11 NIW Property Requires Complex Tension Field (CTF)

"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

11.1 INTRODUCTION

Since ancient times, optical physics has been playing the key role in triggering new concepts and theories in modeling diverse observations in nature. Up to Chapter 10, this book has been essentially devoted to explaining the impact 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 the emergence and development of modern physics. This chapter ventures into proposing several potentially far-reaching concepts [1.8] to bring back hard causality in physics by leveraging the causal model for photon developed in Chapter 10. We simply extend the logical consequences of the universal NIW property of EM waves [2.1].

Our causal model for photons is a diffractively propagating classical wave packet, which conforms well 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 direction. 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 a Doppler frequency shift, very much like classical waves supported by material-based tension fields. An example would be 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 is generated in the CTF due to the release of some energy by a different manifest agent (like an excited atom) of the CTF, which is capable of triggering the harmonic undulation of CTF's potential electric vector field. Once generated, the wave group 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 Chapter 4). This is very much like we are trying to revive the old ether theory [11.1] of the 19th century, even though the prevailing belief is that modern physics has decisively established space to be an empty vacuum, as was 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, but produced through some nonlinear excitations (yet to be modeled), in contrast to linear stimulations by material dipoles, which generate propagating linear 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 toward the identification of space as having some tension field-like properties. However, the concept was not followed through.

The 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 that we have been using for a couple of centuries (see Section 12.7.2). The CTF postulate also helps us to eliminate the noncausal and noninformative hypothesis of *wave–particle duality* we used 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 this tension field as possessing the properties ε_0^{-1} and $\propto_0$ to propel the EM waves as linear undulations with the perpetual velocity $c^2 = (\varepsilon_0^{-1}/\propto_0)$ 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 $\propto_0$ 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 throughout mathematical theories, it does not provide any serious guidance to appreciate, or visualize the physical processes in nature that account for this measured fact and make it out to be the final ontological reality of nature [11.4]. CTF provides us with a physical substrate that allows the physical processes to 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 nonlinear 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, $\alpha = (e^2/2h)(\varepsilon_0^{-1}\propto_0)^{1/2}$, where as 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 a discrete amount to maintain the resonant stability. This is in contrast to the continuous energy exchange between emergent macro assemblies where the resonant states have become a 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 worlds. Planck's law underscored this reality. The quantum mechanical behavior of Planck's radiation law, derived by using data from the 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 electrochemistry. Physically, it is not possible for us to directly perceive the CTF in which we are just assemblies of diverse oscillations and our thinking is some form of complex emergent property of some subassemblies 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 find dark energy separately [11.13–11.15], and perhaps even the dark matter [11.16], to account for the total energy of the universe.

We are postulating that the hundred percent of 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 becomes understandable as a causal rule. However, if the CTF also functions as a weak but energy-recycling sink, then cosmological and particle physics may have to accommodate an explicit form of an energy-recycling process through the CTF that violates our current form of the law of the 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 AS 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 that are 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 the late 17th century. The other three forces are electromagnetic force and strong and weak nuclear forces, recognized during the 19th and 20th centuries. We also have secondary forces like van der Wall's 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 gathered throughout his career and that of 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 is evidenced from Newton's remark quoted in the beginning of this chapter). 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 that 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 rekindled 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 emphasizes that congruency between the predictions of a theory and the measured data, does not make the theory as the *final law* of nature. 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 the 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-periods represent 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 intervals 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 learned 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. Time is, of course, an essential *secondary parameter* to formulate the dynamics of interaction between particles and EM waves, which are behind all terrestrial and cosmic phenomena. We should be cautious about 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 learned 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. The diverse physical properties of CTF directly influence determination of 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 free space has a physical property, ε_0, that we call the *dielectric constant*. Magnetostatics gave us the physical property of the magnetic permeability of free space $\propto_0$. 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 $c^2 = (\varepsilon_0^{-1}/\propto_0)$, then the space ought to have the physical attributes corresponding to ε_0^{-1} an $\propto_0$, which ushered in the concept of ether but was 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 (like spatially varying gradient in CTF) to explain electrostatic and magnetostatic 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 primary school to get 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 (Figure 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

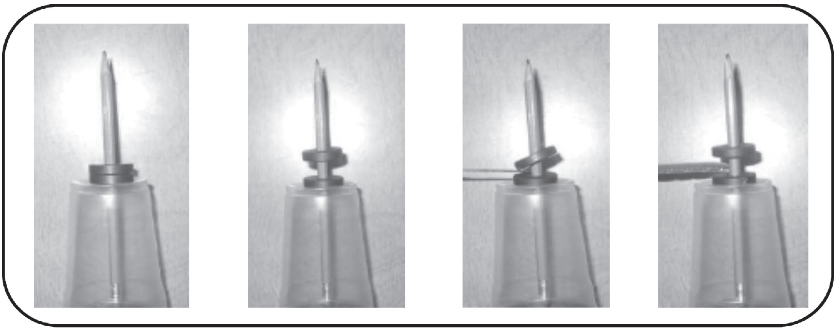


FIGURE 11.1 Space is not empty. A kindergarten experiment to remind ourselves that the space between a pair of magnets with same poles facing each other floats and the space in between contains magnetic and gravitational fields. (a) With opposite polarities, the magnets snap together. (b) With the same 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) A wooden knife cannot perturb the magnetic field between the magnets, so they keep on floating.

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 an 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.

