma\Delta x$ times the mechanical acceleration of the elemental string. Within the assumption of linear restoration limit of the string; and when the string is not in contact with any other physical agent to get rid of the perturbed energy; it can only push away the perturbation from the current site to the next contiguous site while restoring the original quiescent state at the original location where the disturbance was introduced. As the process continues, we observe the propagation of a wave packet on a string. It is the tension field's inability to get rid of the externally delivered perturbation energy, which causes it to adapt to the other alternative option of perpetually pushing away the imposed perturbed energy perpetually through an infinite string. For a finite string, wave packet can evolve into a set of discrete classical resonant waves through multiple reflections from the fixed boundaries and we have learned to use such contraptions to create beautiful music. But the unbound CTF cannot generate such resonance and that is why it can sustain every possible EM wave frequencies from radio to gamma rays. Atoms' musical capability (generating discrete spectral lines) derives from its own discrete set of quantized dipolar undulations, which it imposes on the CTF.

When we re-structure Maxwell's wave equation as in Eq.4.8 (above) to emulate the string wave equation, we can interpret ε_0^{-1} as its intrinsic electric tension field (like T of the string) and μ_0 as the countering response as the magnetic tension field (through the generation of magnetic field). Maxwell's wave equation derives $c^2 = (\varepsilon_0\mu_0)^{-1}$, which implies as if ε_0 and μ_0 play symmetrical role. We have chosen ε_0^{-1} as the electric tension (stiffness) to emulate the string equation, because our detection methods dominate electric dipoles. Besides, magnetic properties emerge usually when moving charges exist. Our interpretation is that CTF possesses some physical properties such that material electric dipoles can enforce some of its energy into the CTF by triggering the emergence of an elemental electric field force $\Delta(\varepsilon_0^{-1}\sin\theta)$. In reaction, the CTF tries to restore its state of equilibrium by generating the countering magnetic field force $\mu_0\Delta x(\partial^2 E/\partial t^2)$. Like the ideal long stretched string, the CTF does not have a mechanism to get rid of the energy already delivered into it by the dipole. So the local CTF keeps on pushing the perturbation away from the original site of perturbation and hence we can observe, once generated, a perpetually propagating EM wave packet with a velocity $c^2 = (\varepsilon_0^{-1}/\mu_0)$.

Even the velocity of longitudinal waves like that of sound due to pressure tension in air follows a velocity relation similar to that of the transverse waves in a string, or transverse EM waves in in the CTF.

$$\mathrm{v}^2 = \frac{B}{\rho}(\text{sound wave}) = \frac{T}{\sigma}(\text{string wave}) = \frac{\varepsilon_0^{-1}}{\mu_0}(\text{EM wave}) \qquad (11.1)$$

Here B is the modulus of bulk elasticity or stiffness, or pressure tension and ρ is the density of air mass.

11.4. Cosmological red-shift: Doppler shift vs. a dissipative CTF

This section shows that 100% of the very large and distance dependent cosmological redshift is not congruent with physical Doppler shift phenomenon [11.20]. Hubble's observations established that the signature spectral dark lines due to absorption by the outer gas corona of stars consistently shift towards lower frequency (red shift towards longer wave lengths), which is proportional to the distance of the star (galaxy) from the earth [11.21]. The prevailing explanation is that the universe is expanding [11.22] and farther the distance of a galaxy, faster is its relative recession velocity from ours. One of the many problems [11.23] with this hypothesis is that the relative velocities of the very distant galaxies could approach the velocity of light, or even exceed it. Accordingly, various alternative theories have been proposed [11.24,11.25a,b], but none apparently are congruent with all the diverse observations. We are proposing that CTF itself could possess a distance-dependent, but very *weak, absorptive capability*, which slowly robs energy from photon wave packets as they propagate through. The exact physical process is yet to be clearly hypothesized and then theorized. But, before discussing this distance dependent red shift, we would like to establish that the application of the concept of Doppler shift to cosmological red shift is not completely free of inherent contradictions from basic physics.

11.4.1. Classical acoustic Doppler frequency shifts – source and detector movements are separable

The concept of Doppler frequency shift developed by observing the apparent shift in the frequency of a sound wave which can be a result of either the source moving or the detector moving with respect each other. Observers standing on a train station can experience both the *blue* and the *red* frequency shifts while a whistling express train enters and then passes through the station. The air, holding the pressure tension, is assumed stationary. Then the physical origin of the Doppler shifts due to source movement and the detector movement are clearly distinguishable for sound waves. But, it is currently assumed that the Doppler shifts of EM waves cannot tell us this distinction since there is no stationary medium for the propagation of these waves. Then, our CTF proposal, as a stationary medium, contradicts this prevailing assumption. In this section, we will establish that the Doppler shifts due to source movement and detector movement are distinguishable for EM waves, as for other material based waves. In reality, QM requirements defined and validated for spontaneous and stimulated emissions validate our assertion. Let us first develop the classical Doppler shift relations for sound from the first principle.

Detector moving: Let us first consider the case of a stationary source and the detector is moving, towards ($+\mathrm{v}_{\det.}$), or away ($-\mathrm{v}_{\det.}$) from the source. Since the medium (air) and the source are stationary with respect to each other, the source frequency remains unaltered in the medium $\nu_{src.} = \nu_{med.}$. However, the moving detector will *perceive an apparent frequency* shift, higher ($\nu_{\det.+}$) or lower ($\nu_{\det.-}$), depending upon whether it is moving towards or away from the stationary source (Eq.11.2), We have used the simple Galilean velocity addition theorem to obtain the perceived velocity for the wave-crests, $c \pm \mathrm{v}_{\det.}$, by the detector and then divide this resultant velocity (distance per second) by the wavelength of the sound in air $\lambda_{med.}$ to obtain the number of oscillations experienced by the detector , where $\nu_{med.}\lambda_{med.} = c$, velocity of sound in air. For mathematical simplicity, we are considering only collinear velocities in this section.

$$\nu_{\det.\pm} = \frac{c \pm \mathrm{v}_{\det.}}{\lambda_{med.}} = \nu_{src.}(1 \pm \mathrm{v}_{\det.} / c) \tag{11.2}$$

Source moving: Let us now consider the cases for the source moving towards or away from the stationary detector. We are assuming that the source velocity is significantly smaller than the wave velocity in the medium. Because of the source movement during the generation of the wave crests and toughs, their separation in the medium will be contracted or dilated. In other words, propagating waves in air will experience a real frequency shift; even though the wave travels with the same velocity c determined by the intrinsic tension/restoration property of the medium. However, this frequency shift is not an apparent shift as is in the case of detector movement. We define frequency as the number of waves within the distance traveled by the wave in one second, $\nu = c / \lambda$. But the real $\lambda_{med.}$ being experienced by the medium is no longer given by $\lambda = c / \nu$. Even though the frequency of the generator remains the same, its velocity with respect to the medium is making contraction (or dilation) of the real spacing between the wave crests as $\lambda_{med.} = (c \mp \mathrm{v}_{src.}) / \nu_{src.}$. Since the velocity of the wave in the medium is still the same, a stationary detector *at a distance* will experience the modified wave frequency as transported by the medium [11.26,11.27]:

$$\nu_{med.\pm} = \frac{c}{\lambda_{med.}} = \frac{c}{(c \mp \text{v}_{src.})/\nu_{src.}} = \frac{\nu_{src.}}{1 \mp \text{v}_{src.}/c} = \nu_{src.}(1 \mp \text{v}_{src.}/c)^{-1} \tag{11.3}$$

Here $\nu_{med.+}$ and $\nu_{med.-}$ correspond to the source moving towards and away from the stationary detector, respectively.

One should note that the above two expressions for frequency shifts, Eq.11.2 & 3, are not symmetric because the two physical processes behind these shifts are different. In the first case, the source being stationary, the propagating wave in the stationary medium maintains the source frequency, but the *moving detector's oscillator* undulates faster or slower depending upon its own velocity, (towards or away from the source, respectively). This frequency shift is only an *apparent* shift as it is subjective to the velocity of the detector. In the second case, the moving source effectively delivers higher or lower frequency into the medium depending upon whether it is moving towards or away from the stationary detector. Note that it is not subjectively dependent on whether the detector is physically present or not. The frequency shift is physical and permanent as the wave packet travels with this new shifted frequency in the medium. However, when $\text{v}_{src.}/c$ is very small, a binomial expansion and rejection of terms of orders $\text{v}_{src.}^2/c^2$ or higher, will make Eq.11.3 appear identical to Eq.11.2. Enforcing this mathematical symmetry suppresses our enquiry into the physical processes, which are different. However, this approximation allows one to obtain the identical Doppler shift $\delta\nu_{Doplr.}$ for both the cases. This is routinely used for most measurements, even for light waves:

$$[(\nu_{\det.} - \nu_{src.})/\nu_{src.}] \equiv (\delta\nu_{Doplr.}/\nu_{src.}) = (\pm \text{v}_{rel.}/c) \tag{11.4}$$

