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CHAPTER TEN

Replacing The Paradigm Shift Model In Physics With Continuous Evolution Of Theories By Frequent Iterations

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We accept messiahs/ super-geniuses -- paradigm shifts -- to bring major changes in society and science. Such paradigm-driven societies become socially-politically-economically stratified into knowledge “haves and have-nots”. We have the responsibility to participate in the process of consciously constructing our purposeful evolution. In the case of Physics, we must replace the paradigm shift with continuous evolution of theories by frequent iterations. Einstein’s photoelectric theory is analyzed to justify Non-Interaction of Waves and introduce space as a Complex Tension Field to re-kindle his dream of a unified field theory. But, all theories must be iterated again and again as continuous evolution.

KEYWORDS: Paradigm Shift; Continuous Change; Evolution is Collective; Theories are Incomplete; Gödel’s Incompleteness Theorem; Evolution Congruent Thinking.

Replacing The Paradigm Shift Model In Physics With Continuous Evolution Of Theories By Frequent Iterations

Chandrasekhar Roychoudhuri
(October 01, 2015)

INTRODUCTION

Towards the end of the last century, the Global Internet and Cellular Communication technologies ushered in the modern Knowledge Age. The level of socio-political consciousness has been steadily rising all over the world. Low-income people all over the world are pooling their 10c resources to discover their own path to sustainable life. Low cost solar panels and LED-lights are spreading in poor communities all over the world where there is no electricity as yet. A part of the inspiration was promoted by the declaration of "2015 is the International Year of Light" by the United Nations in 2013. More and more people are becoming pro-active to assure that the global economic system evolves towards a recyclable and sustainable system, instead of the millennia old paradigm of perpetual growth within a limited biosphere. People are becoming aware that we have been doing many many things because they have been "working" simply out of the desire for a comfortable and stable life. We are forgetting to question why we keep on doing things the only way we have been taught. Globally, the educational systems have been successfully suppressing our evolutionary enquiring minds that we are born with. We have been accepting all the social and scientific theories that have been "working" as if they represent the final truth for us. As if our enquiring minds do not need any further evolution! Even the recent book, "This Idea Must Die: Scientific Theories That Are Blocking Progress" (edited by John Brockman, 2015), implies, as if, only some of the piecemeal antiquated ideas should be dropped to move the scientific progress forward. The social implication is as follows. We must leave the responsibility of challenging the fundamental paradigms behind different established theories only to messiahs like Einstein. But I question this view. It is high time to figure out how to inspire and empower the common citizens and scientists to challenge the foundational postulates behind major

social and scientific theories that are “working”. Elitism must be replaced by active participation by all. We must continue to evolve and the evolution is collective and hence we need broadest possible active participation. This will be possible as the prevailing messiah complex driven culture is slowly changed to accommodate challenges brought forward by the common citizens and scientists continuously in small steps. In physics we must actively move towards constant evolution (as nature is) and overthrow the past model of Paradigm Shift [1] driven revolution. Instead of waiting a century or more for a messiah to come and challenge the foundational postulates of a “working” theory, common citizens and scientists should be inspired to keep on “biting and nibbling” at those postulates as newer and newer observations are gathered. In the Knowledge Age, we must be smart enough to encourage more and more people to collaborate and contribute to the generation of new knowledge.

In physics we are celebrating the centenary year of Einstein’s General Relativity and the 60^{th} year of his death. Let us recognize that we now need the ad hoc hypotheses of Dark Energy and Dark Matter to accommodate the velocity distribution of outer stars in galaxies. This is because Newtonian and Einsteinian gravity theories are unable to match the measured data. Unfortunately, the established culture is not encouraging scientists to challenge the foundational postulates behind any of theestablished theories, Quantum Mechanics and Relativity.

Human mental evolution is better adapted to take conscious creative decision by comparing both past experience and potential future possibilities. This is in contrast to molecule-based biological (genomic) evolutionary process, which builds “layer by layer” on the “pre-adaptive state”. This process does not have the capability of “future vision”. It takes the previous “pre-adaptive state” in conflict with the current environment to the next best “post-adaptive state”. It is also not smart enough to take retro-active correction based upon current state (experience)! But the human neural network, albeit a product of genomic evolution, has developed the capability of correlating present with the recent and deep past and also with the immediate and deep potential future. Unfortunately, our current socio-politico-economic-culture does not pro-actively nurture this evolutionary power of all the members of our society. With the ongoing and prevailing

economic system, 90% or even more of the members of our society cannot afford to put their time to make creative contribution towards consciously constructing a society for our collective and purposeful evolution. They are busy all their lives just making individual material life without participating in the well-being of the biosphere. We have forgotten that a sense of responsibility and ownership evolves with active participation.

As a physicist, I have spent most of my life in optical science and technology related issues. But here I will take this opportunity to promote the development of a culture of continuous evolution, not just in science, but in all knowledge fields, so we can collectively keep on advancing while being evolution congruent to our sustainability. We should be consciously constructing diverse (parallel) paths for our purposeful evolution with frequent iterative feedbacks to remain congruent with the forces of natural evolution, the deeper knowledge of most of which has been perpetually remaining just out of our reach! All our knowledge is partial knowledge; it must keep on evolving. Frequent iterative feedback is the key to avoid falling in love with a paradigm of partial truth, while allowing for the partial ignorance to grow larger and larger, eventually demanding a disruptive revolution. History tells us that social revolutions and scientific paradigm shifts have been highly disruptive, albeit with follow-on better re-organizations.