11.2.4 Modern Quantum Theories

Starting with Schrodinger's *wave* equation [11.19] and moving on to the latest set of string theories [1.31], all show that the structure of mathematical equations resemble some form of field or wave. Some of the theories have *discovered* the existence of *zero point energy, quantum foam, background fluctuations,* and so forth. If a theory is consistently validated through 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 *works in progress*, and are never final. So, the emergence of mathematical results implying the existence of *quantum foam*, for example, 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 that 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. An infinitely extensive wave requires infinite energy, which is simply impossible in nature (see Figure 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 the 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 noninteracting. 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 revisit the comparison between the two wave equations copied from Chapter 4, Equation 4.7 (for mechanical string waves; read from left to right) and Equation 4.8 (for EM waves; read from right to left):

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

$$\propto_0\Delta x\frac{\partial^2 E(x,t)}{\partial t^2} = \Delta(\varepsilon_0^{-1}\sin\theta) \Leftarrow \propto_0\frac{\partial^2 E(x,t)}{\partial t^2} \approx \frac{\Delta}{\Delta x}\left(\varepsilon_0^{-1}\frac{\partial y}{\partial x}\right) = \varepsilon_0^{-1}\ \frac{\partial^2 y}{\partial x^2} \Leftarrow \frac{\partial^2 E(x,t)}{\partial t^2} = \frac{\varepsilon_0^{-1}}{\propto_0}\frac{\partial^2 E(x,t)}{\partial x^2} = c^2\frac{\partial^2 E(x,t)}{\partial x^2} \tag{4.8}$$

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 that causes it to adapt to the other alternative option of perpetually pushing away the imposed perturbed energy through an infinite string. For a finite string, a 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 restructure Maxwell's wave equation as in Equation 4.8 (just shown) to emulate the string wave equation, we can interpret ε_0^{-1} as its intrinsic electric tension field (like T of the string) and $\propto_0$ as the countering response as the magnetic tension field (through the generation of magnetic field). Maxwell's wave equation derives $c^2 = (\varepsilon_0 \propto_0)^{-1}$, which implies as if ε_0 and $\propto_0$ 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 their 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 $\propto_0 \Delta x(\partial^2 E/\partial t^2)$. 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 $c^2 = (\varepsilon_0^{-1}/\propto_0)$.

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 the CTF.

$$\mathrm{v}^2 = \frac{B}{\rho}(\text{sound wave}) = \frac{T}{\sigma}(\text{string wave}) = \frac{\varepsilon_0^{-1}}{\propto_0}(\text{EM wave}) \tag{11.1}$$

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 VERSUS 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 toward the lower frequency (red shifts toward 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 the farther the distance of a galaxy, the 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 the 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 was 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 to 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 to be stationary. Then the physical origin of the Doppler shifts due to source movement, and the detector movement is 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 [11.26, 11.26a,11.27].

Detector moving: Let us first consider the case of a stationary source with the detector moving toward ($+v_{det.}$) or away ($-v_{det.}$) from it. 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 on whether it is moving toward or away from the stationary source (Equation 11.2). We have used the simple Galilean velocity addition theorem to obtain the perceived velocity for the wave crests, $c \pm \nu_{det.}$, 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 [11.26, 11.26a].

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

Source moving: Let us now consider the cases for the source moving toward 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 troughs, 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 $\lambda_{med.} = (c \mp \nu_{src.})/\nu_{src.}$. 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, 11.26a, 11.26b, 11.26c, 11.27]:

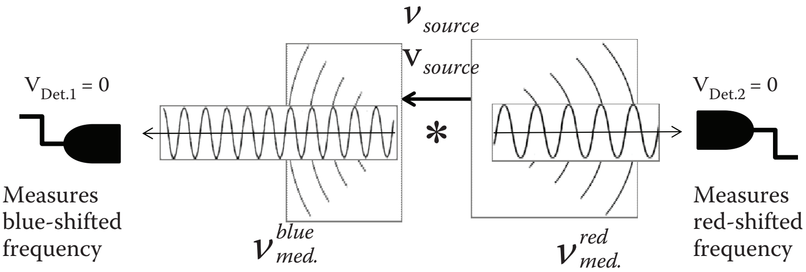
$$\nu_{med.\pm} = \frac{c}{\lambda_{med.}} = \frac{c}{(c \mp \nu_{src.})/\nu_{src.}} = \frac{\nu_{src.}}{1 \mp \nu_{src.}/c} = \nu_{src.}(1 \mp \nu_{src.}/c)^{-1} \tag{11.3}$$

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

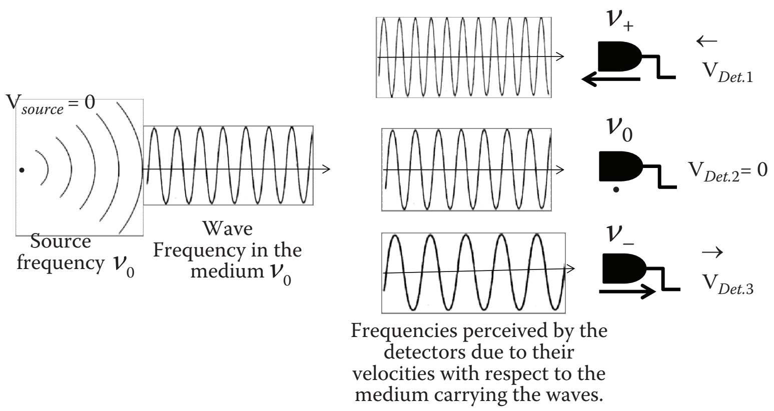
One should note that the previously given two expressions for frequency shifts, Equations 11.2 and 11.3, are not symmetric because *the two physical processes behind these shifts are different.* In the first case, the source being stationary, the propagating wave in the stationary medium maintains the source frequency, but the *moving detector's oscillator* undulates faster or slower, depending on its own velocity (toward 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 on whether it is moving toward or away from the stationary detector. Note that it is not subjectively dependent on whether the detector is physically present. The frequency shift is physical and permanent, as the wave packet travels with this new shifted frequency in the medium. However, when $\nu_{src.}/c$ is very small, a binomial expansion and rejection of terms of orders $\nu_{src.}^2/c^2$ or higher, will make Equation 11.3 appear identical to Equation 11.2. Enforcing this mathematical symmetry suppresses our enquiry into the physical processes, which are really different. However, this approximation allows one to obtain the identical Doppler shift $\delta\nu_{Doplr.}$ for both cases. This is routinely used for most measurements, even for light waves, where "v-sub-src." and "v-sub-det." are replaced by the same "v-sub-rel.", representing the relative velocity between the source and the detector.