Both source and detector moving: It is now natural to synthesize the above two cases where both the detector and the source are moving. There are four possible cases of perceived (or measured) frequency shifts by the detector given in Eq.11.5, which is derived by switching $\nu_{src.}$ in Eq.11.2 by $\nu_{med.}$ (because the source is moving) and then substitute for $\nu_{med.}$ from the Eq.11.3:

$$\nu_{\det.\pm} = \nu_{med.}(1 \pm \text{v}_{\det.}/c) = \nu_{src.}\frac{(1 \pm \text{v}_{\det.}/c)}{(1 \mp \text{v}_{src.}/c)} \tag{11.5}$$

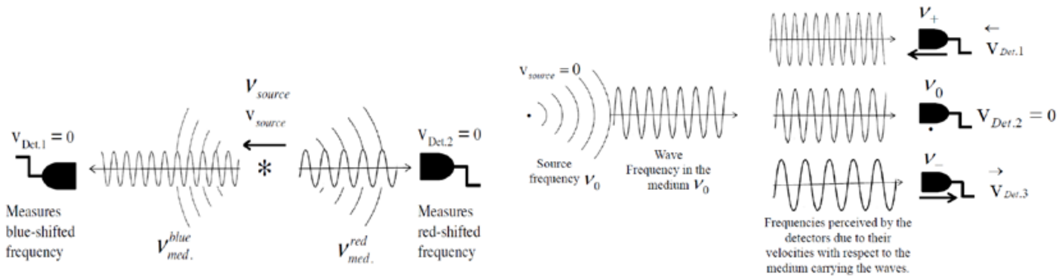
This physically different frequency, $\nu_{med.}$, transported by the medium at a distance from the source, now exists independent of the original status of the source. (The source may have stopped; or it may not exist anymore.). This frequency $\nu_{med.}$ can be perceived as a wide variety of different frequencies, $\nu_{\det.\pm}$, by different detectors moving with different velocities $\pm\text{v}_{\det.}$ with respect to the air. The only way to re-discover the original source frequency $\nu_{src.}$ is to make the detector perceive the $\nu_{med.}$ as $\nu_{src.}$, or $\nu_{\det.\pm} = \nu_{src.}$. This is possible only when the velocity dependent factor in Eq.11.5 is unity, which requires the detector to mimic exactly the same *vectorial velocity* (same direction) of the original source. This is equivalent to creating a zero relative velocity between the original source and the detector with respect to the stationary air. Since we have the means to verify the existence of the air and the pressure tension in it, which undulates and pushes the sound waves, it is not very difficult to validate the existence of both $\text{v}_{\det.}$ and $\text{v}_{src.}$ separately as the absolute velocities with respect to the air. In general, whenever $\text{v}_{\det.} \neq \text{v}_{src.}$, the measured frequency will remain identifiably different, $\nu_{\det.\pm} \neq \nu_{src.}$.

11.4.2. Relativistic Doppler frequency shifts – source and detector movements are not separable

Unfortunately for light, we assume that there is no medium and hence it is not possible to separately determine the absolute velocities of the source and the detector with respect to the free space. Accordingly, Special Theory of Relativity (SRT) has been framed based on the relative velocity only. Application of relativity to derive Doppler shift then has only one velocity $\text{v}_{rel.}$ to consider; even when one conceptually frames the problem, either as the source is moving, or as the detector is moving. One incorporates the relativistic wavelength length contraction, $\lambda\gamma^{-1} = \lambda(1 - \text{v}^2 / c^2)^{1/2}$, or the time dilatation $\nu^{-1}\gamma$, respectively (11.26-11.28a,b); but the conceptual picture used is similar to the classical case for sound waves in *stationary air*. It is then worth pondering whether we are tacitly assuming a stationary *free space* while attributing on it the physical properties of *length contraction* and *time dilatation*. The standard relativistic Doppler shift, which is the counter part of the classical relation Eq.11.5, would be given by:

$$\nu_{det.\pm} = \nu_{src.} \frac{(1 \pm \text{v}_{\text{rel.}} / c)}{(1 - \text{v}_{rel.}^2 / c^2)^{1/2}} = \nu_{src.} \frac{(1 \pm \text{v}_{\text{rel.}} / c)^{1/2}}{(1 \mp \text{v}_{\text{rel.}} / c)^{1/2}} \tag{11.6}$$

The plus and minus signs in the subscript $\nu_{det.\pm}$ imply whether the source and the detector are closing on each other, or getting away from each other with the relative velocity $\text{v}_{\text{rel.}}$. When this relative velocity is $\text{v}_{\text{rel.}} = 0$, the detector registers the original source frequency, $\nu_{det.\pm} = \nu_{src.}$, just as in the classical case for sound waves as in Eq.11.5. However, unlike for the classical Doppler shift as in Eq.11.5, we have lost the capability of identifying the separate velocities and consequent separate contributions from the source and the detector in the total frequency shift. Once again let us note that the fundamental postulates behind the construction of a theory determine what can be measured and what cannot be. In our view, the identification of exoplanets belonging to distant stars through measurement of miniscule Doppler shifts [11.28b] is classical Doppler shift for EM wave frequency as we are explaining here, which is different from the cosmological red shifts shown by distant galaxies.



(a) (b)

Figure 11.2. A detector can perceive the Doppler blue and red frequency shifts whenever there is a relative velocity between the source and the detector. But the source can be "dead" before the signal arrives at the detector! Therefore, the signal carries the information about the source velocity without knowing which moving detector will receive it. For sound and water waves, the stationary media help maintain the source induced Doppler shift. The detector perceives further Doppler shift in the signal if it moves with respect to the stationary medium. (a) Source moving. (b) Detector moving.

11.4.3. Origin of longitudinal modes in a gas laser cavity helps distinguish the Doppler shifts due to source moving and detector moving.

We would like to explore whether it is a broad principle of nature that light-matter interaction processes, and consequent frequency measurement, are literally "blind" to independent velocities of sources and detectors with respect to the stationary CTF; or, whether it is the limitations of our current theories. Let us analyze the physical processes behind the emergence of multiple longitudinal modes (frequencies) out of gas laser cavities, because of the in-homogeneously broadened spontaneous emission gain line width, which is approximately 1.5 GHz wide for He-Ne lasers [4.1,4.2]

The spectral broadening (distribution) of Ne-spontaneous emission, shown in Fig.11.3, is due to Doppler shift caused by random Maxwellian (Gaussian) velocity distribution of the Ne-atoms within the laser discharge tube. Only those spontaneously emitted frequencies succeed in generating sustained stimulated emission that matches the cavity round trip time $\tau = 2L / c$, which can produce a phase delay $(2\pi)\nu\tau$ as an integral multiple of-2π, or $\nu\tau = m$, an integer:

$$(2\pi)\nu_m \tau = (2\pi)m; \quad \text{where } \tau = 2L/c \tag{11.7}$$

Then the frequency separation $\delta\nu_{mode}$ for a pair of consecutive modes m and $m+1$, or $\delta m = 1$, is:

$$\delta\nu_{mode} = \delta m / \tau = c / 2L \tag{11.8}$$

If the total spectral broadening due to velocity distribution is $\Delta\nu_{Doplr.}$ then the number of modes N that can oscillate (survive) in an inhomogeneously broadened gas laser is:

$$N = \Delta\nu_{Doplr.} / \delta\nu_{mode} \tag{11.9}$$

Now, let us carry out a simple conceptual experiment that is quite easy to do in the laboratory. One can simultaneously make the spectral display of both the laser light and the spontaneously emitted light, collected from the output mirror (along the laser axis) and from the side of the discharge tube, respectively. For a He-Ne laser, with $\Delta\nu_{Doplr.} = 1.5GHz$ and the mode spacing for 30cm typical cavity would be $\delta\nu_{mode} = 500MHz$. Resolving such spectra would require a high resolution Fabry-Perot spectrometer. The separate but simultaneous analyses of the spontaneous and laser lights would show curves somewhat; like those shown in Fig.11.3.

To understand the frequency spread of spontaneous emission, let us re-write Eq.11.5 for the Doppler shift due to classical source movement. The sharp quantum mechanical transition atomic frequency ν_{QM} is defined as the source frequency. All the Ne atoms emit the same fixed quantum of energy $h\nu_{QM}$. But because of the Maxwellian velocity distribution $\mathrm{v}_{spont.}$ of all the atoms inside the stationary discharge tube, the evolving photon wave packets acquire many different physical frequencies $\nu_{src.\pm}$ in the CTF, given by Eq.11.10, just as in the case for sound waves in stationary air. This continuous and real physical distribution of spontaneous emission frequency spectrum can be displayed by a spectrometer with suitable resolution (Fig.11.3):

$$\nu_{src.\pm} = \frac{\nu_{QM}}{1 \mp \mathrm{v}_{spont.}/c} = \nu_{QM}(1 \mp \mathrm{v}_{spont.}/c)^{-1} \tag{11.10}$$

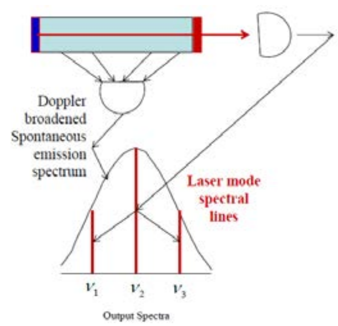


Figure11.3. Simultaneous spectral analysis of spontaneous and laser light from a He-Ne laser validates that Doppler frequency shift due to source-only velocity and detector-only velocity are two separate and independent physical effects, even though the mathematical expression can be shown to be approximately identical. This is corroborated by the fact that the quantum mechanical transition frequency, for both spontaneous and stimulated emissions, remains identical, at least for non-relativistic velocities.