Consider the temporal duration of an accepted human paradigm that can grasp only partial truth. During the initial phase, the paradigm is utilized to understand a broader set of natural phenomena than we could understand and have united before. But, then we start extending it to understand newer observations and newer phenomena utilizing the same foundational postulates behind the working paradigm. Thus, we may be trying to force-fit newer phenomena within the older set of original postulates, which may not be valid. Thus, a large number of brilliant scientist-life-efforts may be wasted in trying to extend a theory that had already reached its limits. However, only a few lives of scientists have been truly endangered though paradigm shifts. In contrast, socio-political revolutions have been endangering uncountable lives throughout “civilized” human history.

Let us also recognize that whether it is the socio-political or the scientific paradigm shifts -- both relate to our innate biological

nature of looking for stability and love for life-time comfort, leveraging what has been working. So we create a culture that is "working" and a life-long conformity is extracted out of everybody, exploiting the innate biological traits of longing, belonging and being loved by the culture we live in. Common people do not need to rationalize to conform; they just follow. But the intellectuals do rationalize the working theories, whether politico-economic or scientific. This causes serious damage to the progress of the evolution of human minds. This is the deadly mistake that Homo Sapiens, the most pervasive species [2,3] on the earth, has been committing for centuries. This is because humans have evolved into thinking animals and the signs of our evolution are our mental concepts. When the guiding concepts behind our cultures are in-congruent with biospheric evolution -- then these concepts, while controlling our cultures, can endanger our sustainability rather than engendering further evolution of our minds. Many millennia ago, if a river was swelling up unusually high in the memory of the elderly tribal members -- the tribal leader paid attention to their recollections and ordered the entire tribe to move to some higher ground while suffering some disruptions. The entire tribe was not held hostage by a smaller group demanding that definitive scientific proof must be produced for over-flooding before the tribe is allowed to take remedial actions because there would be economic losses in abrupt moving. Such attitudes are anti-evolutionary considering all human knowledge is incomplete.

This is the fundamental problem with our paradigm driven culture, whether they are believers or scientists. Scientists hang on to well-validated "evidence based science" just as firmly as the believers to their faiths. Hence the believers and the political maneuverers safely keep on demanding irrefutable evidence; they are unwilling to budge from their material or mental comfort zones. Basically, both these groups are resisting *continuous evolution* of our lives. What I am claiming is that we must accept continuous changes and master our evolution consciously [4].

Unfortunately, belief in the prevailing "working" paradigm by scientists is not very much weaker than those of religious believers in their paradigms. By now, in the 21st century, we recognize that evidence based science, validated by mathematical theories, is the best approach to the modeling of working rules pertinent to

evolving nature. But, we are failing to recognize that experimental evidences are only *partial clues* to the realities of nature and are not the *final ontological truths. All organized bodies of knowledge (theories) so far put together by human intelligence are necessarily incomplete, as they are based upon insufficient knowledge of the universe.*

Being a physicist, the rest of my article will be devoted to examples of various physics concepts that we are steadfastly hanging on to in spite of the fact that new evidence and new knowledge requires us to change and evolve our concepts. Before going into physics concepts, let me cite a couple of examples from other fields. In the field of socio-econo-politics, everybody "knows" that the capitalist economic system, may not be perfect, but it is the best system for us to keep on following. The paradigm of capitalism is continuous growth -- which is impossible for the finite biosphere to sustain in the long run [5]. The long term sustainability of the biosphere demands that Homo Sapiens consciously start re-structuring their economic system towards a 100% recycling one, without waiting for irreversible massive disruptions and extinctions around the globe [6]. Or, consider the pharmaceutical industry, the biggest industry conglomerate controlling everybody's health, at least in the developed countries who can afford the healthcare. The paradigm is to "kill the bacteria"! Fortunately, in this case, slow, iterative and continuous change has already started taking effect. We are now beginning to understand that our best health condition is achieved when our body (10 trillion human cells) has a right synergistic combination of diverse bacteria (100 trillion). This microbiota [7,8] actively facilitates the management of our wellbeing through production of necessary hormones for digestion, thinking, etc. Given the cell number ratio being 1:10; we have to become vigilant that we consciously become the master of our minds and pro-actively construct the direction of our future evolution! The best way is to consciously gather small bits of new knowledge and seek out small mistakes in our immediate past knowledge, and correct ourselves as frequently as possible without waiting for the big paradigm shift to correct big mistakes. We should consciously seek the demise of that aspect of our prevailing culture that hangs on to a paradigm until it becomes grossly disruptive! Consider how it is that bacteria thrive. They proactively seek food by