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

Both source and detector moving: We will now disregard this approach to optical Doppler effect as only due to relative-velocity and assume that the behavior of optical sources and detectors are determined by their respective velocities with respect to the CTF. Accordingly, let us now synthesize the Equations 11.2 and 11.3 (see Figure 11.2). There are four possible cases of perceived (or measured) frequency



(a)



(b)

FIGURE 11.2 The Doppler blue and red frequency shifts can be perceived by a detector 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! So 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. The same is true for light waves in CTF.

shifts by the detector given in Equation 11.5, which is derived by switching $\nu_{src.}$ in Equation 11.2 by $\nu_{med.}$ (because the source is moving) and then substituted for $\nu_{med.}$ from Equation 11.3:

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

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 $\pm\mathrm{v}_{\det.}$ with respect to the air. The only way to rediscover 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 Equation 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 $\mathrm{v}_{\det.}$ and $\mathrm{v}_{src.}$ separately as the absolute velocities with respect to the air. In general, whenever $\mathrm{v}_{\det.} \neq \mathrm{v}_{src.}$, 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, the Special Theory of Relativity (SRT) has been framed, based on the relative velocity only. Application of relativity to derive the Doppler shift then has only one velocity $\mathrm{v}_{rel.}$ to consider; even when one conceptually frames the problem either as the source moving, or as the detector moving. One incorporates the relativistic wavelength length contraction, $\lambda\gamma^{-1} = \lambda(1-\mathrm{v}^2/c^2)^{1/2}$, 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 to it the physical properties of *length contraction* and *time dilatation*. The standard relativistic Doppler shift, which is the counterpart of the classical relation Equation 11.5, would be given by

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

Note that the relativistic Equation 11.6 contains only the relative velocity between the source and the detector. But the Equation 11.5 contains identifiable velocities of the source and the detector with respect to the stationary air for sound, or, CTF for light. When this relative velocity is $v_{rel.} = 0$, the detector registers the original source frequency, $\nu_{det.\pm} = \nu_{src.}$, just as in the classical case for sound waves (Equation 11.5). However, unlike for the classical Doppler shift as in Equation 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 minuscule Doppler shifts [11.28b] is a classical Doppler shift for EM wave frequency as we are explaining here, which is different from the cosmological red shifts shown by distant galaxies.

11.4.3 Origin of Longitudinal Modes in Gas Laser Cavity Helps Distinguish 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 this appears to be true due to the limitations of our current theories. Let us analyze the physical processes behind the emergence of multiple longitudinal modes (frequencies) from gas laser cavities, because of the inhomogeneously broadened spontaneous emission gain line width, which is approximately 1.5 GHz wide for He-Ne lasers [4.1, 4.2]

The spectral broadening (frequency distribution) of Ne-spontaneous emission, shown in Figure 11.3, is due to Doppler shift caused by random Maxwellian (Gaussian) velocity distribution of the Ne-atoms within the laser discharge tube. But 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

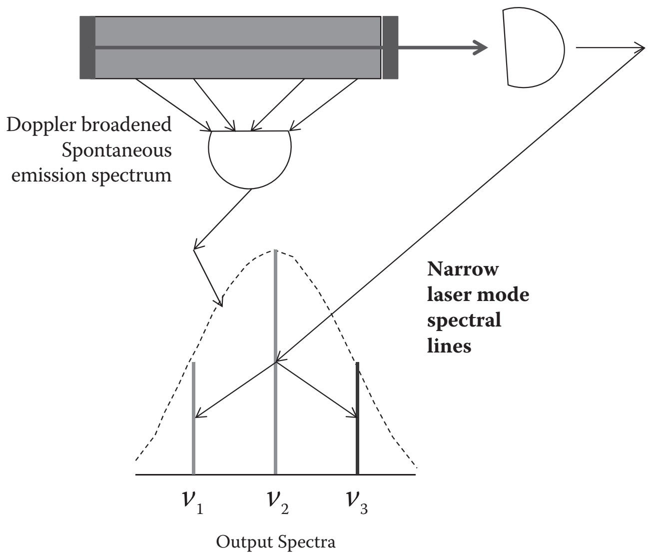


FIGURE 11.3 Simultaneous spectral analysis of spontaneous and laser light from a He-Ne laser validates that Doppler frequency shift due to source-only velocity and detector-only velocity are two separate and independent physical effects, even though the mathematical expression can be shown to be approximately 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.

the laser axis) and from the side of the discharge tube, respectively. For a He-Ne laser, with $\Delta\nu_{Doplr.} = 1.5GHz$, the mode spacing for a 30 cm 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 Figure 11.3.

To understand the frequency spread of spontaneous emission, let us rewrite Equation 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 $v_{spont.}$ 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 Equation 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 (Equation 11.3):

$$\nu_{src.\pm} = \frac{\nu_{QM}}{1 \mp v_{spont.}/c} = \nu_{QM}(1 \mp v_{spont.}/c)^{-1} \quad (11.10)$$

Let us now rewrite the classical Doppler shift relation, Equation 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 $v_{spont.}$ and $v_{stim.}$ as that of a Ne-atom (detector) undergoing stimulated absorption:

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

We can safely assume that for subrelativistic 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 sameν_{QM}. For an atom to be stimulated as a detector, it must *perceive* the frequency of the passing by stimulating wave packets having the same QM-transition-allowed frequency ν_{QM}. This is impossible in a discharge tube because all atoms, emitters, and absorbers are moving with finite velocities in different directions, and the frequency of the emitted wave packets are no longer ν_{QM}. The moving to-be-stimulated-atoms 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 Equation 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. 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, would be in the process of getting reexcited 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 as having carrier frequencies given by Equation 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 their physical carrier frequency $\nu_{QM} \pm \delta\nu$ does not match the frequency set dictated by the cavity round-trip phase-matching condition shown as Equation 11.7. This is why inhomogeneously broadened gain media do not make very efficient lasers.)

The relativistic Doppler shift relation (Equation 11.6) will also match the measurable data. It also predicts $\nu_{\det.\pm} = \nu_{QM}$ when $v_{rel.}$ is zero. However, Equation 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}. But the atom's finite velocity $v_{spont.}$ 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 exactly determine this velocity is to find a resonant detecting atom ν_{QM}, from our knowledge of QM, and give it a controlled velocity $\pm v_{stim.}$ 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. So, 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 $\pm v_{stim.}$. 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 in a discharged tube is fundamentally the same as that between the excited atoms within the stars in the galaxies we study. But, 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. Otherwise, within our measurable accuracy, 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. This is why the line width characteristics of dark spectral lines in the spectra of distant star light are recognizable 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 $v_{star\pm}$ 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 Equation 11.3 by substituting v_{star} for $v_{src.}$ and $\nu_{CTF\pm}$ for $\nu_{med.\pm}$:

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

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:

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

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 red shift 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 Equation 11.11 can help us determine the vectorial $\vec{v}_{star}$ with respect to stationary CTF by sending out a rocket with a precision spectrometer. If we can impart to the rocket a vectorial velocity $\vec{v}_{rockt.} = \vec{v}_{star}$ (*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, $\vec{v}_{rockt.} = \vec{v}_{star}$.