Let us now re-write the classical Doppler shift relation, Eq.11.5, when both the source and the detector are moving relative to the stationary CTF. However, let us identify the source frequency as the quantum mechanical transition frequency ν_{QM} and identify the two velocities as that of a spontaneously emitting Ne-atom as $\mathrm{v}_{spont.}$ and $\mathrm{v}_{stim.}$ as that of a Ne-atom (detector) undergoing stimulated absorption:

$$\nu_{\det.\pm} = \nu_{QM} \frac{(1 \pm \mathrm{v}_{stim.} / c)}{(1 \mp \mathrm{v}_{spont.} / c)} \tag{11.11}$$

We can safely assume that for sub-relativistic velocities of atoms, they do not alter the internal atomic energy levels and hence the intrinsic dipolar frequency during the quantum transition between the same identical pair of energy levels, should remain the same ν_{QM}. For an atom to be stimulated and fill up its quantum cup out of the surrounding EM waves, it must *perceive* the frequency of the passing by stimulating wave packets as having the exact same QM-transition-allowed frequency ν_{QM}. This is impossible in a discharge tube because all atoms, emitters and absorbers, all are moving with finite velocities in different directions and the frequency of the emitted wave packets are becoming ν_{QM}, even though they were emitted as $\nu_{src.\pm}$. And the moving to-be-stimulated-atoms and will perceive them as $\nu_{\det.\pm}$, rather than ν_{QM}. The only way for an atom to perceive $\nu_{\det.\pm} = \nu_{QM}$ is when it has acquired the *zero relative velocity* with respect to the distant spontaneous emission-contributing atom. According to Eq.11.11, the atom to be stimulated must be moving with exactly the same *vectorial velocity* (or, zero relative velocity) as the atom that originally emitted the spontaneous wave packet. In addition, by the time the stimulation process is happening the spontaneous emission contributor is at a very different place and moving with a very different velocity and, most likely, it would be in the process of getting re-excited for the next round of activity! One can easily calculate the set of number of those atoms that perceive a corresponding set of $\nu_{spont.}$ frequencies as exactly ν_{QM} due to their *zero relative velocity* with each other and then contribute to the stimulated emission. Unfortunately, a very large number of moving atoms-to-be-stimulated does not match up with the required *zero relative velocity* and they perceive the passing by wave packets having carrier frequencies given by Eq.11.11. [Many other excited atoms, albeit perceiving stimulating wave packet $\nu_{QM} \pm \delta\nu$ as exactly ν_{QM}, matching the zero relative velocity requirement, cannot contribute to the laser energy, because physical carrier frequency $\nu_{QM} \pm \delta\nu$ does not match the frequency set dictated by the cavity round-trip phase matching condition, Eq.11.7. This is why in-homogeneously broadened gain media do not make very efficient lasers.]

The relativistic Doppler shift relation, Eq.11.6, will also match the measurable data. It also predicts $\nu_{\det.\pm} = \nu_{QM}$ when $\mathrm{v}_{rel.}$ is zero. However, Eq.11.6 cannot help us distinguish between the physically shifted frequency as generated by a moving atom and then being perceived as different frequencies due to relatively different velocities with respect to each other. According to QM theory, an atom would always emit ν_{QM}. However, the atom's finite velocity $\mathrm{v}_{spont.}$ would always shift the frequency to $\nu_{\det.\pm}$. We know that once an atom has emitted a wave packet, it does not have any more physical influence on it. There is no electromagnetic influence between the remotely situated emitter and the detector. The detector receives the wave packet with the shifted frequency $\nu_{src.\pm}$ due to source movement and this frequency can be perceived by the detector as a further modified frequency $\nu_{\det.\pm}$ due to its own movement with respect to the stationary vacuum (CTF). The only way to determine exactly this velocity is to find a resonant detecting atom ν_{QM}, from our knowledge of QM, and give it a controlled velocity $\pm\mathrm{v}_{stim.}$ until it perceives the already Doppler shifted $\nu_{\det.\pm}$ as ν_{QM}. Strictly speaking, even spectrometers are sensitive to relative velocity between the incoming wave packet and the wave-sustaining medium because the phase difference between the replicated beams generated by any spectrometers will be altered when the relative velocity is appreciable. Therefore, a miniature moving spectrometer can also carry out this job of registering ν_{QM} if it is given a velocity exactly equal to the source velocity $\pm\mathrm{v}_{stim.}$. Our key point is that a QM-congruent analysis and visualization of the physical processes behind the generation of selective laser mode in a gas laser clearly indicate that the Doppler shifts due to source movement and detector movement are separately identifiable.

In preparation for the next section, let us appreciate the origin of a dark spectral line, which is the absence of a physical signal, but still provides useful information about the atoms and their velocities. If we send white light through a Ne-discharge tube (without laser cavity mirrors and the discharge maintained below population inversion), a spectral analysis of the transmitted white light will show several dark lines at the frequency locations where one would normally find spontaneous Ne-emission lines. These dark lines will show the characteristic Doppler broadening because the Ne-atoms are moving with Maxwellian velocities and hence they perceive a range of frequencies in the white light as if they are all ν_{QM} .

Let us now imagine that this Ne-discharge tube is our new universe and the Ne-atoms are various little galaxy units. The free space between the Ne-atoms within a discharged tube is fundamentally the same as that between the excited atoms within the stars in the galaxies we study. However, there are also at least three macro differences. First, there is a wide variation in the mean free path between atomic collisions within the stars. Second, complexity of total physical fields experienced by atoms within some specific stars may be appreciably different from others; although spectral analysis implies that most stars are quite similar. And, third, the CTF through which light travels from distant galaxies to our earthly spectrometers may be subjected to complex variations beyond our current knowledge that may introduce *distant-dependent* variations in the EM waves, including their frequencies; etc.. Otherwise, the same set of rules of QM applies to the atoms in emission and absorption characteristics in the stars, and for spectral sources in our laboratory. So the line width characteristics of dark spectral lines in the spectra of distant star light should be recognized as those due to the velocities of emitting and absorbing atoms within the star. If the star, as a big "discharge tube", is moving with a very high velocity $\text{v}_{star\pm}$ with respect to the CTF, all the spontaneously emitted ν_{QM} constituting the white light from the inner layer will suffer a unique systematic line center frequency shift to $\nu_{CTF\pm}$ (now neglecting the Maxwellian Doppler broadening $\nu_{src.\pm}$). The necessary relation for the effective frequency generated in the CTF by a moving star can be derived from Eq.11.3 by substituting v_{star} for $\text{v}_{src.}$ and $\nu_{CTF\pm}$ for $\nu_{med.\pm}$:

$$\nu_{CTF\pm} = \frac{\nu_{QM}}{1 \mp \text{v}_{star} / c} = \nu_{QM} (1 \mp \text{v}_{star} / c)^{-1} \tag{11.11}$$

Then the moving earth with its velocity v_{earth} with respect to CTF will detect various absorption line-center frequencies for different galaxies, shifted as:

$$\nu_{earth\pm} = \nu_{QM} \frac{(1 \pm \text{v}_{earth} / c)}{(1 \mp \text{v}_{star} / c)} \tag{11.12}$$

Unfortunately, we still have not figured out how to determine the separate absolute velocities of stars and earth. Thus, our measurements of frequency shift, $\delta\nu = (\nu_{QM} - \nu_{earth\pm})$, does not give us a decisive tool to ascertain that the measured cosmological red shift definitely corroborates as due to Doppler shift, rather than some other distant dependent reduction in optical frequency.

However, for nearby stars within our galaxy, the Hubble redshift is almost negligible compared to the Hubble data for distant galaxies. But, our technology is now advanced enough to measure minute oscillatory Doppler shifts of star light due to rotating planets around it. Then Eq.11.11 can help us determine the vectorial $\vec{\text{v}}_{star}$ with respect to stationary CTF by sending out a rocket with a precision spectrometer. If we can impart to the rocket a vectorial velocity $\vec{\text{v}}_{rockt.} = \vec{\text{v}}_{star}$ (*zero relative velocity*), then the measured frequency of spectral line will match exactly to ν_{QM} , which we know. Then the rocket has mimicked the velocity of the star with respect to the CTF, $\vec{\text{v}}_{rockt.} = \vec{\text{v}}_{star}$.

