Proc. SPIE 8833-15 (2013)

Tribute to H. John Caulfield
Hijacking of the "Holographic Principle" by cosmologists

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Abstract

I came to know Caulfield as a graduate student while developing suitable techniques to quantitatively evaluate coherence properties of pulsed Ruby and YAG lasers beams during the first decade of their evolutions. We continued our professional acquaintance till 2011 through various yearly conferences. It was at the 2011, 4th biennial conference on, "The nature of light: What are photons?" [1], Caulfield gave a paper on this topic and privately expressed his deep concern that the optical "Holographic Principle" has been hijacked by the cosmologists based upon insufficient understanding of the physical processes behind generation and reconstruction of optical holograms. Unlike our material universe, holographic images do not exist as touchable objects; but the material universe does. Now, in his absence, I have taken the liberty of presenting his views about the holographic principle and extend that to further challenge the prevailing hypothesis that cosmological red shift is purely optical Doppler shift that has led to the postulate that the current universe is expanding rapidly. Rigorously speaking, the core problem is generated when we assign reality to human interpreted information out of experimentally derived data, which can never capture complete behavioral properties of any cosmological object that we try to characterize. In holography, an object is a touch-able reality. Scattered light from an object brings incomplete, but sufficient information about the object to construct a decent hologram. It records phase and amplitude information indirectly as intensity fringes. Further, the reconstructed *IMAGE* does not represent the original touch-able reality. Besides, the image is further degraded from the insufficient information originally recorded on the hologram. Physical theories should be based upon our need to map physical processes behind the phenomenon under study. Information is a subjective human interpretation of measurable parameters registered by instruments, whose registration fidelities are always less than 100%. We illustrate this point by further criticizing the postulate of "Expanding Universe" by analyzing optical Doppler shift as a function of the two velocities, those of source-atoms and those of detector-atoms, in the coronas of stars in different galaxies with respect to the *stationary space*, instead of just the relative velocities between all possible pairs of galaxies.

Keywords: Holographic Principle, Cosmological Redshift, Hubble Redshift, Dissipative Redshift, Expanding Universe, Stationary Universe.

1. INTRODUCTION

I came to know about H. John Caulfield as a graduate student while developing suitable techniques to quantitatively evaluate coherence properties of pulsed Ruby and Nd lasers during the first decade of their evolutions. My adviser, Brian Thompson, at that time the Director of the Institute of Optics, University of Rochester, alerted me that Caulfield and Cathey held the patent on *local reference beam holography*, which I originally thought I invented, while attempting to record holograms of pulsed laser shots. The idea was to leisurely study the coherence properties by reconstructing the holograms with a CW He-Ne laser. From then on, almost every year, we had continued to discuss various scientific issues during different conferences. Our last discussion took place in the summer of 2011 during the 4th biennial conference, "The nature of light: What are photons?", held at San Diego SPIE annual conference. Caulfield held the strong opinion that cosmologists have *hijacked* the "Holographic Principle" by over-extending the information theory and the holographic principle of optics. I would like to support Caulfield's view by underscoring that the very purpose of all physical theories must be mapping of the invisible physical processes that give rise to our observable (measurable) universe. What we call information, is no more than a subjective interpretation of some measurable data registered by our instruments, which is created by some human neural network, expressed in words, and many a times supported by more rigid mathematical logics (equations). Rigorously speaking, the registration fidelity of all sensors and instruments

is always less than 100%. So, our creation of "information" out of such incomplete data is always going to remain incomplete. Optical holograms do record *object information* (phase and amplitude) as a set of superposition fringes registered by photographic plates. But photographic plates always have limited spatial resolutions due to the finite size of the photographic Ag-Halide grains. The registered information is sufficient for the reconstruction of an image with close resemblance to the original object. Further, the image albeit being *realistic*, is an illusory representation of the original object. ***It is not the reality***. However limited understanding we have about our cosmic system; however much we work with our imagination to map its working processes; the details of the working rules of the cosmic universe are still elusive to us. Consequently, the various interpretations of our experience are incomplete and will continue to appear as ***elusive***; but our experience of ***the observable universe is not an illusion*** like a reconstructed image out of a 2D holographic plate. Our experiences are not mere *holographic projections* [2]! This point will be further underscored through discussions that the postulate, *the expanding universe*, is most likely, a mathematical illusion because optical Doppler shift does have two independent components due to velocities of the source and that of the detector; not just the relative velocity between them. Otherwise, the stimulated emissions experienced by Ne-atoms in He-Ne lasers, obeying quantum mechanics, would not have been possible.