touching the molecules in their vicinity, constantly sensing what is food and what is poisonous. They then use the knowledge to act more judiciously in their next attempt in hunting food and successfully proliferate in their number. In fact, in the domain of molecular engineering, the bacteria are demonstrating biological intelligence superior to that of humans. Dozens of our PhD's working together over a period of about 10 years produce an anti-bacteria molecule (medicine!). Then, once we use it to kill the bacteria, a good percentage of the bacteria carry out the molecular engineering feat of becoming "resistant" to this "drug". Humility is needed on our part -- we need to learn to live synergistically with bacteria. *"Conquering" is not an evolution congruent mode of thinking.* The evolutionary functions, in order of priority, are more like: (i) symbiosis, (ii) synergy, (iii) food-chain and (iv) echo-driven, (v) competition. We have been erroneously and madly driving the human culture into accepting dog-eat-dog competition as the inevitable part of evolution to the detriment of our own sustainability. We need to understand that biospheric evolution will continue for another billion years, until Solar Warming becomes deadly to the bacteria population. Homo Sapiens is not an essential species. However, once we learn to appreciate the meaning and purpose of biospheric and cosmo-spheric evolutions, we can function as the "Genesis" facilitator on other barren planets around other distant stars. We are already finding out that almost every star in this universe has planets! Bacteria provide the molecular engineering functionality behind evolving life; evolved humans can provide the engineering capability to travel, first, from star to star in our Milky Way galaxy, and eventually, to other galaxies. But we must change our culture to proactively seek-out little mistakes and implement corrections without waiting for big and risky disruptions! We must eliminate the culture of waiting for major disruptive paradigm shifts, or revolutions! Rather, we want judiciously conscious continuous evolution with frequent small changes.

PROBLEMS IN PHYSICS WHILE WAITING FOR PARADIGM SHIFTS ALLOWED BY KNOWLEDGE GATEKEEPERS

1. ANTI-EVOLUTIONARY MESSIAH COMPLEX IN PHYSICS CULTURE

Towards the end of the 19th century, a top physicist declared that physics was fully mature; the only thing left to do was the dotting of some "i"s and the crossing of some "t"s. But by 1900, Planck's blackbody radiation law, modeling the experimental data, declared that atoms and molecules in material body absorb and emit radiation energy in discrete packets of $h\nu$, and Planck's quanta were born, paving the way for eventual emergence of Quantum Mechanics (1925). And, in 1905 ("the miracle year of Einstein"), Einstein defied Planck by explaining photoelectric effect by assigning the quantumness to light itself as "indivisible quanta" instead of to bound electrons in solids. During the same year, Einstein also published his Special Theory of Relativity (STR). STR did away with the ether in space that was supposed to facilitate the propagation of light through the entire galactic space, making this 3D space into a 4D one, time being the new 4^{th} coordinate. By 1915, Einstein also formulated the General Theory of Relativity (GTR), where he brought back "ether" with a modified form. Ether is not filling the space; space itself is physically curve-able generating the effect of gravitational attractions around "masses". These were major paradigm shifts achieved by Einstein due to his 1905 and 1915 publications. During the mid-1920's and forward, there came another burst of publications, led by Heisenberg and Schrodinger, firmly establishing Quantum Mechanics as the model for the micro world of atoms and elementary particles. Question: Were the successes of these mathematical theories accepted because of their sheer conceptual and mathematical brilliance and experimental validation? Or, was it also because the knowledge gatekeepers of those days were more open to new ideas as compared to today? Are these theories the final theories of physics? By definition they simply cannot be. All scientific theories are works in progress -- since they were formulated based upon incomplete knowledge of the universe at the time of the formulation. Those who are

reluctant to accept this simple self-congruent logical assertion are directed to consult Gödel's mathematically elegant Incompleteness Theorem [9].

Unfortunately, that is not the attitude of the current knowledge gate-keepers. The academy, the mainstream publication editors and the supervisors of funding agencies, simply reject any ideas that are very critical of the theories of Relativity and Quantum Mechanics. Is the modern scientific culture suffering from the Messiah Complex? It is now a hundred years since the theories of Relativity were formulated and it is about 90 years since the original formulation of Quantum Mechanics. Much new experimental knowledge has been accumulated and many contradictions are becoming abundant [10-14]. But the physics community is still "computing" while accepting the finality of the same foundational postulates of the old theories. Fortunately, with today's revolution in knowledge dissemination technology and the global internet system, some individuals and small groups [15] are attempting to encourage new enquiry based thinking.

We are suggesting that the foundational postulates behind all working theories (Classical; Relativity; Quantum Mechanics) be collated, and re-evaluated and re-formulated to form a single coherent set of new postulates that can give rise to the dream of all physicists, including that of Einstein -- the construction of a unified field theory [16]. The foundational postulates behind each one of the older theories evolved during periods of fairly distinct and different guiding cultures. We know that framing the enquiring questions determine the answers or the articulated postulates. Since human thinking is a product of the culture, our enquiring questions are influenced and shaped by the prevailing culture. Thus, the three theories, Classical, Relativity and Quantum, cannot be merged into one, while keeping their distinctly different foundational postulates intact. This is why I have proposed [17,18], as one possible unification approach, that space be considered as a Complex Tension Field (CTF) with the intrinsic embedded properties like,) ε_0, μ_0, $e^{\pm}$ and $\hbar$. Then a linear excitation by a "material" dipole will emerge as EM waves that perpetually propagate across the cosmic space with velocity $c^2 = (\varepsilon_0^{-1} / \mu_0)$ without any assistance from the emitter, just like sound wave propagates leveraging the air-pressure tension field.

Let us now postulate that the particles are self-looped (some form of doughnuts) like localized harmonic oscillations of the same CTF, generated by some strong nonlinear excitations. [Notice the fine structure constant for particles, $\alpha = (\pi e^2 / \hbar)(\varepsilon_0 / \mu_0)^{1/2}$]. Then we have integrated both "matter" and waves as *emergent excitation properties* of the same CTF. We do not have the conflict posed by old ether as supporting EM waves, but conflicts with the material particles as something different moving through it. The quantum concept emerges out of the *resonant stability* of the self-looped EM-like waves of CTF. Wave-particle duality is also resolved! Thus, enforcing a mathematical solution to generate such self-looped EM waves out of the CTF would become a major break-through to achieve the next level of unification of the rules being played by nature.