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 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 versus Energy-Dissipative CTF

The model of the 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 $v_{rel.}$ dependent Doppler shift, which itself is distance x dependent. This is also known as the Hubble's law, where $H_0 = 100h$ km/s Mpc, h being the fudge factor that can vary between 0.4 and 1.0 [11.21, 11.22].

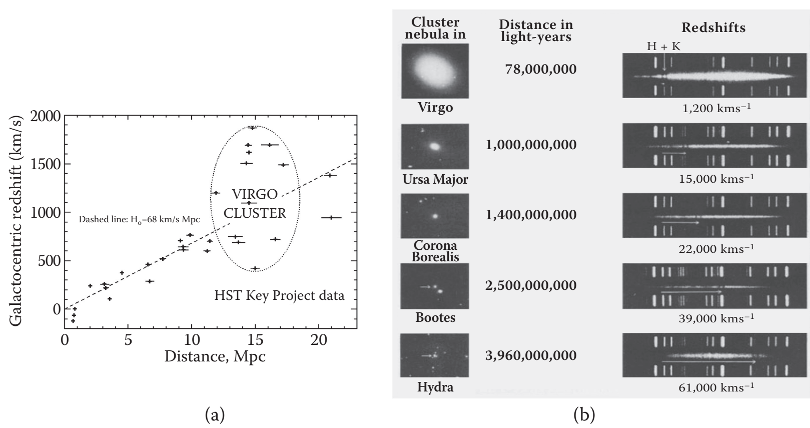
$$v_{rel.} = \frac{c}{\nu}\delta\nu = H_0 x \tag{11.13}$$

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

$$z \equiv (\delta\nu/\nu) = (v_{rel.}/c) \quad \Rightarrow \quad v_{rel.} = cz \qquad (11.14)$$

The measured value of z varies widely. For some galaxies, it can go as high as 3.8 and can be as high as 4.8 for some quasars. The galaxies in the Virgo cluster has $z = 0.004$, yielding a velocity $v_{rel.} = 0.004c = 1200$ km/s (see Figure 11.4).

Explaining this cosmological red shift as a relativistic Doppler shift suffers from several problems besides distant quasars moving away from us at $v_{rel.} = 4.8c$. A recent discussion on these issues can be found in [11.23–11.25]. Our view is as follows. First, there is a nagging problem. The measured data for red shift show rather wide deviations from the linear distance dependency of Hubble's law, indicated by the fudge factor h for the Hubble constant $H_0 = 100h$. So, there are other local phenomena involved, besides just distance-dependent frequency reduction. 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* (Equation 11.11) to preserve mathematical elegance and *symmetry* of special relativity may not be highly justifiable. Third, acceptance of $v_{rel.}$ 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 physical processes at the time of emission and at the time of detection are influenced locally by the velocities of the emitter and



(a) (b)

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

the detector, respectively. The emitter and the detector cannot influence the properties of the waves during their 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 we are neglecting for this part of the discussion the frequency ν_{CTF} has a distribution [Maxwellian Doppler broadening] around ν_{QM} due to intrastar atomic velocity distribution.) Then, using Equation 11.14 we have

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

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 $\delta\nu = \beta x$:

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

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 $\delta\nu$ versus 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, intense gravitational field, 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 1 Hz to all the way up to gamma rays of 10<20> Hz that are capable of generating electron–positron pairs under appropriate environments. In contrast, particles, whether stable (protons and electrons) or unstable (neutron, muons, pions, etc.), all exist as possessing unique and discrete amounts of energy, as if quantized due to some underlying fundamental natural process [11.12d]. *With our current state of knowledge, all resonances require some form of boundary conditions*. How can something be quantized in an unbound space?

Let us now assume that CTF also possesses some intrinsic dynamic properties that allows it to assume some localized self-looped doughnut-like or similar 3D harmonic undulations, of which some could acquire *resonant stability* within its surroundings, giving rise to all the stable and semistable 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 and understood. This is different from the generation and propagation of EM waves induced by linear oscillation of some dipole. Such 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 consists of measuring and mathematically analyzing resonance phenomena. Watches for keeping "time" and 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 particles, as they have developed some *structure* due to their self-looped harmonic 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 $\propto_0$, possibly become manifest as charge and magnetic moment gradients, 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 found [11.12d] to actually 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:

$$ {}^{rst.}_{p}E = {}^{rst.}_{el.}E(2\alpha)^{-1}l; \quad \text{where } \alpha = (e^2/2h)(\varepsilon_0^{-1}\propto_0)^{-1/2} \tag{11.18} $$

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 self-looped resonant 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 interrelated due to the success of the relation $E = h\nu$.

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*; particles are its excited states only. 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. But 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 that move them.

11.5.1 Four Forces as Gradients Imposed on CTF around 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. And 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 gradients are generated only around charged particles. Perhaps, stable particles are doughnut-shaped oscillations of the CTF. The gradients of opposite polarity are imposed by outside-in and inside-out spiralling oscillations. 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 like 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 restart 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 an internal resonant frequency $({}^{in.}f)$ as spiralling doughnuts. 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 apparent "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 onto the same quantum mechanical particle needing a discrete amount of energy to undergo QM-allowed transition, which is behind the superposition effect.

We can now rewrite Equation 11.18, using Equation 11.19, in terms of rest-frequency ratio of particles-to-electrons, as in

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

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 pushable 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. 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 Chapter 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 onto the same particle, making ψ statistically dependent on 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, has 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 nonphysical parameter. But our proposed ${}^{k}f$ tends to zero just as the kinetic energy tends to zero: ${}^{k}E = m\mathrm{v}^2/2 = h\,({}^{k}f)$.

Let us briefly return to the limiting velocity for particles, which we left unanswered earlier.