The key message of this paper is that over the last several centuries, we have slowly veered off from the very fundamental paradigm of carrying on scientific investigations. The purpose of scientific investigation is to keep on trying to visualize the invisible interaction processes going on in nature so that we can emulate them efficiently and keep on developing newer tools and technologies to assure our sustained evolution through our progenies. I have defined this approach as Interaction Process Mapping Epistemology (IPM-E) [3]. This approach is to be applied over and above the currently successful approach of Measurable Data Modeling Epistemology (MDM-E). By iteratively applying IPM-E to modify and/or correct MDM-E derived working-theories-in-progress, evolution of science can continue without the need of repeated revolutions in scientific paradigms [4]. Continued revolutions in paradigms, one after another, imply each preceding paradigm had become stagnant; and hence its further promotion was effectively wasting away vast amount of intelligent man-hour promoting good-in-the-past but now-obsolete hypotheses. We have forgotten that all foundational hypotheses (postulates) behind all scientific theories have been constructed based upon insufficient knowledge of the universe. Our sensors can never provide us with the complete information about any single entity we study. Hence none of our theories can be final theories. So, it is the scientific responsibility of all future generations to rationally challenge the foundational hypotheses behind working theories and re-organize and re-structure them through continuous iterations to make them evolve as our knowledge gathering capabilities keeps on evolving, without waiting for paradigm revolutions. Our scientific enterprise must not fall a victim to the prevailing social messiah complex (the final knowledge has already been obtained) which we are familiar with the world of religions that claim the ultimate knowledge has already been obtained some millennia past [5].

The paper will be divided into six sections. The Section 2 describes very briefly my first graduate research beginning with holography, which made me aware of some very early contribution of Caulfield, the generation of a *local reference beam* (LRB) out of the very object beam that one wants to record in a hologram [6]. In Section 3, we first summarize the basic optical holographic principle to underscore that touch-able cosmic bodies should not be compared with un-touch-able optical images generated by optical holograms. Then we discuss that information is always some subjective interpretation of experimental data, which can never give complete information about anything we study. In this context we discuss the historic "Measurement Problem" identified by the founders of quantum mechanics as the in-surmountable "Information Retrieval Problem". This is to strengthen our view that information is no more than subjective human interpretation, limited further by insufficient information that we can gather from any set of experiments. Section 4 presents further questions raised by Caulfield's paper [1] and it resolves them by analyzing the problem behind the concept of "Indivisible Quanta" as due to our neglect of the obvious: Non-Interaction of Waves (NIW). We support this NIW-property by summarizing that various historical postulates and working theories actually contain the NIW-property, even though they do not explicitly recognize it as such. This leads to the recognition that the space is a physical tension field and supports the perpetual propagation of EM waves, just as air, as a substrate, holds pressure tension field and allows the perpetual propagation of sound waves. This leads us to the Section 5**.** It summarizes that optical Doppler shifts, like Doppler shifts for sound waves, depend separately upon the velocities of the source and that of the detector with respect to the stationary cosmic medium. Section 6 presents a brief summary of our core points again.

2. KNOWING CAULFIELD FOR THE FIRST TIME (1972-73)

I came to know H. John Caulfield personally for the first time around 1972-73 during a conference on holography as I wanted to know the holder of the patent on *local reference beam holography*. In the days of 1960's and early 1970's most of the pulsed solid state lasers were running in higher order spatial modes unless they were successfully controlled by intra-cavity spatial filters to oscillate in the fundamental spatial mode. Under the supervision of professors Brian Thompson and Michael Hercher, I was trying to develop some holographic technique to study the spatial coherence properties [6]. A single pulse from the laser was split into two beams: (i) a direct 'object' beam and (ii) a 'local reference' beam generated through a pinhole spatial filter. The two beams were then combined on a holographic plate to register 'coherent' superposition fringes on the hologram (Fig.1). The developed hologram was then reconstructed using a CW He-Ne laser to study the degree of spatial coherence; the reconstructed intensity being proportional to the degree of spatial coherence, $I(x,y) \propto |\gamma(x,y)|^2$. The Ruby laser we used was an old commercial one donated by Professor Leonard Mandel whose plumbing was re-done by me. The Nd-Glass laser was a *home made* one by me using a unique design taught by professor Hercher during the Summer School at the Institute of Optics in 1969. Nd-rod was made into a long (very thick!) plano-convex lens so that one can obtain a large-volume single spatial mode with a short cavity length. This was an ARPA project (now DARPA). Some of these details are meant for historical record. Scientific details of the research can be found from the reference [6].

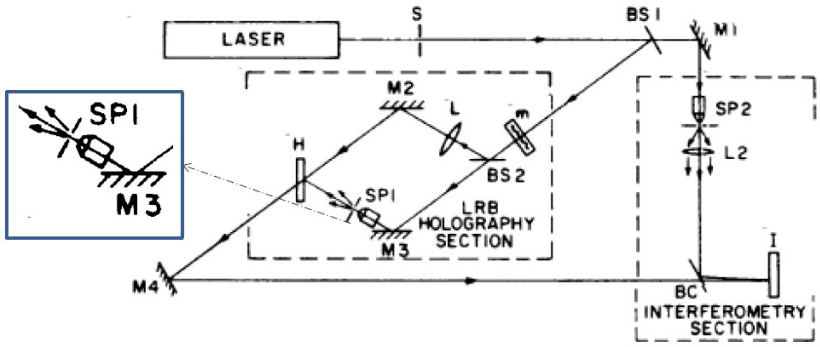

Figure 1. Local reference beam holography to study the coherence properties of pulsed Ruby and Nd-Yag lasers. The laser pulse was split into two beams by a Mach-Zehnder interferometer. One beam was treated as the object beam and the other was sent through a spatial filter to generate a *local reference beam*. The developed holograms were studied using a CW He-Ne laser.