Let us underscore our key point again behind the suggestion for the above experiment. The Ne-atoms in a He-Ne laser discharge tube play the roles of both emitters and detectors (spectrometers). They clearly demonstrate that the velocities of the emitters and those of the detectors are identifiable with respect to CTF that pervades the space between Ne-atoms, just as between the galaxies. Our knowledge of cosmological physics has not advanced enough to reject the classical Doppler shift by relativistic Doppler shift as the *final answer*. However, it is worth noting that the physical process of transferring the frequency to air by an acoustic oscillator would definitely be different from an oscillating atom transferring the frequency to CTF. Unfortunately, current QM formalism does not guide us to visualize this physical process. This is a definite shortcoming of QM as it stands now.

11.4.4. Expanding universe vs. energy absorptive CTF

The model of expanding universe derives from the consistently measured distant dependent red shift of the line centers of some characteristic dark lines in the spectra of stars. The accepted theory assumes a relative velocity $\mathrm{v}_{rel.}$ dependent Doppler shift, which itself is distance x dependent. This is also known as the Hubble's law, where $H_0 = 100h$ km/sec.Mpc, h being the fudge factor that can vary between 0.4 and 1.0 [11.21,11.22].

$$\mathrm{v}_{rel.} = \frac{c}{\nu}\delta\nu = H_0 x \tag{11.13}$$

It is also customary to use a red shift parameter z in terms of the relative velocity and the measured frequency shift:

$$z \equiv (\delta\nu / \nu) = (\mathrm{v}_{rel.} / c) \quad \Rightarrow \quad \mathrm{v}_{rel.} = cz \tag{11.14}$$

The measured value of z varies widely. For some galaxies, it can go as high as 3.8 for some galaxies and can be as high as 4.8 for some quasars. The galaxies in the Virgo cluster has z =0.004, yielding a velocity $\mathrm{v}_{rel.}$ = 0.004 c =1200km/s.

Explaining this cosmological redshift as a relativistic Doppler shift suffers from several problems besides distant quasars moving away from us at $\mathrm{v}_{rel.}$ = 4.8 c . A recent discussion on these issues can be found in [11.23-11.25]. Our view is as follows. (i) First, there is a nagging problem. The measured data for red shift show rather wide deviations from the linear distance dependency of the Hubble's law, indicated by the fudge factor h for the Hubble constant $H_0 = 100h$. So, there are other local phenomena involved, other than just distance dependent frequency reduction. (ii) Second, our understanding of the physical processes behind the longitudinal laser mode generation tells us that the Doppler shifts for optical radiation, due to moving emitter and detector, require separate identification of the velocities of the source and that of the detector. Rejecting this *asymmetric velocity dependence* (Eq.11.11) to preserve mathematical elegance and *symmetry* of special relativity may not be highly justifiable. (iii) Third, acceptance of $\mathrm{v}_{rel.}$ between galaxies at staggeringly large distances determining the frequency shift implies a basic violation of causality. Light coming to earth for frequency shift analysis from galaxies that lie at distances beyond five billion light years, were emitted before the Sun was even born! *A causal model would assume that neither the velocity of the distant galaxy, nor the velocity of earth, can influence the frequency of a propagating wave packet, except during emission and during measurement.* The velocities of the emitter and the detector, respectively, influence the physical processes at the time of emission and at the time of detection, but locally. The emitter and the detector cannot influence the properties of the waves during their long transit. Yet, the measurement consistently shows a clear distance dependency!

So, our postulate is that the a CTF, which supports the EM wave propagation across the galaxy, has a distant dependent *absorptive* property causing a very slow reduction in the frequency $\delta\nu = \beta x$, propagating through a distance x , independent of the emitting and detecting galaxies, where β represents the characteristic physical *absorptive* property of CTF. The frequency ν_{CTF} of a propagating wave packet, as generated by an emitting atom in CTF, does not remain constant in the long cosmic journey; it slowly decreases with distance of propagation. [Note that the frequency ν_{CTF} has a distribution (Maxwellian Doppler broadening) around ν_{QM} due to intra-star atomic velocity distribution]. Then, using Eq.11.14 we have:

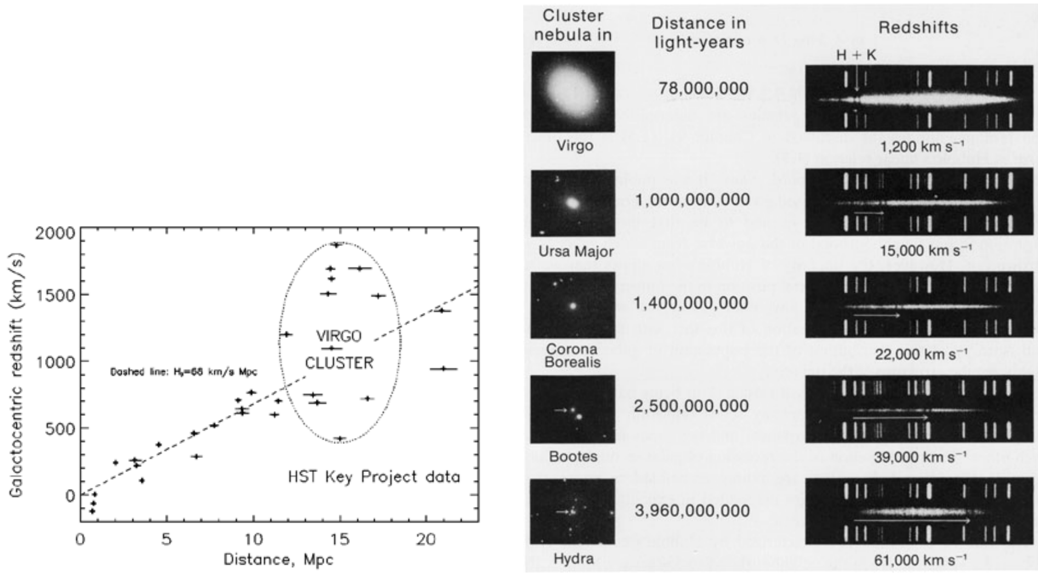
$$\delta\nu = \beta x \quad \Rightarrow \quad \beta = \delta\nu / x = (\nu / x)z; \quad \text{Or,} \;\; z = (x / \nu)\beta \tag{11.15}$$

The corresponding expression for the propagating plane wave can be expressed as:

$$E(x,t) = a(t)\exp i[2\pi(\nu_{CTF} - \beta x)t] \tag{11.16}$$

Now we can derive our distant dependent frequency loss factor β in terms of H_0 by using $\delta\nu$ as Doppler shift as used by Hubble and our assumption of $\delta\nu = \beta x$:

$$\mathrm{v} = H_0 x = (c/\nu)\delta\nu = (c/\nu)(\beta x) \;\; \Rightarrow \;\; \beta = (\nu/c)H_0 \tag{11.17}$$



(a) (b)

Figure 11.4. Hubble's law and frequency shift spectrographs. (a) Plot of galactic distance vs. red shift [11.29]. (b) Comparison of different amounts of red shifted dark absorption spectral lines for several galaxies [11.30].

Instead of computing β from H_0 , one can also down select a set of data for galaxies for which the distances are known without much ambiguity and then derive the slope β from $\delta\nu$ vs. x plot. Then use this β value to compute the distances for other galaxies and check whether it makes better sense. This could be a roundabout way of strengthening our proposed postulate. For example, z =4.8 would imply much larger distance. If it does not make sense from other analyses, then other local effects like intense gravitational field, etc., become relevant discussion issues. The role of CTF as a physical field with many complex physical properties should be considered seriously.

11.5. Massless particles as localized resonant harmonic oscillations of the CTF

Nature allows the existence of EM waves of every possible frequencies continuously from very long radio waves of one Hertz to all the way up to gamma rays of 10<20> Hertz that are capable of generating electron-positron pair under appropriate environment. In contrast, particles, whether stable (protons and electrons) or unstable (neutron, muons, pions, etc.), all exist as possessing unique and discrete amount of energy, as if quantized due to some underlying fundamental natural process [11.12d]. To our current state of knowledge, all resonances require some for of boundary conditions. *How can something becomes quantized in an unbound space?*

Let us now assume that CTF also possess some intrinsic dynamic properties that allows it to assume some localized self-looped vortex-like harmonic undulations, of which, some could acquire *resonant stability* within its surroundings giving rise to all the stable and semi-stable particles. We are suggesting that the generation of such self-looped harmonic undulations require some nonlinear energetic excitation of the CTF, which is yet to be modeled. This is different from the generation propagating EM waves by linear oscillation of some dipole. Linearly oscillating dipole-induced oscillation can be *pushed away* by the CTF to restore its original stationary state, giving rise to the perpetual motion of the waves. Such a conjecture is strengthened by the fact that from macro classical to micro quantum world, a very large number of phenomena consist of measuring and mathematically analyzing resonance phenomena. Watches for keeping 'time', LCR circuits for radio emitters and receivers are some examples of classical resonances. Measurement and analysis of stimulated absorptions and emissions from visible light to gamma rays by the appropriate entities like molecular, atomic and nuclear resonance processes underscore the key success stories behind the evolution of QM formalisms. The universe is basically full of resonances as the root of their existence and their associations and dissociations are more resonances guided by the principle of acquiring minimum possible energy states [11.12a,b,c,d].