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, stimulating the same detecting molecule, and all of them trying to transfer some of their energy, which would mathematically appear to be like 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

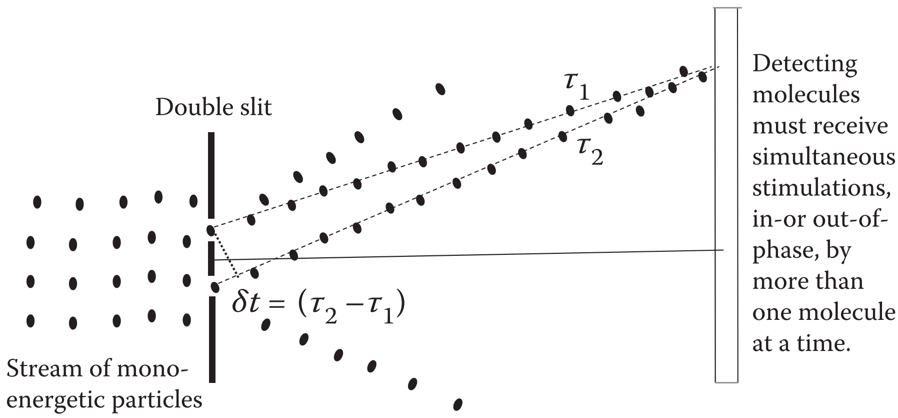


FIGURE 11.5 Understanding two-slit particle-beam superposition effect as due to multiple particles arriving in-phase and out of phase at different locations and correspondingly triggering very strong, very weak, and phase-dependent energy transfer to detecting molecules. The detecting molecules absorb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

(detector) is being stimulated or 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.

As depicted in Figure 11.5, monoenergetic 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 delay. If χ is the linear response characteristic of the detecting molecules and the same molecule (or their assembly) experience two stimulations, $\psi_{1,2} = \chi \exp[i2\pi {}^{k} f t_{1,2}]$, 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 $\psi_{1,2} = \chi \exp[i2\pi {}^{k} f t_{1,2}]$; QM formalism of Equation 11.24 clearly implicates this. Trajectories of the individual particles are not mysteriously redirected 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 traveled 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 the 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 that accordingly producing fringes of visibility less than that obtained using the 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 Equation 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 and 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.

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

So, we are copying here in Figure 11.6, the classic two-slit neutron diffraction pattern by Zeilinger et al. [11.34] as modified in Figure 7 of Reference [1.26]. The visibility of the cosine fringes, instead of being unity, is steeply degrading with the angle starting from the center to the edge. For a recent experiment with heavy molecules, consult [11.34a]. Even at the center the visibility is only 0.6, far below unity. In the middle (third 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 fringe [6.9]; computed two-slit fringes are shown [11.35] for comparison in Figure 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

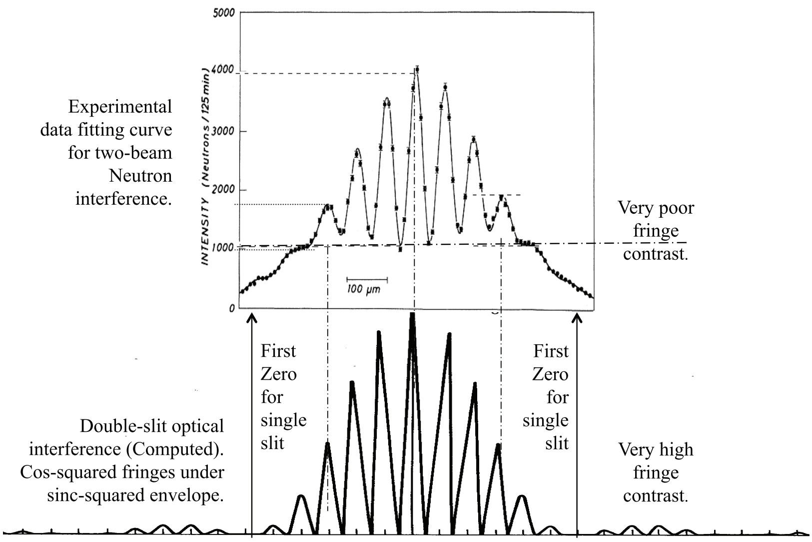


FIGURE 11.6 Comparison of double-slit diffraction patterns due to neutrons (upper curve; experimental) and optical (lower curve; computed). A classic double-slit neutron diffraction pattern by Zeilinger et al. [Figure 7 in Reference 11.34] as presented earlier [1.26]. Note that the visibility of the 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 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.

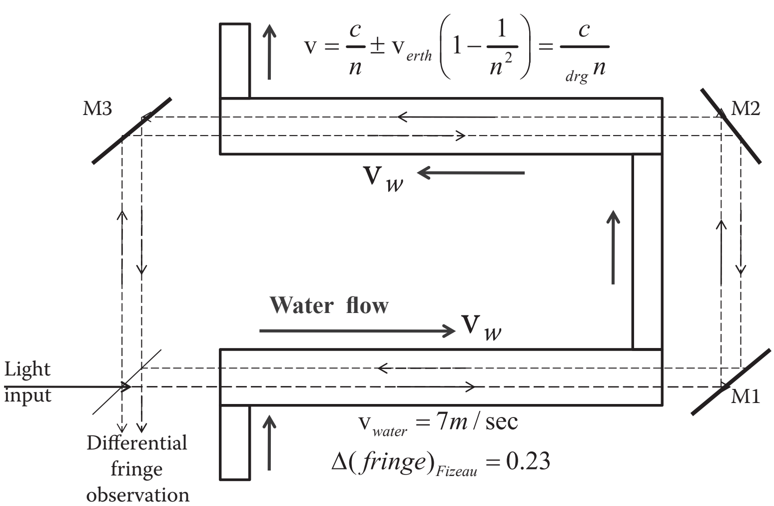


FIGURE 11.7 Fizeau found a clearly measurable positive fringe shift quite close to that predicted by Fresnel using a two-way circular interferometer while imparting velocity to water in the tube. The fringe shift implies that the ether (CTF) is being dragged by moving water.