But without substantial and sustained financial support for a large group of researchers, these audacious attempts cannot be implemented successfully. They will wither away, causing a great loss in the sustained evolution of scientific enquiry.

2. NON-INTERACTION OF WAVES (NIW) IS A NEGLECTED UNIVERSAL PROPERTY OF ALL WAVES

In this section I will justify my assertion (the title of the article) as to why we must replace the culture of Paradigm Shift Model while waiting and waiting for another messiah to come and lead us into a better direction of Physics. We must change the culture of Paradigm Shift into a culture of continuous evolution of theories of all knowledge through frequent iterative reviews of the "working" theories (a step-wise advancement of our knowledge). I will avoid detailing fifty years of my frustrations, self-doubts and confusions as to why we do not openly accept the reality that the waves cannot interfere! Waves, being linear excited states of some parent tension field, simply cannot interact with each other to re-organize their energy distribution and create superposition fringes unless we insert some resonant interacting detector within the volume of superposition. The impact of accepting the universal NIW-property is profoundly deep in all of physics [see Ch.10-12 in ref.10]. It may also remove the final bottleneck to construct a

new unified field theory of nature while building upon the successes of current physics knowledge (Classical; Relativity; Quantum Mechanics).

Let us apply our common sense to appreciate the NIW property. When we look at a chosen scenery and image the incoming light on our retina, this light has to cross through innumerable other light waves from other sceneries and remain *un-perturbed* to deliver a stable image on our retina. When we listen to a large orchestra, we can pan our head to identify which player is playing which instrument. The sound waves are entering our ear drum *un-perturbed* even though they are co-propagating through our narrow ear canal. Innumerable resonant hair cells independently pick up all the different frequencies; the sound waves do not interfere with each other to alter mutual wave properties. Surprisingly, this NIW property was underscored almost a thousand years ago by *Alhazen* [19]. He experimented by using a set of candles and watching their images through a pinhole camera. Lighting or extinguishing different candles never altered the images of the other candles. Since the pinhole camera makes inverted images while light travels through the miniscule pinhole; the candle lights are crossing through each other and still producing unperturbed images. *He correctly interpreted that light does not interact with light.*

Then, more than three hundred years ago, Huygens, the father of the postulate, “secondary wavelets”, explicitly stated in his book [20] that these wavelets do not interact with each other while diffractively evolving through each other. In 1818, Fresnel gave the formal mathematical structure to Huygens’ postulate. This is now known as Huygens-Fresnel (H-F) diffraction integral. Since then, till today, scientists and engineers in the field of optics use the H-F integral as their survival “staple food”! In 1900 Planck gave birth to the concept of energy quanta while modeling and deriving the correct expression for the measured blackbody radiation. This originator of the quantum concept underscored [21] that light energy during emission by atoms and molecules is quantized; but they evolve as diffractively spreading wave packets (Huygens wavelets) while passing through each other *unperturbed*.

3. EVIDENCE BASED SCIENCE IS LIMITED SCIENCE

Unfortunately, the Copenhagen Interpretation of Quantum Mechanics (QM) ignored this foundational knowledge of NIW, and replaced this with wave-particle duality while staying focused on "evidence based science" using Measurable Data Modeling Epistemology (MDM-E), essentially founded on Descartes' *Reductionism*. We now need to implement another layer of information gathering via the tool of Interaction Process Mapping Epistemology (IPM-E) to smoothly incorporate Emergentism with Reductionism [see Ch.12 in ref.10]. Why do we need to integrate more modes of thinking? Over the last few hundred years, evidence based science, with the sole guidance of MDM-E has extracted a staggering amount of knowledge about both the micro world of elementary particles and the macro world of the cosmic system. Is not MDM-E (evidence based science) the best and the final form of a thinking tool for science? Diverse recent publications [11-14] and small conferences [15] tell us otherwise; physics has become stagnant for close to a century. We have been ignoring the fact that we are not exploring the hidden (invisible) information that is remaining buried behind the invisible interaction processes that facilitate the *emergence* of the measurable data. Hence we need to add the repertoire (iterative application) of IPM-E over and above the prevailing MDM-E.

Another way to appreciate the fundamental limitations of evidence based science is to explore the *process* steps behind the *emergence* of measurable data. Unfortunately, the influential Copenhagen School behind the interpretation of QM, interpreted this as a *"Measurement Problem"*. This interpretation provided various elegant mathematical solutions, including broadening Heisenberg's *Indeterminacy Relation* as a Principle of Nature -- rather than recognizing that it just reflects some limitation of the logics behind the Homo Sapiens invented mathematical approach. The indeterminacy relation is an ad hoc product of the widths of a Fourier transform pair in conjugate mathematical Fourier spaces [22]. Let us dissect the steps behind any measurement to appreciate that we have a permanent *Information Retrieval Challenge*, rather than an already resolved *Measurement Problem.*

1. *The Measurables Are Transformations*: We can measure only physical transformations between the interactants we choose in our instruments.

2. *Preceded by Energy Exchange:* There cannot be any measurable physical transformations without energy exchange between the interactants.