Stable particles being localized self-looped resonant oscillations, they will remain stationary in space unless acted upon by some potential gradient in the CTF within the vicinity of the particle. This provides a rationale behind the observational validity of Newton's laws of motion. As long as the sum total perturbations at any local point do not exceed the linear restoration capacity of CTF, the linear waves will move through each other without perturbing each other's field amplitudes. This is another way of appreciating the existence of the universal NIW-property, valid for EM waves. This is not true for self-looped oscillation, we call particles, as they have developed some *structure* due to their harmonic but high frequency oscillations.

One can hypothesize that the spin quantization is one of the required properties to provide resonant stability to the 3D self-looped oscillations that will always have a preferred axis within the 3D CTF. Under the dynamic motion 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. The resonant (long lived) and semi-resonant (short lived) particles should possess a set of quantized energy values defined by all the intrinsic properties of CTF. In fact, the energy values of most of the particles have recently been actually found [11.12d] to possess an integer relation in terms of internal energy of an electron multiplied by $(2\alpha)^{-1}$, where α is the fine structure constant and l is an integer:

$$ {}^{rst.}_{p}E = {}^{rst.}_{el.}E(2\alpha)^{-1}l; \;\; \text{where } \alpha = (e^2 / 2h)(\varepsilon_0^{-1}\mu_0)^{-1/2} \tag{11.18} $$

Here, ${}^{rst.}_{el.}E$ and ${}^{rst.}_{p}E$ represent internal (or rest) energy of electrons and particles, respectively. This implies that the electronic charge e and the Planck's constant h are also two more intrinsic properties of CTF, which play key roles in bringing out the quantumness in the material universe through localized stable undulations. The unit of quantum h being 'erg.sec', it supports the hypothesis that the energy and the undulation periods of self-looped 3D *resonant* oscillations are inter-related

Note that the identities of the particles are expressed, as is conventional, in terms of their rest energy of the 3D oscillation, not in terms of Newtonian mass. Further, the energy is still contained by the CTF. The manifest oscillations and the concomitant properties, internal and around, represent the identity of the particles. Particles do not exist without the CTF, just like the propagating EM waves do not exist without the CTF. Waves and particles represent different manifestations of the same CTF energy. The energy is still contained within and by the CTF. However, the different kinds of oscillations allow for rule-driven interactions between them through energy exchange and undergo consequent physical transformations; which still remain as modified waves and particles. Our model of particles as 3D oscillation of 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 oscillations and 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, which move them.

11.5.1. The four forces as gradients imposed on CTF around the localized oscillations (particles)

We have postulated that the particles are 3D self-looped harmonic oscillations [1.8]; but generated by some nonlinear process. Thus, the local CTF field is *content* that the imposed perturbation is perpetually moving away with the velocity c, just like the propagating EM waves generated through linear perturbation. We now postulate that the *nonlinear physical processes* that generate these different kinds of high-energy self-looped waves, also give rise to several different kinds of potential gradients around these elementary particles. In addition, four of those gradients represent the physical causes behind our currently discovered four forces. The complexities of the structures of the oscillations of the particle determine the structure of the potential gradients around them. It is difficult to visualize how one can quantize these various potential gradients. Quantization comes from the fundamental structural stability of the various 3D oscillations and their assemblies and the consequent allowed quantized energy exchange between them.

We can separate out the gravitational force as purely a *mechanical depression* like the negative potential gradient imposed on the CTF around particles. 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 *electrical* potential gradients imposed on the CTF, generated through vortex movement 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 modeled. These two forces are long range and hence the gradients extend far out from the particle vortices, which are also linearly additive based on the number of particles in the assembly. The two nuclear forces have been found to be very short range and are quite complex [11.31]. Thus, just as the EM waves and the particles are emergent properties of CTF as different kinds of oscillations, the four forces are also associated emergent properties (gradients) of the same CTF. Thus, CTF provides a common substrate to re-start the development of a unified field theory.

11.5.2. Wave-particle duality for particles and locality of superposition effects between particle beams

Albeit generated through some nonlinear physical processes, the harmonic undulations of particles of internal energy E have been captured by Schrodinger for free particles as:

$$\exp(-iEt/\hbar) = \exp[-i2\pi\ ({}^{in.}f)t]; \quad \text{where } E = h\ ({}^{in.}f) \tag{11.19}$$

If we assume that a stable particle of energy E exists as some form of 3D structural oscillation of the CTF of a resonant frequency (${}^{in.}f$). Then we have particles as localized harmonic oscillations of specific amplitude-gradient of the CTF. Schrodinger's expression, $\exp(-iEt/\hbar) = \exp[-i2\pi\ ({}^{in.}f)t]$, represents a real physical undulation. It does not represent either a plane wave, or "*an abstract mathematical probability amplitude*". The "*Hidden Parameter*" is this physical frequency of oscillation already built into QM formalism. The phase of this oscillation becomes a critically important parameter when more than one particle tries to exchange energy on to the same quantum mechanical particle needing a discrete amount of energy to undergo QM allowed transition.

We can now re-write the Eq.11.18, using Eq.11.19, in terms of rest-frequency ratio of particles-to-electrons as:

$${}^{in.}_{p}f = {}^{in.}_{el.}f\,(2\alpha)^{-1}l \tag{11.20}$$

The internal frequency for an electron can be computed from $E = h({}^{in.}f)$ as ${}^{in.}_{el.}f \approx 1.23 < 20 >$. 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 self-looped-frequency of electron and positrons.

One can now appreciate that the heuristic concept of de Broglie wave or *pilot wave* is not necessary to understand why harmonic phases embedded in Schrodinger's ψ plays such a vital role in all of quantum mechanics. Since ψ represents the stimulation of a particle (in complex representation) for a single quantum transition, and $\psi^*\psi$ represents energy transfer as a real number for a single event (a quadratic process). Further, there is a very brief *quantum compatibility sensing interval* built into the mathematical step $\psi^*\psi$ [1.49; see also Ch.3]. During this time interval, all other ever-present and randomly passing-by particles and waves also try to share their energy by inducing their own stimulations on to the same particle, making ψ statistically dependent upon the background fluctuations. These background fluctuations can rarely match the QM resonance in strength and induce the QM-compatible strong linear undulations; but they can still perturb the stimulation process and share minute amounts of energies. Since we can never track and quantify these innumerable background stimulants, all QM formalisms will always have to remain statistical forever. This is, of course, already built into the current QM formalism as the step of taking ensemble average $<\psi^{*}\psi>$ [1.49].

We know that stable elementary particles remain stable even when they are accelerated to reasonably high velocities with high kinetic energy. Hence, their acquired, continuously variable, kinetic energy, most likely, have some separate manifestation than interfering with the internal 3D oscillations of CTF of energy $({}^{in}E) = h({}^{in.}f)$, which is at the root of its stability as a particle. More research would be needed to delineate this point. The particle's internal 3D oscillations, as a stable unit, are tied to all the various tension components built into CTF. Let us then postulate that stable particle oscillators can assume another kind of simpler 3D harmonic oscillation of frequency, ${}^{k}f$, associated with its acquiring translational kinetic energy as, ${}^{k}E = m\mathrm{v}^2/2$. Or,

$$ {}^{k}E = m\mathrm{v}^2/2 = h\ ({}^{k}f) \tag{11.22} $$

Then, we can create a *fictitious* wavelength parameter ${}^{k}\lambda$ using the logic that the particle travels a distance ${}^{k}\lambda = \mathrm{v}\ ({}^{k}f^{-1})$ while completing one cycle of its *kinetic oscillation* for a given velocity, which facilitates the kinetic movement through CTF, initiated by some force gradient in the CTF.

$$ ({}^{k}\lambda)({}^{k}f) = \mathrm{v} \Rightarrow ({}^{k}\lambda) = \mathrm{v}/({}^{k}f) = h\mathrm{v}/(m\mathrm{v}^2/2) = 2h/p \tag{11.23} $$

Note that our heuristic derivation gets, ${}^{k}\lambda = 2h/p$, instead of ${}^{k}\lambda = h/p$ derived by de Broglie [11.32,11.33]. The reason behind separating ${}^{k}f$ from ${}^{in.}f$ can be appreciated from the fact that a particle with zero velocity (momentum) cannot represent itself with infinitely long wavelength parameter ${}^{k}\lambda$. It becomes infinity when the kinetic energy (velocity) becomes zero. Thus, de Broglie ${}^{k}\lambda$ is a non-physical parameter. But our proposed ${}^{k}f$ tends to zero just as the kinetic energy tends to zero: ${}^{k}E = m\mathrm{v}^2/2 = h\ ({}^{k}f)$. We will now use this proposition to explain the phase-dependent superposition effects due to superposition of phase-steady (mono-velocity) particle beams.