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 780 nm 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. The measured superposition effects are generated by resonant detectors due to phase-dependent joint stimulations induced by more than one physical beam. 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 that we call *vacuum*. Thus, we need to address the issue whether there is a physical running time 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 11.2.2 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 such as $\varepsilon_0^{-1}, \propto_0$, and α, which can be *dilated* and *contracted*? We have already proposed that its physical properties generate various types of its own undulations (propagating waves and doughnut-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 the extended lifetime of muons? It is quite logical to hypothesize that the lifetime 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 a 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: (1) Bradley telescope parallax for stars due to earth's motion, (2) Michelson–Morley null experiments to detect earth's motion around the Sun, (3) positive and negative Fresnel drag experiments for moving and nonmoving medium within an interferometer, and (4) 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 intergalactic spaces must be stationary. Then, CTF should be experiencing intergalactic 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 intergalactic and interplanetary 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 that matches with our understanding of EM waves and 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, it is still an unsolved problem. We discuss below only the 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, and the rotation and the translation of the Sun in our Milky Way, which, rotates and translates in the cosmic space. Fizeau nullified these motions by using a bi-directional circular propagation path for light in his interferometer (Figure 11.7)! Fresnel derived his proposed drag based on arguments of electromagnetism consisting of two components, (1) stationary ether with the velocity determining factors for free space $\varepsilon_0$and $\propto_0$, and (2) the changes on the values of ε_0 and $\propto_0$ 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:

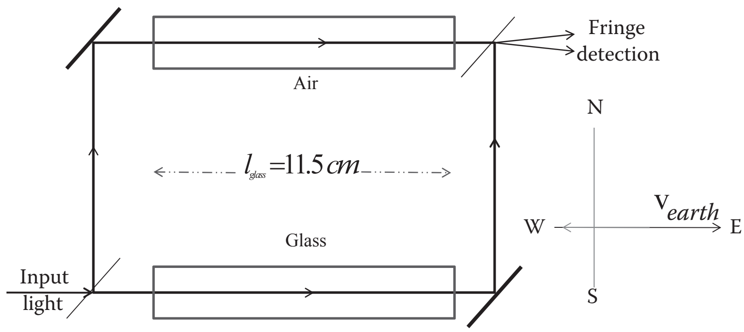
$$u' = \frac{u \pm \mathrm{v}}{1 \pm u\mathrm{v}/\mathrm{c}^2} \tag{11.26}$$

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 (Equation 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 completely stationary CTF everywhere, or complete drag of 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 Figure 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 Figure 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°.

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 between CTF and Earth could have produced positive result (fringe shift). The results are shown in Figures 11.8 and 11.9 [4.14]. The stationary glass block had a length of 11.5 cm, 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°. The rotation was such that in one orientation, the laser beam travels through the glass block from the east to the west direction, then from the west to the east direction.

Of the two possibilities, a fully dragged CTF, or a completely stationary CTF, both states can 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



$$v_{glass} = 0 \ m/\sec$$

$$\Delta(fringe)_{\text{our expt.}} = 0$$

(a)

$$n_{gls} = 1.500000 \qquad n_{air} = 1.000293$$

$$_{+drg}n_{gls} = 1.499876 \qquad _{drg}n_{air} = 1.000293 \text{ (unchanged)}$$

$$_{-drg}n_{gls} = 1.5001243$$

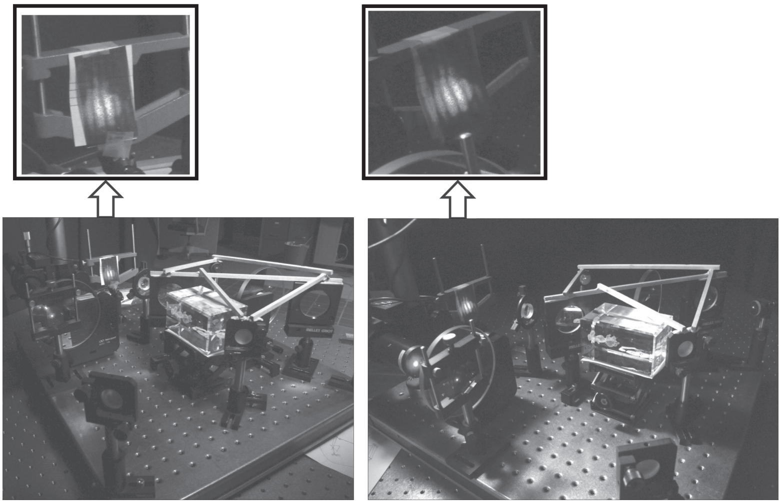
$$\Delta\tau = \tau_{WE} - \tau_{EW} = (l/c)[\,_{-drg}n_{gl} - {}_{+drg}n_{gl}\,]$$

$$\Delta(fringe) = \nu\Delta\tau = \frac{4.96}{cm} \times 11.5cm = 57 \ fringes$$

(b)

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 the 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 a 57 fringe shift if CTF were not stationary with respect to the Earth's surface.

is completely stationary between the Sun and 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. An 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: (1) CTF is stationary around the Earth (ether drag) and (2) CTF is stationary



Light traveling from east to west | Light traveling from west to east

FIGURE 11.9 The relative velocity between the Earth and the Sun does not produce any Fresnel drag. Demonstration of the experimental null result of Fresnel drag due to a stationary glass block (foreground) in one arm of a Mach–Zehnder interferometer when the source is on the same turntable. Unmoved fringes are visible in the background (fixed stationary screen on the interferometer table), while the interferometer base was rotated through 180° sitting on a turntable [4.14].

everywhere universally. We are accepting the second hypothesis to accommodate the constancy of c everywhere. However, high-altitude satellite-based experiments are being considered.

11.6.4 Do We Really Understand the Physical Significance of the Velocity Addition Theorem?

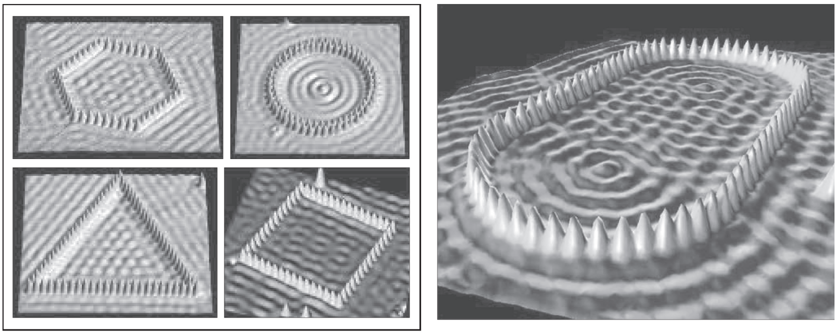
We have seen in the last section that in interferometric experiments, relativistic velocity addition theorem works only if the there is a relative velocity between the light source and the delay-inducing material in the interferometer arm. We cannot detect any influence of the earth's orbital motion 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 escalators: 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 nanotechnologies are now giving us deeper glimpses behind the workings of atoms and molecules. Consider the two corrals of atoms arranged by nanotip 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 (Figure 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 do 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]; 30 km/s 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.