3. Guided by Forces of Interaction: Energy exchange, and consequent transformations in the interactants, must be guided by an allowed force of interaction.

4. Must Experience Physical Superposition: Since all forces are of finite ranges, the 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 are always "local"! There cannot be non-local interactions.

5. Through Some Physical Interaction Process: Physical transformation through energy exchange is a physical process. The understanding & visualizing the invisible interaction process anchors us to inch towards understanding cosmic logics (reality).

6. Always Requires a Finite Duration: Transformations in the interactants from one specific state into another specific state requires "compatibility sensing dancing period" before accepting the energy exchange and transition.

Corollary 1: Impossibility of Instantaneous Interaction-free Transformation: We can now logically re-derive the NIW-property (Non-Interaction of Waves) based upon our understanding of the processes behind any measurement. The propagating wave packets, being independent linear excitations of the same parent tension field, cannot but propagate through each other unperturbed in the absence of any frequency resonant ***interacting*** material detector. We have not discovered any forces of interaction between linear waves.

I hope the reader can now fully appreciate that evidence based science can never be infallible, or be the final knowledge about nature. We can never gather all the information about anything through any set of experiments. None of the details of the interaction processes and those of the interactants are completely known to us as yet. But *the rules (cosmic logics) behind interaction processes are invariant.* We must seek after them by iterative application of IPM-E, over and above the prevailing

MDM-E (evidence based science). *When we teach our younger generations to accept the working theories without questioning ("just compute") as nature's final theories; we are not just forcing them to conform to the currently understood laws of physics; rather, we are enforcing a slow anti-evolution of their minds because we are suppressing their nature-endowed enquiring capacities.*

4. APPLICATION OF NIW TO EINSTEIN'S "INDIVISIBLE QUANTA"

In this section, we iterate again the damage we have been doing to generations of younger physicists by teaching them to wait for another messiah physicist (Paradigm Shift driven change only). I will use the case example of Einstein, who is venerated as a messiah physicist. Interestingly, Einstein was a true scientist, constantly re-enquiring about his own great contributions again and again. His STR implied that space does not require any ether-like entity. But within ten years, he created GTR, which explicitly requires space to possess the physical property of being curve-able; gravity is a curvature of space. Einstein in 1905 famously postulated light as "indivisible quanta"; this eventually paved the way towards the formulation of Quantum Mechanics. After QM was formulated in 1925, ad hoc interpretations like "entanglement", etc., got enforced on the physics community; Einstein's "EPR" paper [23] challenged these interpretations of "spooky action at a distance". This indicated that his view of the present form of QM is that it does not constitute a complete description of the micro world. In countering Bohr's argument of completeness of QM, Einstein did not use the self-evident argument that all theories are necessarily incomplete (they are constructed based upon insufficient knowledge of the universe). Instead, he proposed complicated experiments in his "EPR" paper; since then, such actual experiments apparently routinely defeat Einstein's opinion and support Bohr's opinion (Copenhagen Interpretation)! But notice that it is the conceptual approach and theory that determines what we can and cannot measure. Interestingly, this last sentence is also a rephrased statement made by Einstein. Let us now appreciate Einstein's life-long, persistently

exploring mind. Shortly before his death in 1955, Einstein exclaimed [24]:

"All the fifty years of conscious brooding have brought me no closer to the answer to the question: What are light quanta? Of course today every rascal thinks he knows the answer, but he is deluding himself."

This is both inspiring and very puzzling. It is inspiring because the father of the proposer of indivisible quantum of light was still not happy with his original "light quanta", albeit being accepted by the knowledge gatekeepers for fifty years. It is puzzling because Einstein is using the same enquiring question, "What are light quanta?" over a span of fifty years without developing doubt that light may not propagate as quanta at all! Framing the question determines the answer. If fifty years of brooding did not yield newer answers, Einstein should have re-framed his questions in many other alternate forms to derive different answers. It is puzzling why he did not. Huygens in 1678 postulated light as non-interacting waves. Planck in 1900 postulated light-quanta, but accommodated Huygens by explaining that after emission, they propagate as diffractively evolving wave packets. Strangely enough, even the entire optics community survives by using the H-F diffraction integral -- and yet continues to give firm lip-service to "indivisible light quanta". Let us then explore the emergence of the photo electric equation, but using the new prescription of trying to visualize a light-matter interaction process map.

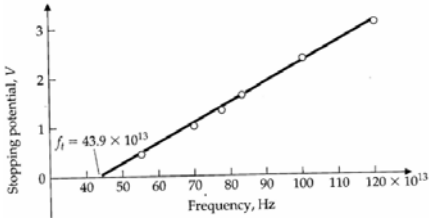

Figure 1. Millikan's plot of photoelectric effect [27].

Based upon the then data on photoelectric effect, Einstein recognized that there is some quantumness behind the effect. See the "cut-off" frequency in Fig.1, below which no electrons are

emitted. So Einstein proposed a book-keeping energy-balancing equation with the assumption that light consists of energy quanta that are delivered fully in each encounter of releasing an electron:

$$h\nu = \phi_{work\ fn.} + (1/2)m\mathrm{v}_{el.}^2 \qquad (1)$$

The total energy of the "photon" $h\nu$ is spent in extracting the electron (work function $\phi_{work\ fn.}$) and the rest goes to give kinetic energy to the released electron, $(1/2)m\mathrm{v}_{el.}^2$. Eq.1 works! Question: Should we remain content with this result as we have been for 110 years (especially in view of sustained successes of the concepts of Huygens and Planck in the broad field of all applied optics)? Notice that Eq.1 does not give any clues regarding the invisible light-matter interaction process, underscored in the previous section.