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 arriving simultaneously and stimulating the same detecting molecule and all of them trying to transfer some of their energy, which would mathematically appear to be like a phase dependent interactions, or a superposition effect. The sharing of the quantity of the kinetic energy between any interacting particles is guided by the type of interaction. If the particle (detector) is being stimulated, is a resonant quantum entity, it will fill up its *quantum cup* by accepting the necessary amount of energy from all the donor stimulators present simultaneously as per QM recipe.

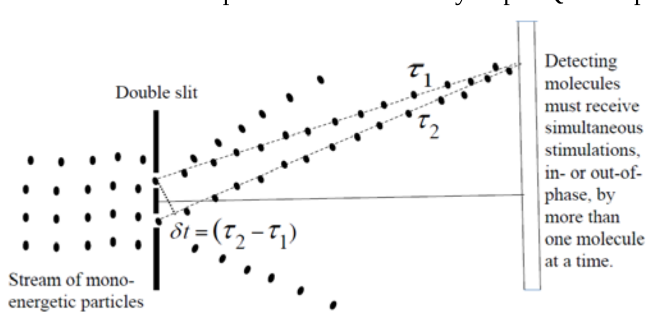


Figure 11.5..Understanding two-slit particle-beam superposition effect as due to multiple particles arriving in-phase and out of phase at different locations and correspondingly triggering very strong and very weak and phase-dependent energy transfer to detecting molecules. The detecting molecules absorb energy according to the QM recipe, square modulus of the sum of all the simultaneous stimulations it experiences.

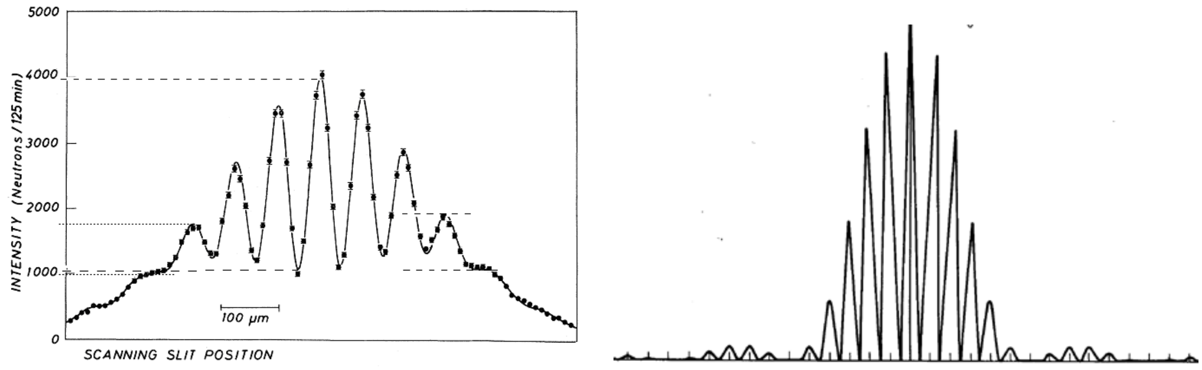
As depicted in Fig.11.5, mono-energetic particles with velocity v and corresponding kinetic frequency ${}^{k}f$, arrive at location P in the detectors surface with distinctly two different phase information, $\exp[i2\pi({}^{k}f)t]$ and $\exp[i2\pi({}^{k}f)(t+\tau)]$, due to their distinctly different propagation path dely. If χ is the linear response characteristic of the detecting molecules and the same molecule (or their assembly) experience two stimulations, $\psi_{1,2} = \chi \exp[i2\pi^{k} ft_{1,2}]$, then the spatial distribution of energy transfer and consequent transformation experienced (fringes registered) by the detector would be given by:

$$D(\tau) = \left|\chi\psi_1 + \chi\psi_2\right|^2 = \left|\chi e^{i2\pi^{k} ft} + \chi e^{i2\pi^{k} f(t+\tau)}\right|^2 = 2\chi^2[1+\cos 2\pi({}^{k}f)\tau] \qquad (11.24)$$

The absorbed energy comes from both the stimulating particles $\psi_{1,2} = \chi \exp[i2\pi^{k} ft_{1,2}]$; QM formalism of Eq.11.24 clearly implicates this. Trajectories of the individual particles are not mysteriously re-directed by some unknown force to create the fringes. The two different stimulating phases $\chi \exp[i2\pi({}^{k}f)t_{1,2}]$ are two causal signals brought by two real particles arriving simultaneously to stimulate the same detecting molecule at P. They have travelled different distances, $\tau = (r_2 - r_1)/\mathrm{v}$, where r_2 and r_1 are two distances to the same detector at the point P from the two slits.

If our postulate is correct that phase sensitive superposition effect generated by particle beams is due to particles acquiring harmonic oscillation ${}^{k}f$ due to velocity v, then it may not be impossible to generate same kind of superposition fringes by sending two different kinds of particle beams having the identical kinetic frequency through the two slits. Then the detecting particle will experience two distinctly different and causal *amplitude stimulations* $\chi_{1,2} \exp[i2\pi({}^{k}f)t_{1,2}]$ and absorb energy accordingly producing fringes of visibility less than that one can get using same kind of particle. This would clearly establish that the postulate, *single-particle-interference*, is not a causality-congruent hypothesis. We should underscore again that the detecting molecule must be a resonant energy absorber, which first experiences amplitude-amplitude stimulation and then extracts energy from all the stimulating fields (particles). This, of course, is already built into Eq.11.24; which is mathematically similar to light-detector stimulation.

Let us review the situation more critically. To bring back hard causality, we have posited that stable single indivisible particles, while propagating in a force-free region, cannot distribute their arrivals in some well-defined patterns, which we can be modeled analytically as due to two distinctly different physical path delays [1.26]. Simultaneous stimulation of the same detecting molecule by two or more particles is critical for in-phase or out-of-phase excitation is behind the generation of superposition effects due to particle beams. This is because, unlike EM waves, individual particles are not divisible and cannot diffractively divide as a classical coherent wave front does. Therefore, the only possible way to explain the phase driven superposition effect generated by detectors is to assume that a detecting particle must have a finite time of interaction to get stimulated before any quantum transition takes place. During this very short interaction period, if two exciting particles with opposite phases (of internal undulations) are superposed on a detecting particle, the detecting particle cannot be stimulated just as it happens when two EM undulations of opposite phases cannot stimulate a photo detecting molecule. What does this mean to fringe quality in particle-particle superposition experiments? Since most particles arrive with enough energy to be detected by the detecting particles, the "bright fringe" peaks will have relatively more "clicks" than the dark fringe minima. For dark fringe minima to remain 'zero' after a prolonged exposure, the stimulating particles must always arrive in even numbers with opposite phases to keep the detector particle from registering them at all. This is statistically almost impossible. In other words, our analysis implies that the minima in a two-slit particle diffraction experiment can never register 'perfect zero' even with the best possible experimental attempts.



(a) (b)

Figure 11.6. (a): A classic double slit neutron diffraction pattern by Zeilinger et al [Fig.7 in ref.11.34] as presented earlier [1.26]. Note that the visibility of the fringes even at the center of the pattern is barely 0.6 which indicates the detection (arrival of) a large number of neutrons at the null regions. We explain this as arrival of some random single neutrons besides simultaneous arrival of even number of neutrons with opposite phases. The phase we hypothesize is due to some actual internal sinusoidal undulations of the particles that dictate interactions capability with the detectors. The opposite phases required to generate the null fringes is not due to de Broglie *Pilot Waves*. (b): For the sake of comparison, we have copied a theoretical double-slit pattern of unit visibility, when one uses phase-steady optical beam [11.35].

$$\mathbb{V} = (I_{\max} - I_{\min}) / (I_{\max} + I_{\min}) \tag{11.25}$$

So, we are copying here in Fig.11.6, the classic two-slit neutron diffraction pattern by Zeilinger et. al. [11.34] as modified in Fig.7 of ref. [1.26]. The visibility of the cosine fringes, instead of being unity, it is steeply degrading with the angle starting from the center to the edge. Even at the center the visibility is only 0.6, far below unity. In the middle (3rd fringe from the center), the visibility is between 0.27 and 0.32. It is practically zero at larger angles even where the accumulated count is close to 300. In an optical two-slit experiment, one can easily register unit visibility fringes, shown for comparison in Fig.11.6b.

Another way to validate our proposed explanation for superposition effect due to particle beams would be as follows. Assume we are using a mono-energetic beam of Rb atoms through a two-slit system. The far-field detection plane contains a thick high-resolution photographic plate. The arrangement is such that the development of the photographic plate will show black and white fringes as predicted. The next question is as follows. Are the bright lines (the zeros of the fringe pattern in the photographic negative) completely free of Rb atoms? We suggest that this plate be illuminated by 780nm laser beam to generate resonant fluorescent spontaneous emission which can be recorded as a one-to-one quantitative image. Our prediction is that the distribution of Rb fluorescent intensity will resemble approximately the superposition of two slightly displaced Gaussian beams as classical *bullet* theory would predict.