3. BEING WITH CAULFIELD IN 2011 – HIJACKING OF THE HOLOGRAPHIC PRINCIPLE

It was during the 2011 summer that we had some clear discussions on the *hijacking of the holographic principle* by cosmologists while we were participating in the "What are photons?" conference. To solidify his views to the readers, let me quote some sections from the paper he presented at this conference [1].

"String theory has most cosmologists excited, but some of the excited scientists are excited because they feel certain that string theory is wrong."

Those of you who have read reviews of the theories related to cosmology and string [2,7], would recognize that *Holographic Principle* has been co-opted and supported by some of the stalwarts in this field. Since most of us here, including myself, are not specialists in the above mentioned theories, I will quote a couple of popular definition of the *Holographic Principle*.

By Kate Becker on November 15, 2011 [8]

"The holographic principle, simply put, is the idea that our three-dimensional reality is a projection of information stored on a distant, two-dimensional surface. Like the emblem on your credit card, the two-dimensional surface holds all the information you need to describe a three-dimensional object—in this case, our universe. Only when it is illuminated does it reveal a three-dimensional image."

WIKIPEDIA [9]

The holographic principle is a property of quantum gravity and string theories that states that the description of a volume of space can be thought of as encoded on a boundary to the region—preferably a light-like boundary like a gravitational horizon. First proposed by Gerard 't Hooft, it was given a precise string-theory interpretation by Leonard Susskind who combined his ideas with previous ones of 't Hooft and Charles Thorn. As pointed out by Raphael Boss,[2] Thorn observed in 1978 that string theory admits a lower-dimensional description in which gravity emerges from it in what would now be called a holographic way.

Now to appreciate that above definitions of the Holographic Principle, as adapted by the cosmologists, we just need to remind ourselves of the very basic principles behind recording and reconstructing optical holograms. Then it will be quite apparent as to why Caulfield considered it to be an irrational hijacking of the optical holographic principle.

3.1 Optical holographic principle

The basic principle behind recording an optical hologram of a real object and re-constructing the image of the object afterwards out of the developed hologram [10] can be appreciated from the Fig.2, where the basic but elementary mathematical expressions are also given. Note that in holography, the information about the object (amplitude and phase imposed on the scattered wave fronts by the object from different points on its body) is recorded (coded) as superposition, dark-bright fringes with curvatures and contrast variations, in the photographic plate. The developed hologram can be transported anywhere to reconstruct an image of the original object, as long as one has access to reproduce the reference beam that was used to record the optical hologram.

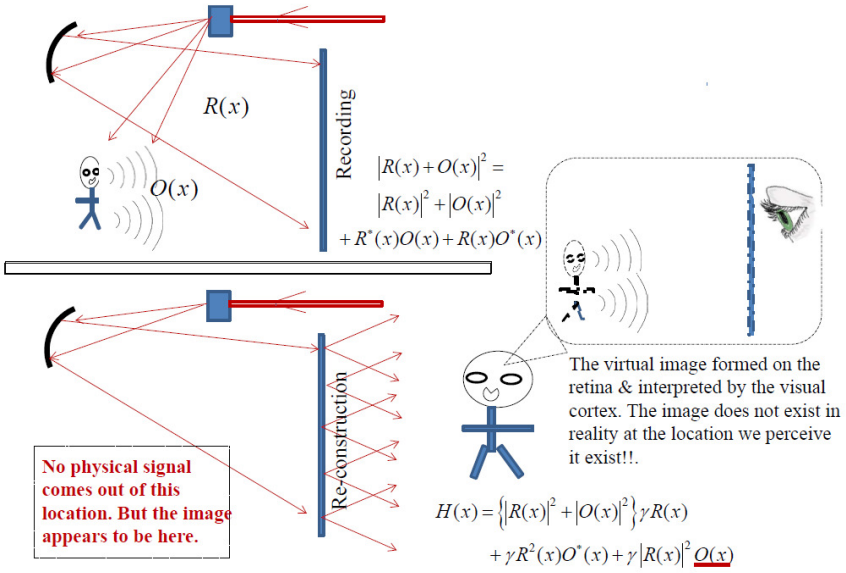

Figure 2. A hologram can never reconstruct a perfect image of an original object! The basic approach and formula behind optical holographic recording of a real object and its reconstruction to generate the image of the original object even. The re-construction can be done anywhere one can generate a reference beam that is identical to the original recording-reference beam. Notice that the reconstructed image $O(x)$ is multiplied by the intensity of the reference beam $|R(x)|^2$ and holographic process constant γ, besides, there are three other reconstructed beams, fortunately, which can be manipulated to separate them out of the reconstructed object beam $O(x)$.

Note carefully that the projected (reconstructed) image generated out of an optical hologram, while may appear to be a very realistic 3D replica of the original object; the image is not real. Even its resolution in extremely fine details will be limited due to resolution limit of the recorded hologram permanently imposed due to the finite size of the Ag-Halide grains in the original holographic plate.