Let us explore this interaction process based upon our 90 years of success using QM (which Einstein did not have in 1905). All accumulated experiments tell us [25] that electrons are always bound quantum mechanically in solids, albeit in very complex fashions. But because they have to be bound to some assembly of positive charges and the *energy band* is quantized, the electron at any site must first be stimulated as a resonant dipole within the allowed frequency band. The result of light-matter interaction can now be symbolically given by the stimulation $\psi = \chi(\nu_q)E(\nu_q)$, where $E(\nu_q)$ is the amplitude of the incident light wave and $\chi(\nu_q)$ is the linear susceptibility to quantum dipolar polarization. In real life, we always have many different light pulses present simultaneously on our photodetector. So, the total stimulation has to be the sum of all stimulations, $\psi_{res.} = \sum_q \chi(\nu_q)E(\nu_q)$. The QM recipe for measured data is given by the statistical ensemble average of the square modulus (energy transfer in individual events) of the dipolar amplitude stimulations:

$$\left\langle \left|\psi_{res.}\right|^2 \right\rangle = \left\langle \left|\sum_q \chi(\nu_q)E(\nu_q)\right|^2 \right\rangle \equiv \left\langle h\nu_q \right\rangle \qquad (2)$$

Since the energy transfer in a quantum event is always proportional to $h\nu$, the left and right hand sides of Eq.2 are equivalent. This does not mean the energy carrying waves are quantized. It only means that quantum entities fill up their quantum cups with the necessary amount of energy out of the

"sea" of EM fields to "quench the thirst". Since this energy is spent to detach the electron ($\phi_{work\ fn.}$), the rest is assimilated by the electron as its kinetic energy $(1/2)m\mathrm{v}_{el.}^2$. We can now re-write Einstein's simple energy book-keeping relation more rigorously, while incorporating the invisible interaction process:

$$\left\langle h\nu_q \right\rangle = \left\langle \left| \sum_q \chi(\nu_q) E(\nu_q) \right|^2 \right\rangle = \left\langle \phi_{work\ fn.} + (1/2)m\mathrm{v}_{el.}^2 \right\rangle \quad (3)$$

We can now recognize Einstein's original Eq.1 in Eq.3, but by using a more rigorous QM recipe for energy transfer. Had Einstein originally quantized the binding energy of the electrons, instead of those of light wave packets (spreading diffractively) -- Einstein could have invented QM some 25 years earlier with his own stamp. Perhaps he would not have had to "debate" Bohr, over many years, on the measurement and interpretation problems of quantum mechanics.

Let us briefly digress to one of the many fundamental problems behind Homo Sapiens invented mathematical rules, which sometimes can divert us to make serious mistakes in physics. Eq.3 is re-written by taking χ^2 out of a series of three mathematical operations, sum, square modulus and ensemble average -- which is allowed if $\chi(\nu_q)$ happened to be a constant under many actual experimental condition of having

$$\left\langle h\nu_q \right\rangle = \left\langle \left| \sum_q \chi(\nu_q) E(\nu_q) \right|^2 \right\rangle = \chi^2 \left\langle \left| \sum_q E(\nu_q) \right|^2 \right\rangle \quad (4)$$

a very narrow band of optical frequencies. Now, let us compare the potential physical interpretation of the implied physical interaction processes behind the emergence of the measurable data. The second step of Eq.4 implies that the quantum dipole sums all of the simultaneous stimulations induced by the light waves and then carries out the energy transfer executing the non-linear square modulus step. Human instruments carry out the ensemble average. However, the last mathematical expression of Eq.4, where the χ^2 has been taken out as a constant, implies that all the EM field amplitudes sum themselves and then carry out the non-linear quadratic operation of square modulus of the linearly summed fields. This last mathematical expression then erroneously implies that EM waves interfere (interact) by

themselves. This has been the assumption for centuries and is continuing till today, in spite of counter assertions by Alhazen, Huygens and Planck [10].

5. EXPERIMENTS YIELD INTERPRETATION BASED ON OUR EXPECTATIONS AND DESIGNS

We have already mentioned Einstein's comment that a theory determines what one can measure because the structure of the theory and the founding postulates determine the parameters used in constructing the theory. To this I would like to add that even the design of an experiment is dictated by the conceptual belief of the experimenter. I will describe an experiment that I have carried out with the specific desire to understand whether optical spectrometers can carry out *Fourier decomposition* to display spectrum of light pulses [10, 26]. This is the experiment that convinced me of the NIW-property of waves; eventually I searched the old literature (Alhazen, Huygens and Planck), now becoming available through the internet, thanks to Gutenberg Press and others.

The experimental layout is given in Fig.2. Conceptually, it is very similar to studying N-beam superposition effect by using a tilted plane-parallel Fabry-Perot spectrometer instead of using a traditional N-slit grating. My enquiring question was whether a spectrometer can really carry out the algorithm of Fourier transformation of a light pulse (spontaneous emissions constitute independent light pulses). But the initial testing of the setup with a laser gave me a much broader understanding of the nature of light, the universal NIW-property of all waves (described above).