Thus, by imposing interaction process visualization epistemology and assuming particles as 3D localized undulations, we find that QM has more realities built into it than the Copenhagen Interpretation has allowed us to imagine. Our hypothesis, particles as 3D localized oscillators, safely removes the *wave-particle duality* for particles; just as we have established for photon wave packets in Ch.10. Superposition effects due to EM wave beams and particle beams are two distinctly different but causal phenomena. The commonality derives from the detectors being quantum mechanical. Resonant detectors, due to phase-dependent joint stimulations induced by more than one physical beam, generate the measured superposition effects. Detectors with different intrinsic properties will generate different types of superposition pattern for the same set of beams. The quantumness observed in the data is due to the quantum mechanical energy absorption properties of the detectors used. Superposition of radio waves on an LCR-detecting circuit does not show any quantumness.

11.6. CTF-drag and special relativity

11.6.1. Is CTF four-dimensional?

Does CTF need to be four-dimensional? We have already proposed CTF as a physical tension filed representing the entire 3D space what we call vacuum. Thus, we need to address the issue whether there is a physical running time t that we need to incorporate and then make CTF as a 4D-field, or not. Interaction process guided thinking encourages us to question the physical process behind the measurement of a physical parameter we use in any practical theory. We have already discussed in section 1.2.2 that we have not yet discovered any physical object that possesses running time t as one of its primary physical parameters. Does CTF possess t as one of its primary physical parameters like $\varepsilon_0^{-1}, \mu_0, \alpha$, etc., which can be *dilated* and *contracted*? We have already proposed that its physical properties generate various types of its own undulations (propagating waves and vortex-like localized oscillation) of *different frequencies*. And we have been measuring some of these frequencies to define the secondary parameter, a *time interval*, $\delta t = 1/f$. We create the semblance of running time by counting larger and larger number of oscillations, $\Delta t = N\delta t$.

What about observation of extended life time of muons? It is quite logical to hypothesize that the life time of an off-resonant 3D oscillation is enhanced due to its high kinetic velocity induced oscillation, somewhat like the extra stability enjoyed by a biker as his wheels spin faster and faster. Muon's kinetic frequency may have altered, but its clock has not changed, because it does not have clock.

If CTF is not four dimensional, then the old *ether drag* question is brought out again [11.1]. We need a self-consistent explanation for all the traditional *ether drag* experiments:– (i) Bradley telescope parallax for stars due to earth's motion, (ii) Michelson-Morley null experiments to detect earth's motion around the Sun, (iii) positive and negative[12] Fresnel drag experiments for moving and non-moving medium within an interferometer, (iv) positive results of Signac's rotating ring gyro interferometer. All these experiments can be accommodated with two different hypotheses. One hypothesis could be that all material particles, or their assembly, like, earth and all stellar objects, drag the CTF in their immediate vicinity, which means that the drag should terminate at some distance that can be verified and mathematically modeled. The laboratory frame and CTF are then mutually at rest with respect to each other near the surface. If this assumption is correct, then CTF in the inter-galactic spaces must be stationary. Then, CTF should be experiencing inter-galactic shear velocities between planets and stars and galaxies. The effect will be to introduce minute second order transverse Fresnel drag on the star light traversing through inter galactic and inter planetary spaces.

The other assumption would be that material particles, and their assembly, like all major stellar objects, do not drag CTF. But CTF remains perfectly stationary within and all around stellar objects and individual particles. We intuitively prefer this second hypothesis, which matches with our understanding of EM waves, which does not drag CTF. The CTF just pushes away the perturbed undulating gradient imposed in it. In the same way, the particles are 3D oscillations of appropriate field gradients in the CTF; but the CTF itself is not moving. However, we believe that whether CTF is dragged or completely stationary, is still an unsolved problem. We discuss below only Fresnel drag experiment, along with our own experiment, since it shows both positive and null drag under different conditions.

11.6.2. Positive Fresnel's ether-drag, as measured by Fizeau, takes place only when water moves with respect to the light source!

Fizeau designed a brilliant two-way circular interferometer [11.36], somewhat like that of the Signac, to test Fresnel's proposition and to obtain a *positive* result by giving a finite velocity to the water inserted inside the interferometric path. The approach also avoided any controversy that could have been introduced by the four different velocities of the Earth due to axial spin, orbital rotation around the Sun, the rotation and the translation of the Sun in our Milky Way as it rotates and translates in the cosmic space. Fizeau nullified these motions by using a bi-directional circular propagation path for light in his interferometer (fig.11.7)! Fresnel derived his proposed drag based on arguments of electromagnetism consisting of two components, (i) stationary ether with the velocity determining factors for free space ε_0 and μ_0 and (ii) the changes on the values of ε_0 and μ_0 due to polarizability of the moving dipole assembly of the material [11.37]:

$$u' = \frac{c}{n} \pm \mathrm{v}_{water}\left(1 - \frac{1}{n^2}\right) \equiv \frac{c}{{}_{drg}n} \tag{11.25}$$

This is also derivable from Einstein's velocity addition theorem, neglecting (v^2 / c^2) terms:

$$u' = \frac{u \pm \mathrm{v}}{1 \pm u\mathrm{v/c}^2} \tag{11.26}$$

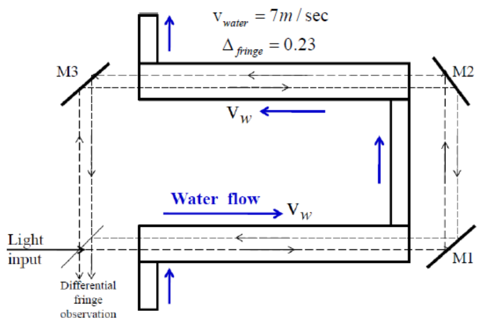


Figure 11.7. Fizeau found clearly measurable positive fringe shift quite close to that predicted by Fresnel using a two-way circular interferometer while imparting velocity to water in the tube. The fringe shift implies as if the ether (CTF) is being dragged by moving water.

11.6.3. Null Fresnel drag in the absence of relative velocity between the interferometer light source and the material in its arms.

It is clear from the positive Fresnel drag result that there is a partial increase and decrease of the velocity of light in moving water. In other words, the moving water does *drag* light. The question is whether it positively establishes a drag of ether (or CTF), as is generally believed and is also supported by the velocity addition theorem of Einstein (Eq.11.26). It is also possible, as per Fresnel's original assumption, that it has nothing to do with ether (or CTF). So, we wanted to test whether the axial spin velocity and the orbital rotational velocity of the Earth around the Sun can introduce any Fresnel drag due to a block of glass inside an interferometer. Either stationary CTF everywhere, or complete drag CTF on the surface of the earth, should produce null result. However, we recognized that we cannot emulate Fizeau's two-way ring interferometer of Fig.11.7 for our experiment. It is null by design made by Fizeau, as mentioned earlier. So, we set up a simple Mach-Zehnder interferometer with a glass block in one arm and air in the other. This is a one-way comparator interferometer shown in Fig.11.8. The light source and the glass block remain relatively stationary to each other on a small optical table sitting on a turntable free to rotate 360^0.

We have carried out this one-way comparator interferometer experiment and the result was null, $\Delta_{fringe} = 0!$, as we expected. Only high relative velocity with respect the earth could have produced positive result (fringe shift). The results are shown in Fig.11.8 and 11.9 [4.14] . The stationary glass block had a length of 11.5cm, which should have produced a shift of about 57 fringes due to earth's 30km/s orbital velocity as we rotated the interferometer by 180^o. The rotation was such that in one orientation, the laser beam travels through the glass block from the East to the West direction, then to the West to the East direction.

Either a complete drag of CTF around the vicinity of a moving material body, or complete stationary state of the CTF state, both accommodate the null results of Michelson-Morley and the theory of Special Relativity. Further, our inability to interferometrically measure the relative velocity between the Earth and the Sun also implies that CTF is stationary on the surface of the Earth. The velocity addition theorem of Special Relativity applies to Fizeau's experiment when there is a relative velocity between the light emitter (source) and the delay-generating material medium (flowing water). The Earth's velocity with respect to the Sun is not experienced by our glass-block because of complete drag of CTF, or complete stationary state of CTF. It makes the relative velocity between the light source and the glass-block zero. Alternate way of saying is that water moved relative to stationary CTF in Fizeau's experiment, but our glass-block remained stationary with respect to CTF. These experiments cannot discern between the two hypotheses: (i) CTF is stationary around earth (ether drag); (ii) CTF is stationary everywhere universally. We are accepting the second hypothesis to accommodate constancy of *c* everywhere. However, high altitude satellite based experiments are being considered.