With this brief background in optical holography, let us look at the scenario behind the cosmological *Holographic Principle*. Suppose there is some cosmological hologram, which holds all the cosmological object-information in dynamical details, and which somehow gets re-constructed to project all the structures like the galaxies, the stars, the Sun, the earth and then you and me, who decide to read and write this critical article. This defies our experience of the ontological reality. Touch, feel and intellectually communicate with an image re-constructed out of an optical hologram is not possible. So, at a minimum, the optical holographic principle and the cosmological holographic principle do not any commonality behind their fundamental functional logics and rules. At a minimum, it is a misleading analogy. The detailed laws behind the operation of the vastly complex cosmic system may appear to be ***elusive*** to us; but their ontological existence is not an ***illusion*** as the images reconstructed out of optical holograms are.

3.2 What is information?

This last paragraph above raises the question as to how to understand what is really meant by ***information*** in science and engineering. Has a super-being set the evolving cosmic system as a super-computer pre-programmed [11] with all the necessary ***information***? Should our enquiring scientific minds be constrained by this paradigm? Let me present my modest understanding as to what is information using my personal thinking logics which are seriously limited by my finite set of neural network connections; which are also controlled by inherited genome and the strong influences of diverse cultural upbringing. Science is supposed to be anchored to objectivity through reproducible precision data we gather and then convert them into ***information*** as our interpretations that can be as varied as our individual neural connectome [12]. Since our gathered data are neither complete, nor do they represent absolute precision; human interpreted ***information*** must always be treated as provisional and work-in-progress. Thus, it would be pragmatic for us to remain persistently alert that we are forced to advance science and scientific thinking based upon insufficient information about the working rules of the vastly complex cosmic universe. A small sub-set of an orderly but vastly complex and very large system can be modeled with a set of self-consistent rules, none of which may coincide with the actual operating rules behind the entire system [13]. We should remain humble with our limited and ***subjective information*** (interpretation) while using them to keep on discovering and refining our epistemological working rules towards ontological cosmic rules. We should refrain from telling nature how she ought to function. We need to add to our scientific repertoire *Interaction Process Mapping Epistemology* (IPM-E), over and above the prevailing *Measurable Data Modeling Epistemology* (MDM-E) [3]. Measurable data, being intrinsically incomplete, cannot assure us that an experimentally validated theory and the corresponding foundational postulates, are definitely the right logical path to discover all that are there to learn about the evolving cosmic system. We must allow the scientific paradigms to evolve also. But we must not rigidly adhere to building on the same foundations of the preceding working theories. That would be like following the physical limits of biological evolution, which is stuck in enhancing the previous limitations by adding new building blocks on the same foundational structure of the DNA. Fortunately, the evolution of ***human imaginations*** out of the same DNA provides the complete freedom to keep on building and re-building newer and different working theories to get closer and closer to the ontological cosmic rules, or logics. But our imaginations must be anchored towards discovering the ontological reality, which is still unknown to us. We are the ancient allegorical blinds trying to model the cosmic elephant. Adding IPM-E upon MDM-E provides us with that guidance. ***Interaction processes*** in nature, albeit being invisible to our direct visualization capability, are well within our biology-provided faculty of imaginations. Our continued biological evolution and sustainability are being driven our ability to continuously create advanced tools and technologies. Such skills are empowered by our ***capability to emulate*** diverse natural processes in different combinations using our imperfect but evolving imaginations, irrespective of whether we have succeeded in constructing the unified perfect and the final theory that can model all these processes. Our thinking and imaginations must be guided by our conscious insistence that they always use evolution congruency as the guiding star [5].

3.3 "Measurement Problem" is "Information Retrieval Problem"

As Quantum Mechanics matured through 1920's and 1930's through its great predictive successes but without the capability to visualize the invisible interaction processes in the atomic world, *Hidden Variable* was proposed by Bohm

[14,15]. But the alternative idea of *Measurement Problem* thrived and many elegant mathematical solutions were established. However, even after over 80 years of development, "nobody understands quantum mechanics" (Feynman); hence, we should simply keep on computing like robotic computers without critically investigating the foundational hypotheses behind QM. It is not the fault of QM formalism because it has been designed with hypotheses to predict the measurable data, not to visualize the processes. In fact, if we briefly summarize the steps behind any measurement, we will realize that the QM formalism is eminently successful in predicting the measured data inspite of the fact that complete information retrieval from any set of experiments related to any entity under study can never be complete. This information gap is filled by the hypotheses and postulates constructed by our genius scientists. But we need to explicitly recognize this perpetual information retrieval problem to gather the confidence that we must keep on iteratively improving/correcting all our working theories.

3.3.1. Dissecting the measurement process

Founders of QM appreciated the deeply embedded and intricate *Measurement Problem* which is behind the interpretation of QM. Accepted solutions turned out to be various elegant mathematical theorems [16-18]. Let us try to dissect and understand the measurement problem from the stand point of *process visualization*. How do we succeed in registering data in any experiment? Let us try to articulate the steps based upon our current experiences [17].

(i). Measurables Are Physical Transformations: We can measure only physical transformations that take place in our instruments.

(ii). Proceeded by Energy Exchange: There are no physical transformations without energy exchange.