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



(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 implies 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 [11.41].

depending on the physical arrangement of the single atoms. One can propose a rational hypothesis that the atoms, being assembly of oscillating elementary particles, display 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 that 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 (Figure 11.10b) do not represent any "virtual atom" [11.38], but in-phase superposition of oscillatory gradients due to all the neighboring atoms.

On the basis of 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 attributes necessary to accommodate EM waves as a perpetually propagating wave and particles as localized resonant self-looped oscillations. This model clearly finds distinctly different, but causal, physical explanations for various physical phenomena along with potential experiments to validate or invalidate the CTF hypothesis.

The strength of the advocacy for the CTF model derives from the very broad conceptual continuity it brings among diverse observable phenomena in the universe as a new platform to develop different possible unified field theories. It provides simple causal explanations for EM waves as classical linear sinusoidal oscillations of the CTF. The waves are simply excited states of CTF; energy remains in the CTF. The natural tendency of a tension field is to persistently propel away any external perturbation energy imposed on it so that its perturbed location can restore its nascent state; because it does not possess the physical mechanism to assimilate the external perturbation energy on its own. The particles are also undulations of the same CTF through some nonlinear perturbation; again, the energy is still held by CTF, eliminating the need for Dark Energy and Dark Matter. 100% of the energy is retained by the CTF. The quantumness in the universe arises from the need for stability of the particles and their stable assemblies as localized, doughnut-like self-looped resonances. Their resonant stability allows them to stay-put in the same place and confirming to Newton's first law of motion. Until they experience different kinds of "pushing" or "pulling" potential gradients imposed on the CTF by different kinds of their own self-looped nonlinear oscillations. These potential gradients are the different forces we experience. Most of the interactions are driven through amplitude-amplitude resonant stimulations (Schroedinger's "psi" function) before the interacting entities can exchanges quantum cupful energies resonant state. Presence of almost infinite number and types of undulations all around them introduce the inherent quantum statistical fluctuations in the interactants while they are going through the processes of amplitude stimulation and energy exchange. We do not need ad hoc postulates like non-locality, non-causality, wave-particle duality, delayed choice, etc. CTF makes the universe quite causal while eliminating the need for mystical postulates."

REFERENCES

[11.1] F. Selleri, "Recovering the Lorentz ether," *Apeiron*, Vol. 11, No. 1, January 2004.

[11.2] A. Harvey, "Dark energy and the cosmological constant: A brief introduction," *Eur. J. Phys.*, Vol. 30, pp. 877–889, 2009.

[11.3] W. W. Carter, "A new approach to unifying fields," *Phys. Essays*, Vol. 20, No. 3, pp. 360–365, September 2007. doi: http://dx.doi.org/10.4006/1.3153410.

[11.4] S. J. G. Gift, "The invalidation of a sacred principle of modern physics," *Phys. Essays*, Vol. 17, No. 3, 2004.

[11.5] D. C. Miller, "The Ether-Drift experiment and the determination of the absolute motion of the earth," *Rev. Mod. Phys.*, Vol.5, pp. 203–244, July 1933.

[11.6] R. Resnick, *Introduction to Special Relativity*, John Wiley & Sons, 1968.

[11.7] H. Muller, S. Herrmann, C. Braxmaier, S. Schiller, and A. Peters, "Modern Michelson-Morley experiment using cryogenic optical resonators," *Phys. Rev. Lett.*, Vol. 91, No. 2, 020401,1 to 4, 2003.

[11.8] A. Drezet, "The physical origin of the Fresnel drag of light by a moving dielectric medium," arXiv:physics/0506004v1 [physics.optics] June 1, 2005.

[11.9] F. L. Walker, "The fluid space vortex: Universal prime mover," *Phys. Essays*, Vol. 15, No. 2, pp. 138–155, 2002.

[11.10] G. S. Sandhu, "Fundamental Nature of Matter and Fields," http://www.amazon.com/Fundamental-Nature-Matter-Fields-Sandhu/dp/1440136564/ref = sr_1_4?s = books&ie = UTF8&qid = 1316629764&sr = 1-4, 2009.

[11.11a] D. Sanvitto et al., "Persistent currents and quantized vortices in a polariton superfluid," *Nat. Phys.*, pp. 1–10, 2010. http://www.nature.com/doifinder/10.1038/nphys1668.

[11.11b] G. Nardin, G. Grosso, Y. Léger, B. Pietka, F. Morier-Genoud, and B. Deveaud-Plédran, "Hydrodynamic nucleation of quantized vortex pairs in a polariton quantum fluid," *Nat. Phys.*, Vol. 7, pp. 635–641, 2011. DOI: 10.1038/NPHYS1959.