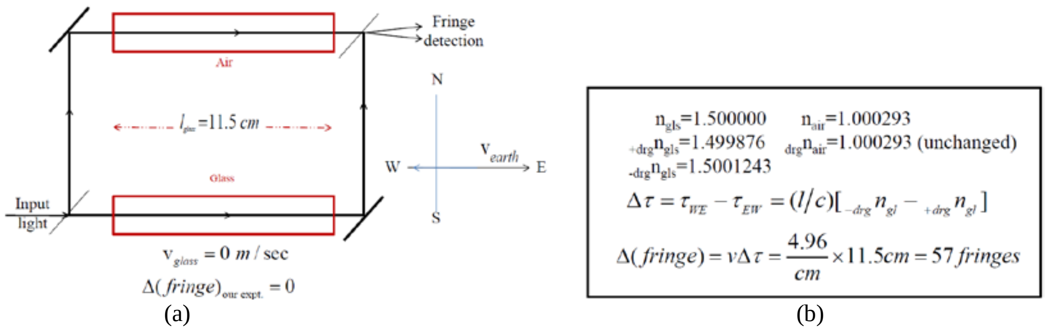


Figure 11.8. One-way comparator for relative phase delay between two arms of a Mach-Zehnder interferometer. One arm contains air, the other arm contains a glass block. The purpose was to find out relative phase delay due to Fresnel drag by the glass block that could be introduced due to the orbital velocity of the earth. As expected from the ether drag hypothesis, the result was null [4.14]. The sketch in (a) shows experimental arrangement. The in (b) shows the numerical computation that there would have been 57 fringe shift if CTF was not stationary with respect earth's surface.

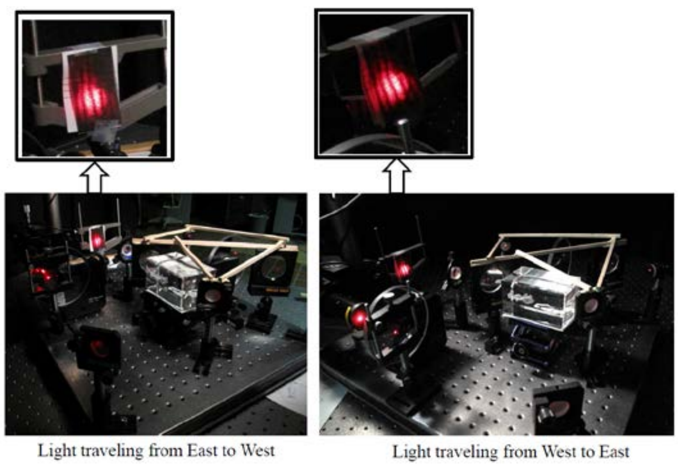


Figure 11.9. Demonstration of experimental null result of Fresnel drag due to a stationary glass block (fore-ground) in one arm of a Mach-Zehnder interferometer when the source is on the same turn-table. Unmoved fringes are visible in the background (fixed stationary screen on the interferometer table) while the interferometer base was rotated through 180^0 sitting on a turntable [4.14].

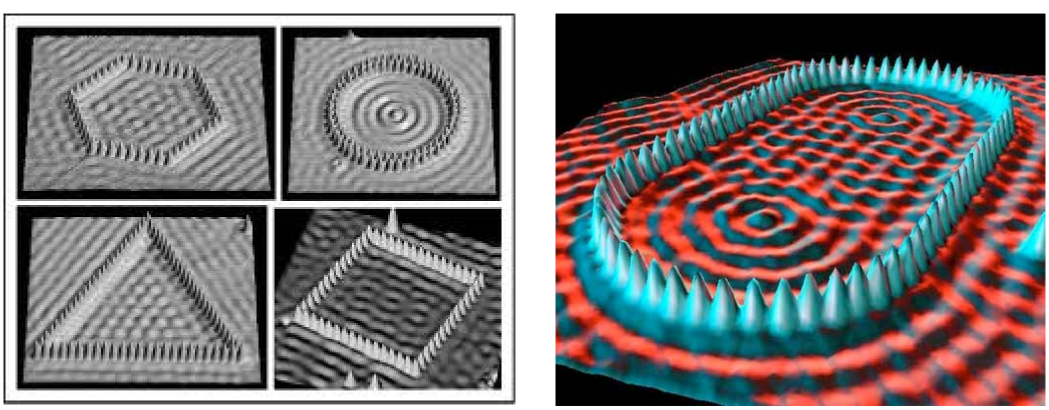
11.6.4. Do we really understand the physical significance of the velocity addition theorem?

We have seen in the last section that in interferometric experiments, relativistic velocity addition theorem works only if the there is a relative velocity between the light source and the delay-inducing material in the interferometer arm. We cannot detect any influence of the earth's orbital motion by this method. So, it is worth pondering over the limitations of working theories. If we do not fully understand the deeper physical meaning or process of a working theory, it is legitimate for us to question the utility of the foundational hypotheses behind such theories until we start understanding the invisible interaction processes that is being mapped by the working theory. If we cannot discover any interaction processes behind the phenomenon modeled by the theory, it is legitimate to question whether the theory really predicts the correct measured result by coincidence or not.

Consider a simple example of a pair of two-story high elevators; one is stationary and the other one is moving up as normal. A stationary observer from the top floor (the building as the inertial frame of reference) is computing the absolute and relative velocities of two persons walking up two separate elevators with absolutely identical personal speed, say, two-elevator-steps per second. Obviously, to the observer, the person walking on the moving elevator will have faster relative velocity than the person walking up the stationary elevator. The observer, of course, can apply the velocity addition theorem for the person walking up the moving elevator. At low velocities of the elevator and the walking person, Einstein's velocity addition theorem converts to the Galilean velocity addition theorem as we do in our daily lives. If I now imagine that the speed of the moving elevator and that of both the robotic persons have increased very close to that of light, of course, we will now claim that the velocity addition theorem will work because it has been found to work for accelerated elementary particles. Does it really matter from the perspectives of the two persons? Both of them have been walking with the same speed (low or very high) with respect to the elevators! Would the electromagnetic properties of the body molecules of the person walking on the moving elevator behave differently than those of the person walking on the stationary elevator? Their movements relative to the local CTF becomes a relevant issue. The answer is yes, and Fresnel drag already establishes that the effective dielectric constant does change.

11.6.5. Existence of CTF may be corroborated by atomic corral recorded by AFM pictures

We already know that atoms and electrons do not have sharp boundaries. The advent of nano technologies are now giving us deeper glimpses behind the workings of atoms and molecules. Consider the two corrals of atoms arranged by nano tip tools and pictured by scanning AFM. The extended boundaries of all the atoms clearly influence each other to create superposition patterns of resultant extended field gradients which implicates harmonic oscillatory behavior even when their center of oscillation is stationary (Fig.11.10). The symmetric patterns of extended *fields* around the arranged atoms clearly indicate that organized collective extension of the oscillatory fields of the patterned atoms can be considered as modified CTF that appears to stay with the array of atoms. However, such patterns does not help us resolve the issue whether CTF itself is mobile with moving atoms, or only the field-gradients move, just as it is for EM waves, while CTF itself remains stationary. Of course, the extended beautiful *superposition patterns of field gradients* have been facilitated by other atoms on the surface of the substrate. But, the extended influence of the fields due to the symmetrically placed individual atoms through many atomic distances is clear. *From our existing knowledge of atoms getting self-organized to form crystals out of solutions, the corral pictures below make perfect sense as extended guiding fields for new arriving atoms.* These recorded corral patterns, extending beyond many atomic diameters, were stationary in the lab, otherwise these slow meticulous measurement could not have been registered [11.38-11.42]. 30km/sec earth's orbital velocity clearly did not distort these corral patterns. So there is no local drag of CTF at the atomic dimension, just as it is for the macro surface of the earth.



(a) (b)

Figure 11.10. Quantum Corrals of atoms in many different arrangements recorded by Scanning Tunneling Microscope (STM). The reader should note that there are spatially extended stationary but *superposition-effect-like* oscillations of the measured AFM signals around the measured *atomic fields*, which are stationary. One can postulate that each atom is a localized oscillation of the CTF, which creates phase-oscillating potential gradients around it. Superposition of many stationary but harmonically oscillating

potential gradients, corresponding to the periodically arranged atoms, creates the spatially periodic superposition patterns. Stationary states of these various superposition patterns extending over many atomic distances implicates that the CTF, which supports all these oscillatory gradients, must be spatially stationary with undulating local field values. The CTF (ether) is not dragged by atoms [from the web; 11.41, 11.42].

However, it is worth pondering over the root cause behind the emergence of the stationary, superposition effect-like wave pattern in the corrals, which vary depending upon the physical arrangement of the single atoms. One can propose a rational hypothesis that the atoms are some kind of localized oscillation of the CTF of finite extent. This oscillation generates symmetric and oscillatory potential gradient around each atom, whose amplitude die out after certain distance. It is the superposition of these extended but localized oscillatory potential gradients of CTF due to the orderly array of atoms, which generate the wavy corral patterns. In other words, the appearance of a pair of image-like single-atom bumps within the race-course-like corral (Fig.11.10b) do not represent any "virtual atom" [11.38], but in-phase superposition of oscillatory gradients due to all the neighboring atoms.

Based upon the observation that EM waves do not interact with each other like tension-field based classical waves, we have revived the old *ether*, but as a pure but complex field containing diverse attribute necessary to accommodate EM waves as a perpetually propagating wave and particles as localized resonant self-looped oscillations. This model clearly finds distinctly different physical explanations for various physical phenomena along with potential experiments to validate or invalidate the CTF hypothesis.

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