(iii). Guided by Forces of Interaction: Energy exchange, and consequent transformations, must be guided by an allowed force of interaction.

(iv). Must Experience Physical Superposition: Interactants must be within each other's sphere of influence to be able to interact under the guidance of an allowed force to exchange energy and undergo transformations. Thus, all interactions producing transformations must be ***local*** in the sense that the interactants must be within each other's sphere of influence (whether mega meter as for gravitational force or femto meter as for strong force).

(v). Through Some Physical Stimulation Process: Although invisible, all transformations are preceded by some real physical stimulation process before the interaction can be consumed through energy exchange.

(vi). **Always Requires a Finite Duration:** Transformations in the interactants from one specific state into another specific state requires *quantum compatibility sensing dancing period* [19] between the interactants before they can acknowledge the force of interaction as a legitimate stimulation; and then exchange energy; and then undergo the measurable transformation (transition).

(vii). Impossibility of Interaction-free Transformation: The above set of self-consistent logical arguments clearly implies that we cannot observe any measurable transformation unless the entities under study interact with each other under the guidance of some allowed force operating between them.

(viii). Perpetual Information Retrieval Problem: Our theory-constructing enterprise suffers from perpetual information retrieval problem for the following reasons. (i) First, we have not succeeded in constructing any instrument that has 100% fidelity in transferring all the quantitative data (information) it generates as secondary transformations induced by the primary transformations experienced by our chosen interactants. (ii) Second, we have never succeeded in setting up an experiment where the interactants can experience all the allowed four forces that could introduce various measurable transformations in the same experiment helping us to construct a unified theory with all the forces in nature. So, we are unable to gather all the four force related properties of any entity in any single experiment.

(ix). Information out of transformations is our subjective interpretations: Useful information is always limited by our subjective human interpretation of some observable transformation. The interpretation may be reproducible; but it does not exist independent of a physical transformation triggered in an experiment. In other words, information is what we make out of our observations and hence it is very subjective as it depends upon who interprets it. The objective part lies with the interaction process that exist hidden within the interactants and is determined by the allowed force of interaction between them.

Thus, the root behind our Measurement Problem is the loss of some real information and some information that could never be directly extracted out of the entities we study through any experiment. This lost and unknown information

cannot be recovered unequivocally by some elegant mathematical theorems! Only our creative imaginations can fill this information gap, which, then, has to be refined through repeated iterative reconstruction of the working theories by gathering feedback through process-visualization approach (i.e., IPM-E) and thereby inch forward closer and closer to the ontological reality. Evidence based knowledge is definitely the best knowledge, however, by itself, it is insufficient for us to extract the complete story out of nature [Ch.12 in ref.5].

The reason behind elaborating on how to understand what information is that we should not assign information the role of primary foundation behind the emergence of our continuously evolving universe; because information is no more than subjective interpretation by human minds out of incomplete data,.

4. DEEPER QUESTIONS RAISED BY CAULFIELD IN 2011

"Here is a problem that used to bother me. I list facts that I had difficulty understanding:

(i) Electromagnetic waves travel at the speed c. This is a remarkably beautiful aspect of Maxwell's equations.

(ii) In terms of OPD's (Optical Path Distance), light takes the shortest path.

(iii) But how can light do that without exploring the other paths?

(iv) But whatever does that exploration must not be an electromagnetic wave. It can have no speed limit. I call these Feynman waves, because they are implied by his sum over histories approach to finding the shortest path."

The above quote is from the same paper by Caulfield cited earlier [1]. Here he raises deeper questions related to the fundamental nature of EM radiation. Of course, framing the questions determine our internal viewpoints and then what answers we derive out of nature using them. And, our view points are different at the subtle level. Let me reframe the Caulfield's questions so I can formulate an answer that may not be the best one; but, at least, it will be self-congruent along with deeper connections with many branches of physics. Do EM radiation propagate as Einstein's *indivisible quanta*, or as Planck's *diffractively spreading wave packets* spreading through (Huygens-Fresnel wavelets) *without interacting with each other*?

4.1 Problems with "Indivisible Quanta" lie with our neglecting the obvious: Non-Interaction of Waves (NIW) [19b]

We assert that, upon closer observations of propagating waves in the linear domain, we can recognize that all propagating waves represent a perturbed state of a tension field held by some physical substrate. The *spontaneous tendency of propagation* of the perturbation as a wave packet is derived from the tension field's intrinsic capability to *push away* (wave velocity) the perturbation to restore its original quiescent state, as long as the perturbation is within its linear limit (effective Young's modulus). The *push away* tendency is most likely because the cosmic space, while holds the tension field properties ε_0 and μ_0, is unable to assimilate the external energy that has perturbed it electromagnetically. This is why the perpetual propagation velocity of the wave packet of light everywhere in the free space is $c = (\varepsilon_0^{-1} / \mu_0)^{-1/2}$. This is simply the old *ether theory* that is embedded into Maxwell's wave equation (1964). We have generalized this old ether as a Complex Tension Field (CTF) to accommodate particles as various kinds of localized resonant undulations of this same CTF [3].