A single incident narrow laser beam gets multiplied into N-beams when passed through a pair of highly reflecting flat beam splitters. The beams were then focused by converging lens on a tilted glass plate, polished on the front side (laser side). The back of this same glass plate was deliberately roughened (grounded). It is technically called a "ground glass" consisting of sub-wavelength silica lumps on the back surface.

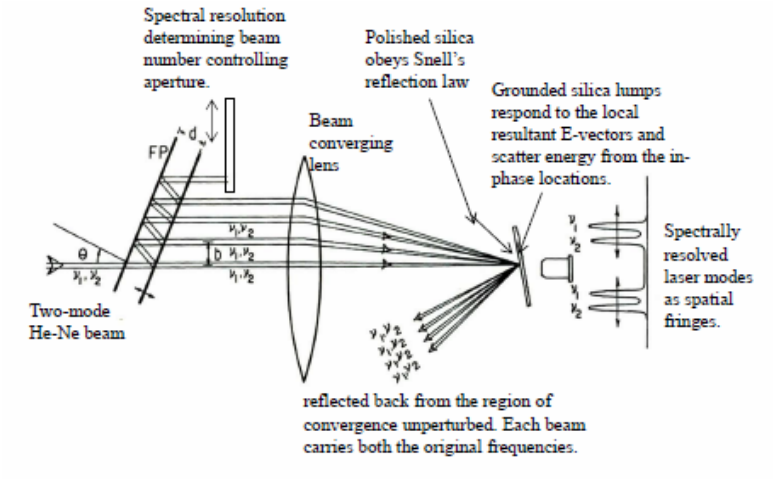

Figure 2. Experimental demonstration of Non-Interaction of Waves [10,26]

One can notice from Fig.2 that a part of the energy of each one of the convergent set of beams gets reflected out, forming again a symmetric divergent set of beams. This is not at all surprising. The basic law of reflection is obeyed by each one of the separate beams. Otherwise we would not have seen our reflected images from a flat mirror. But, the NIW-property is now obvious. Even though this phase-steady ("coherent") set of beams got focused and superposed on a common spot on the flat glass surface, the beams are not interfering or interacting with each other. The Poynting vector for each beam remained independent from the others and facilitated the law of reflection for each one of the beams to be preserved (albeit they were emanating out of the same superposed spot).

This conclusion is further strengthened by analyzing the diffusely scattered light from the back of the ground-glass surface. When one precisely reimages the enlarged ground surface on screen on the right, one can see a beautiful set of fringes. In other words, the minute silica lumps are no longer transmitting the unperturbed individual beams (like the reflection from the front side). Again, this is not a surprise at all until one attempts to analyze the effect in terms of the Copenhagen Interpretation of "single photon interference". Miniscule silica lumps are now

responding *individually* to the joint stimulations due to simultaneous presence of phase-steady N-beams. When a silica lump experiences resultant E-vector stimulation equivalent to zero, it simply does not scatter light energy. The places where a silica lump experiences resultant positive E-vector stimulation, scatters light as the square modulus of the sum of all the stimulations. Since the silica granules are not quantum mechanical detectors, they are not absorbing or scattering "quantum cupful of energies"; they are just responding to classical "square modulus" operation.

Notice further that the emergence of superposition effect by any Silica lump is a result of simultaneous superposition effect (phase sensitive) due to all the N-wave amplitudes. It is not due to scattering of individual "indivisible light quanta". Without simultaneous joint stimulation by all the N-waves, the N-wave phenomenon can become manifest! The resultant fringes due to scattered intensity variation, produced by the ground glass, (a purely classical phenomenon), are given by Eq.5 [30]. Mathematics clearly indicates that the intensity variations are due to all the N-beams collectively, not due to "indivisible photon" from one or the other beam.

$$I = \sum_{n=0}^{N-1} \chi^2 a_n^2 (t - n\tau) + 2 \sum_{\substack{n,m=0 \\ n \neq m}}^{N-1} \chi^2 a_n (t - n\tau) \cdot a_m (t - m\tau) \cdot \cos[2\pi (m - n) \nu \tau] \quad (5)$$

The concept of "Single photon interference" does not represent a causal approach to physics [10].

These observations clearly indicate that *observable optical superposition phenomenon is neither quantum mechanical, nor are generated by indivisible photons.* Scattering phenomenon is a quite mature field in optical engineering. Nobody wastes time analyzing scattered fringes or speckles from rough surfaces in terms of "indivisible quanta". Light beams are not made out of indivisible quanta. They constitute diffractively spreading wave packets [20,21,10].

6. CONNECTING IT ALL TOGETHER!

Perpetual Enquiry: The “cosmic elephant” is too complex for us to fathom in all its details. We will require perpetual re-enquiry, repeated iteration, of the foundational postulates behind all latest theories. We cannot wait a century or more for another messiah to come to our rescue. Today’s epistemology will be made obsolete by tomorrow’s advanced knowledge. Framing a question today determines the intermediate answer we can extract now. It is the purpose of today, accepted or pre-supposed by our neural network, which dictates the inherent structure of our enquiring questions. Our biological and intellectual purposes, “live forever and prosper through our progenies”, must now be integrated with our evolution congruent engineering and intellectual activities!