[11.11c] G. Falkovich, *Fluid Mechanics*, Cambridge University Press, 2011.
[11.12a] S. Sakata, *Prog. Theor. Phys.*, Vol. 16, pp. 686–688, 1956.
[11.12b] J. Beringer, et al. (Particle Data Group), *Phys. Rev. D*, Vol. 86, 010001, 2012.
[11.12c] H. Frauenfelder, and E. M. Henley, *Subatomic Physics*, Prentice Hall, 1974.
[11.12d] K. O. Greulich, "Understanding the masses of elementary particles—a step towards understanding the massless photon?" *SPIE Proc.*, 8121–15, 2011.
[11.13] J. M. Greben, "The role of energy conservation and vacuum energy in the evolution of the universe," *Found. Sci.*, Vol. 15, pp. 153–176, 2010. doi: 10.1007/s10699-010-9172-0.
[11.14] J. M. Greben, "A Resolution of the Cosmological Constant Problem," 2012, http://arxiv.org/abs/1209.4734v1.
[11.15] C. W. Turtur, "Experimental Verification of the Zero-point Energy of Electromagnetic waves in the Quantum-vacuum," http://www.ostfalia.de/export/sites/default/de/pws/turtur/FundE/English/Schrift_03f_englisch.pdf.
[11.16] P. D. Mannheim and J. G. O'Brian, "Fitting galactic rotation curves with conformal gravity and a global quadratic potential," *Phys. Rev. D*, Vol. 85, 124020, 2012.
[11.17] J. B. Hartle, "The quantum mechanical arrows of time," arXiv:1301.2844v1 [quant-ph], January 14, 2013.
[11.18] I. E. Bulyzhenkov, "Geometrization of radial particles in non-empty space complies with tests of general relativity," *Journal of Modern Physics*, Vol. 3, No. 9A, pp. 1342–1355, 2012.
[11.18a] J. Barbour, *The End of Time: The Next Revolution in Physics*, Oxford University Presss, 2001.
[11.18b] L. Smolin, Time reborn: From the crisis in physics to the future of the universe; Houghton Miffin, 2013.
[11.19] D. J. Griffiths, *Introduction to Quantum Mechanics*, 2nd ed., Pearson Prentice Hall, 2005.
[11.20a] C. Roychoudhuri, "Tribute to H. John Caulfield: Hijacking of the 'holographic principle' by cosmologists," Proc. SPIE 8833-15 (2013).
[11.20b] C. Roychoudhuri and M. Ambroselli, "Can one distinguish between Doppler shifts due to source-only and detector-only velocities?" Proc. SPIE 8832-49 (2013).
[11.21] H. C. Ohanian and R. Ruffini, *Gravitation and Spacetime*, 2nd ed., W. W. Norton & Co, 1994.
[11.22] M. Demianski, *Physics of the Expanding Universe*, Springer, 1979.
[11.23] Yu. V. Baryshev, "Expanding Space: The Root of Conceptual Problems of the Cosmological Physics," http://arxiv.org/abs/0810.0153, 2008.
[11.24] F. Potter and H. G. Preston, "Cosmological redshift interpreted as gravitational redshift," *Prog. Phys.*, Vol. 2, April 2007.
[11.25a] R. B. Driscolla, "The Hubble–Humason effect and general relativity need no cosmological expansion," *Phys. Essays*, Vol. 23, No. 4, pp. 584–587, 2010.
[11.25b] L. Rota, "The alternative universe," *Appl. Phys. Res.*, Vol. 4, No. 3, 2012. doi:10.5539/apr.v4n3p123.
[11.26] J. Bernstein, P. M. Fishbane, and S. Gasiorowicz, *Modern Physics*, Prentice Hall, 2000.
[11.26a] R. Resnik, D. Halliday and K. S. Krane, Physics, see Section 20.7 in 4th Ed., Vol.1, John Wiley, 1992.
[11.26b] W. Guo, "Light scattering from a moving atom"; J. Opt. Soc. Am. A29, No. 12, p. 2576 (2012).
[11.26c] W. Guo and Y. Aktas, "Reexamination of the Doppler effect through Maxwell's equations"; J. Opt. Soc. Am. A29, No. 8, p. 1568 (2012).
[11.27] R. W. Ditchburn, *Light*, Dover Publication, 1991.

[11.28a] C. I. Christov, "The effect of the relative motion of atoms on the frequency of the emitted light and the reinterpretation of the Ives-Stilwell experiment," *Found. Phys.*, Vol. 40, pp. 575–584, 2010. doi: 10.1007/s10701-010-9418-2.

[11.28b] M. López-Morales, "Exoplanet caught speeding," *Nature*, Vol. 465, pp. 1017–1018, June 24, 2010.

[11.29] Web link for the Hubble curve: http://www.google.com/imgres?start=156&biw=925&bih=531&tbm=isch&tbnid=UsIKdgzxxaeQ4M:&imgrefurl=https://en.zero.wikipedia.org/wiki/Hubble%27s_law&docid=e_n-rtVJRU0UUM&itg=1&imgurl=https://upload.wikimedia.org/wikipedia/commons/thumb/2/2c/Hubble_constant.JPG/250px-Hubble_constant.JPG&w=250&h=186&ei=BJGmUYKZCLa34AO5yYD4Dw&zoom=1&ved=1t:3588,r:58,s:100,i:178&iact=rc&dur=2086&page=15&tbnh=146&tbnw=186&ndsp=11&tx=122&ty=87

[11.30] Web link for galactic red shifts: http://astro.wku.edu/astr106/H_K_redshift.jpg

[11.31] F. Wilczek, *The Lightness of Being: Mass, Ether, and the Unification of Forces*, Basic Books, 2010.

[11.32] L. de Broglie, *Matter and Light: The New Physics*, W. W. Norton & Co., 1939.

[11.33] G. Gamow, see Ch.4 in *Thirty Years that Shook Physics*, Dover, 1985.

[11.34] A. Zeilinger et al., "Single- and double-slit diffraction of neutrons," *Rev. Mod. Phys.,* Vol. 60, No. 4, p. 1067, 1988.

[11.34a] S. Eibenberger, S. Gerlich, and M. Arndt, "Matter-wave interference with particles selected from a molecular library with masses exceeding 10 000 amu"; http://arxiv.org/pdf/1310.8343v1.pdf.

[11.35] F. L. Pedrotti and L. S. Pedrotti, *Introduction to Optics*, See page 340, Prentice Hall, 1993.

[11.36] H. Fizeau, "Surleshypothèsesrelativesàl'étherlumineux," *Comptes Rendus*, Vol. 33, pp. 349–355, 1851.

[11.37] E. Falkner, Hoek Experiment, http://gsjournal.net/Science-Journals/Research%20Papers-Mechanics%20/%20Electrodynamics/Download/1903.

[11.38] H. C. Manoharan, C. P. Lutz, and D. M. Eigler, "Quantum mirages formed by coherent projection of electronic structure," *Nature*, 403, 512–515, 2000. doi:10.1038/35000508.

[11.39] Web reference for Nano corrals: M. F. Crommie, C. P. Lutz, D. M. Eigler, and E. J. Heller, "Waves on a metal surface and quantum corrals," *Surf. Rev. Lett.*, Vol. 2, No. 1, pp. 127–137, 1995.

[11.40] K. W. Kolasinski, *Surface Science: Foundation of Catalysis and Nanoscience*, Wiley, 2012.

[11.41] M.F. Crommie, C.P. Lutz, D.M. Eigler, E.J. Heller. "Waves on a metal surface and quantum corrals"; Surface Review and Letters 2 (1), 127–137 (1995).