Quantization of EM waves [20] by Dirac and extended by Feynman, are filled with built-in logical contradictions, which arise simply because we have been neglecting the NIW-property (Non-Interaction of Waves) for centuries. Even though the NIW-property has been handed to us through the classical mathematical logics of our working theories, we have been ignoring it, most likely, blinded by taking MDM-E as the final paradigm of doing science. Historically, Huygens (1629 – 1695) hypothesized the NIW-property through his *secondary wavelet* hypothesis without recognizing it because the final measurement as energy absorption is always guided by the quadratic light-matter interaction process. All the secondary wavelets keep on expanding while co-propagating and cross-propagating through each other as the intrinsic response (undulation) of the parent EM tension field. But, let us stay focused on EM wave propagation. The H-F integral, being a linear superposition of many secondary spherical wavelets, it is a solution of the Maxwell's wave equation. Thus, the mathematical Superposition Principle that is built into the Maxwell's wave equation implies that all possible EM waves with all possible Poynting vectors, can propagate through the same volume of the space without causing any changes in each other complex amplitudes or the energy distributions; provided the local sum total complex amplitude never

exceeds the linear restoration capability of the CTF. Fringes due to superposition of waves, which we register as energy distribution, are a result of physical transformation experienced by our detectors when they carry out the square-modulus energy absorption process out of all the superposed beams that simultaneously stimulate them.

Thus, the NIW-property has deeper consequences. We treat the classical time-frequency Fourier theorem (TF-FT) (1768 –1830) as if the superposed waves, by themselves, sum and re-distribute the energy to create temporal energy re-distribution. But, the NIW-property implies that, in reality, it does not happen. One should also appreciate that Fourier monochromatic waves, existing in all space and time, are non-causal signals as they violate the principle of energy conservation. So, the time-frequency bandwidth product $\delta\nu\delta t \geq 1$, is an artifact of elegant, but non-causal mathematics; and hence it does not represent nature's fundamental limit of spectral resolution. One can cleverly obtain super-resolution.

Michelson's *Fourier transforms spectrometry* (1852–1931) works under his proposed assumption that EM waves of different frequencies do not interfere. Thus Michelson discovered the NIW-property, but applied it in a restrictive way. Today, we know that high speed detectors can generate heterodyne difference frequency current when excited by multiple waves of different frequencies. So, it is not that the *waves interfere*; rather the detector sums the superposition effect and then generates current depending upon the integration time we set in our detectors. All waves are non-interacting by themselves.

Note that the mathematical superposition principle established by Fourier theorem, has been keeping us blinded to the universal NIW-property of all waves, even though time and again many of our follow-on working theories have been indicating the reality of the NIW-property. In 1924, Bose (of the fame Bose-Einstein statistics) developed a statistical counting method for Einstein's indivisible photon and derived "fully quantum mechanical formulation" for Planck's radiation law. The core of his assumption was that photons are indistinguishable particles and can be put in the same box for counting purposes. If one can count the correct number of *indivisible photons* within the same box, then they must not be interacting by themselves and change the number of photons. So, Bose's successful counting method implied the NIW-property that we have been neglecting.

Then in 1929, Dirac quantized the EM field and was forced conclude that "different photons never interfere" [21]. Like Huygens, Michelson and Bose, Dirac found the NIW-property, but applied in a restrictive way to perpetuate the classical mistake that waves by themselves interfere and re-organize wave energy. The neglect of the NIW-property has been at the root of the belief in *wave-particle duality*. Once we acknowledge that the optical detectors are quantized and hence we always find that a discrete number of electrons are released by optical waves in all photo detection instruments.

Here it is worth recognizing that gamma-gamma interactions do represent indivisible-quanta-like interaction trajectories with matter in our complex voluminous particle and photo detectors. This can be appreciated from the HF integral that clearly defines that the far-field divergence of EM waves packets is always inversely proportional to the frequency of the radiation. Thus, radio waves are most diffractive in their propagation. It is less for optical waves and even lesser for soft X-rays. But, effectively zero diffractive spreading for gamma rays should imply the limit of HF integral and a natural indication to look for new physics to obtain non-diffracting gamma rays out of the same Maxwell's wave equation.

Once we recognize that photons are truly non-interacting EM waves, we need to accept a physical medium for their propagation across the entire cosmic system, which we have named earlier as the stationary CTF. Then atoms as sources of emission and detection must function in such a way as to recognize their independent velocities with respect to this CTF. Hence, optical Doppler shifts should be explained, just like Doppler shifts for sound waves, as propagating undulations of the stationary pressure tension field. So, a moving atom, when it emits a photon wave packet as per quantum rule $\Delta E_{mn} = h\nu_{QM}^{mn}$, will evolve with a Doppler shifted frequency, $\nu_{med\pm} = \nu_{QM}(1 \mp \mathrm{v}_{atm.}/\mathrm{c})^{-1}$ [22-25]. The velocity of a detecting atom will perceive this $\nu_{med.}^{\pm}$ as another different frequency $\nu_{\mathrm{det.}\pm}$ as shown in Eq.1 below.