Inseparability of Diversity and Sustainability: Society-wide Consilient Thinking [14,28,29] will emerge automatically when everybody is engaged in looking after their long-term wellbeing and will be synergistically strengthened by an environment of overall collective wellbeing. The root causes behind the various ideological differences will automatically melt away in the long run. The necessary healthy diversity and sustainable culture will evolve when our motto becomes, “Consciously Constructing a Path for Purposeful Evolution”. Consciously nurturing the emergence of a diversity of healthy concepts will be our safeguard because nobody knows the final answer. But a merely "working" social or scientific model of today could lead us towards self-destruction if it is not congruent with the complex cosmic rules of evolution!

New/Revitalized Research Institutions: We need to organize new and re-vitalized research institutions for all major fields of investigation -- the explicit mission is to assure sustainable evolution through continuous and iterative Evolution Process Congruent Thinking. The Revolutionary Paradigm Shift model is now obsolete for our Knowledge Age. We must promote continuous progress, continuous evolution through the full and proper utilization of all our resources of wisdom and knowledge.

REFERENCES

[1] Kuhn, T. and Hacking, I. , *The Structure of Scientific Revolutions*, 50th Anniversary Ed., University of Chicago Press, 2012.

[2] Kolbert, E., *The Sixth Extinction: An Unnatural History*, Henry Holt & Co. (2014).

[3] Maren, C. W., "The most invasive species", Scientific American, August (2015)

[4] Banathy, B. H., *Guided Evolution of Society: A Systems View*, Springer Sc.+Biz., (2000).

[5] Schumacher, E. F., *A Guide for the Perplexed*, Sphere Books, (1986).

[6] Kolbert, E., *The Sixth Extinction: An Unnatural History*, Henry Holt & Co. (2014).

[7] Rosenberg, E. and Zilber-Rosenberg, I., [The Hologenome Concept: Human, Animal and Plant Microbiota], Springer, (2013).

[8] Enriquez, J. and Gullans, S., *Homo Evolutis*, TED publication, (2015).

[9] Nagel, E. and Newman, J. R., *Gödel's Proof*, New York U. Press, (2001).

[10] Roychoudhuri, C., Causal Physics: Photon Model by Non-Interaction of Waves, CRC and Taylor and Francis, (2014).

[11] Leggett, A. J., *The Problems of Physics*, Oxford University Press (1987).

[12] Smolin, L., *The Trouble With Physics: The Rise of String Theory, The Fall of a Science, and What Comes Next*, Houghton Mifflin Co., (2007).

[13] Weinberg, S., *Physics: What we do and don't know*, The New York Review of Books, Vol. LX, No.17, p.84, Nov.7, (2013).

[14] Roychoudhuri, C., "Urgency of evolution process congruent thinking in physics", Proc. SPIE Vol.9570, Paper #7, (2015).

[15] An SPIE biennial conference series (every odd years), "The nature of light: What are photons?" http://spie.org/Publications/Proceedings/Volume/9570?&origin_id=x4325&start_volume_number=9500&end_volume_number=9599&num_results=100

[16] See updated references here: https://en.wikipedia.org/wiki/Unified_field_theory

[17] Roychoudhuri, C., "Next frontier in physics – space as a complex tension field", J. Mod. Phys., Volume 3, Number 10, pp.1357-1368, (2012).

[18] Roychoudhuri, C. and Ambroselli, M., "Could space be considered as the inertial rest frame?", Proc. SPIE Vol. 9570, paper #30 (2015).

[19] Ronchi, V., See p.53 in *The nature of Light*, Harvard U. Press, (1970).

[20] Huygens, C., "Treatise on Light", (1690). Search Project Gutenberg eBook, free from web.

[21] Planck, M., *The Theory of Heat radiation*, Translated M. Masius, P. Blakiston's Son & Co. (1914).

[22] C. Roychoudhuri, "Heisenberg's Microscope – A Misleading Illustration", Foundations of Physics, 8(11/12), p.845 (1978).

[23] Einstein, A., Podolsky, B. and Rosen, N., "Can quantum-Mechanical Description of Physical Reality Be Considered Complete?", Phys. Rev. Vol.47, pp.777-780, (1935).

[24] Roychoudhuri, C. and Roy, R. Eds., see the first article in "The nature of light: What is a photon?", Optics and Photonics News, Special Issue, October, 2003. Free download: http://www.osa-opn.org/home/articles/volume_14/issue_10/features/opn_trends%E2%80%94the_nature_of_light_what_is_a_photon/#.VfhFMpfivHA

[25] Rogalla, H. and Kes, P. H., *Hundred years of Superconductivity*, CRC Press, (2012).

[26] C. Roychoudhuri, "Is Fourier Decomposition Interpretation Applicable to Interference Spectroscopy?", Boletin InstitutoTonantzintla, Vol.2(2), 101 (1976). Free download; go to paper #1976.3: http://www.natureoflight.org/CP/

[27] Bernstein, J., Fishbane, P. & Gasiorowicz, S. *Modern Physics*, see Fig.4-8. Prentice Hall (2000).

[28] Wilson, E. O., [Consilience: the unity of knowledge], Alfred A. Knopf, (1998).

[29] C. Roychoudhuri, "The consilient epistemology: structuring evolution of logical thinking"; Chap. 16 in [Proc. 1st Interdisciplinary CHESS Interactions Conf.], Eds. C.

Rangacharyulu and E. Haven; Imperial College Press, London (2009).

[30] N. Prasad and C. Roychoudhuri, “Tabletop demonstration of Non-Interaction of Photons and Non-Interference of Waves”, Proc. SPIE Vol.9570, paper #47 (2015).