5. OPTICAL DOPPLER SHIFT IS A FUNCTION OF TWO VELOCITIES; THAT OF THE SOURCE AND THAT OF THE DETECTOR

The Doppler frequency shift that would be experienced by a sound wave detector due to simultaneous velocities of the source and the detector with respect to the stationary air-pressure tension field is given by Eq.1 [22]. But we have

changed the suffixes to represent optical Doppler shift where the wave is mediated by CTF. The suffixes "src." and "det." for velocities and frequencies are obvious.

$$\nu_{\text{det.}\pm} = \nu_{med.}(1 \pm \text{v}_{\text{det.}} / c) = \nu_{QM} \frac{(1 \pm \text{v}_{\text{det.}} / c)}{(1 \mp \text{v}_{src.} / c)} \qquad (1)$$
$$= \nu_{QM}; \quad \text{for } \bar{\text{v}}_{\text{det.}} = \bar{\text{v}}_{src.}$$

The suffix in ν_{QM} indicates the intrinsic frequency of the optical radiation that *would be spontaneously emitted* by an atom with zero velocity, which, in reality, quickly evolves into a frequency $\nu_{med.}$ in CTF when the real velocity of atom is $\text{v}_{src.}$. Of course, as per MDM-E, explained earlier, the prevailing postulate of relative velocity correctly matches with the measurable data when the relative velocity between the source and detector is given by a single vectorial velocity $\bar{\text{v}}_{\text{det.}} = \bar{\text{v}}_{src.}$ However, it fails to map the detailed physical process behind (i) stimulated absorption spectrum generated in different planets and stars (galaxies) and (ii) stimulated emissions in gas lasers.

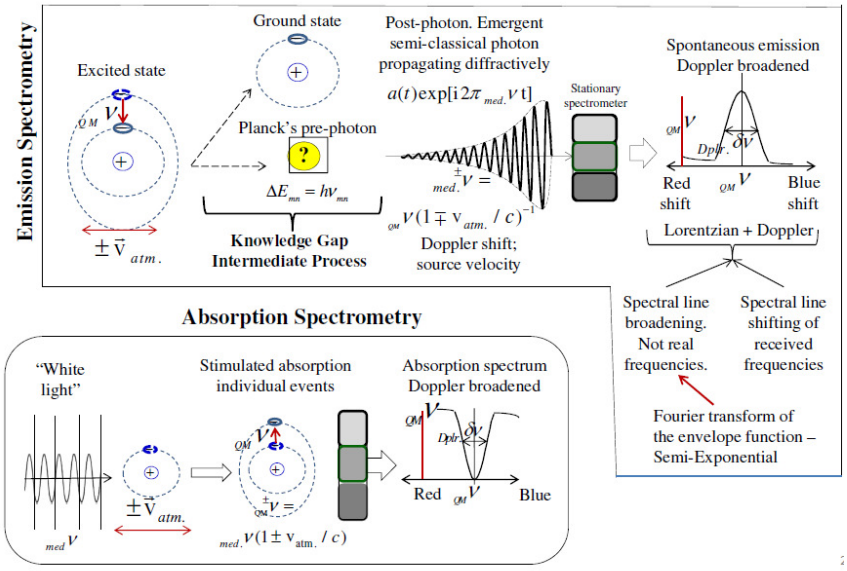

Figure 3. Appreciating two different Doppler shifts. Absorption and emission spectrometry demonstrate that source velocity produces a physical Doppler shift in the emitted photon. A detecting atom perceives this photon as carrying a different frequency due to its own velocity. Only when it can mimic the identical vectorial velocity of the emitting atom, can it perceive the incident wave as quantum transition frequency $\Delta E_{mn} = h\nu_{mn}$.

5.1 Appreciating two different Doppler shifts during emission and absorption, demonstrated by spectrometry

The top box in Fig.3 illustrates the origin of real physical Doppler shift due only to the source velocity for atoms undergoing spontaneous emission, while carrying on temperature dependent Maxwell-Boltzmann velocity distribution. Even though the quantum transition frequency is ν_{QM}, the emerged photon wave packet has the Doppler shifted frequency $\nu_{med.}$ and preserves this new carrier frequency until modified by some new physical interaction. The corresponding Doppler formula is given below the exponential photon envelope function. The lower box in Fig.3 demonstrates the apparent Doppler shift, as perceived by a moving detector; a moving atom absorbing light and undergoing upward transition. It can undergo the quantum transition only if it can perceive the $\nu_{med.}$ as ν_{QM}, for which it must nullify the Doppler shift introduced during the velocity of the emitting atom. This *detector perceived* Doppler shift formula is given below the absorbing atom in the lower box of Fig.3. From the combined Doppler shift formula, given

by Eq.1, it is obvious that to obey the quantum transition frequency, the absorbing atom must mimic the exact vectorial velocity as the original light emitting atom was executing, as shown in the second line of Eq.1.

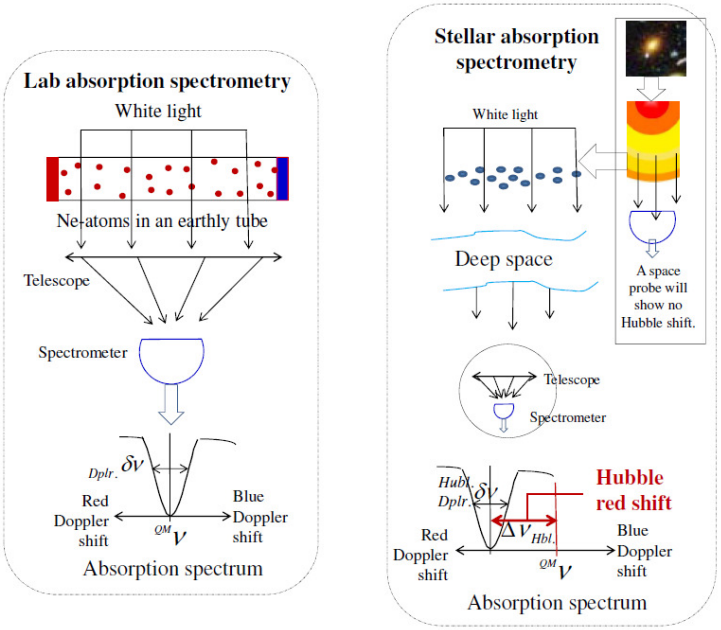

Figure 4. The velocity of atoms in a discharge tube on earth and in the corona of a star follows the same statistical Maxwell velocity distribution and hence structure of the absorption spectrum is identical. This helps the identification of cosmological Hubble red shift through long space travel of star light.

Note that the measured Doppler broadening of both the emission and absorption lines are due to the Maxwell-Boltzmann velocity distribution of the atoms due to the effective temperature of their respective environments. Physical Doppler shift introduced by a moving light emitting atom and the perceived Doppler shift by a moving light absorbing atom correspond to two distinctly identifiable physical processes. The total Doppler shift should be presented by a single relative velocity between the source and the detector as in Eq.1. The source may have died before the detector receives the signal. So, the detector's arbitrary velocity should not be absorbed in the vectorial sum of the two velocities. Detailed discussion of this issue can be found in [26].

5.2 Comparing laboratory and stellar absorption spectrometry

Figure 4 represents the similarity and dis-similarity in absorption spectrometry carried out on earth and by a star while the assembly of atoms are absorbing white light propagating through them (assuming we can send a spectrometer in a stationary orbit of the star). In both cases, the statistical velocity distribution determines the width of the absorption lines. The line center will be determined by the mean velocity of the assembly of the atoms in their respective locations with respect to the stationary CTF. Thus, a large cosmological (Hubble) red shift that appears in the earth-based record of the absorption spectrum due to a star represents a spectral line-center shift that is different from source and detector velocities. These velocities with respect to the stationary space are quite modest compared to that of light. For some galaxies, this line-center shift is so large that it implies the relative velocities between the earth and various galaxies are many time larger than the velocity of light. Thus, the postulate of *Expanding Universe* (space expanding) has been developed to accommodate the physically limiting the absolute velocity of galaxies never exceeding that of light, $c = (\varepsilon_0^{-1} / \mu_0)^{-1/2}$. We are suggesting that ε_0 and μ_0 are physically real parameters of the CTF, which is stationary. A large portion of the cosmological red shift of star light is occurring during the propagation through the vast cosmic

space (CTF). It possesses some distance dependent frequency reduction mechanism either influenced by the omni-present *diverse fluctuations* in it and/or some innate distance-dependent property of the CTF itself.

The corresponding expression for the propagating plane wave packet $E(x,t)$ can be expressed as:

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

Here $\nu_{src.}$ is the frequency of the emitted wave packet in neighborhood of the emitting atom and β is the distance dependent frequency reduction factor. To simplify the argument, let us assume that the total Hubble redshift $\delta\nu_{Hbl.} = \beta x$. The prevailing model is that it is all due optical Doppler shift, $\delta\nu_{Dplr.} = \mathrm{v}_{rel.}\nu_{src.}/c$, where $\mathrm{v}_{rel.} = H_0 x$ (the Hubble relation), H_0 being the Hubble constant and x being the distance between the target galaxy and the earth. Then, one can express the distance dependent frequency reduction factor β in terms of H_0 as [27]:

$$\beta = (\nu_{src.}/c)H_0 \tag{3}$$

6. DISCUSSION

Based upon the basic physical processes behind recording of optical holograms and the non-real properties of reconstructed image, we have presented our position that the principle of optical holography does not represent a causally valid analogy for the emergence of touch-able cosmological objects as some holographic reconstruction. Since the derivation of all the cosmological theories accepts the foundational hypotheses behind Relativity and Quantum Mechanics, we have also presented one of the fundamental weaknesses behind cosmological (Hubble) redshift that it is due to optical Doppler shift depending solely upon the relative velocity between the source and the detector. Based upon observed spectrometry and quantum transition properties of atoms, we have shown that optical Doppler shift, just like Doppler shift for sound waves, has two independent components: (i) real Doppler shift due to source velocity and (ii) apparent Doppler shift due to detector velocity. The deeper implication of our proposition is that the postulate of rapid increase in the distance between the galaxies of our universe (expanding universe) may not be founded on strong cause-effect hypotheses, which is supposed to be the basic tenet behind enquiring nature's ontological reality.

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