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The Consilient Epistemology: Structuring Evolution of Logical Thinking

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Abstract

When we carefully analyze the current principles or foundational hypotheses and thinking (epistemology) behind all of our major bodies of knowledge constituting our modern *culture* (politics, wealth creating policies, technology, science, etc.), we find that they are not congruent with the demands for long-term sustainable evolution of either for our physical or for our mental (spiritual) well being. Even our modern democracy is run by the “Golden Rule” developed by our tribal fore-fathers several hundred thousand years ago. Irrespective of the greatness of various modern constitutions, the social games are decisively kept stacked in favor of the “Gold” owners. To assure our peaceful and sustainable evolution, we need to replace this “Golden Rule” by the true democratic rule, or “Knowledge & Debate Rule” through the development of an over-arching *consilient epistemology*, now enabled by the global internet system. The logics behind this methodology of thinking must keep on evolving perpetually by iteratively enforcing conceptual continuity and logical congruence among all the foundational hypotheses behind all the major organized bodies of knowledge we use to organize our collective social well being. This will nurture our minds to look for *unity in diversity*, and in the process, the emerging synergy between diverse fields of knowledge will assure an evolving *culture* that promotes all those concepts organized for conscious and purposeful evolution. The key tools of thinking are to focus on understanding the hidden or invisible or complex processes that give birth to all the observables or measurables we use to build our theory. Most of our “successful and working” theories, developed over the last few centuries, have been focused on modeling and predicting just the measurable outcomes, as if understanding and visualizing the invisible processes are of little significance. This has seriously slowed down our mental evolution from exploring the role and the purpose of human evolution within the evolving cosmic system. We substantiate our proposition by giving examples of limitations built into several of our current bodies of knowledge and by analyzing the limits being experienced by the field of physics. We underscore our propensity for quickly accepting subjective interpretations for survival provided by our hardwired genomic programs, which overshadow our enquiring minds and human logics from seeking the objective reality and the actual cosmic logics that generate the observables. Inseparable connection between the consilient epistemology and our successful evolution is justified from an understanding that, for many millennia, the rapid evolution of human minds is being driven dominantly by the cultural-selection (intra-cultural and inter-cultural conflicts and pressures) rather than by the Darwinian natural-selection pressures since we have essentially conquered the threats from other species and natural calamities.

1. WHY DO WE NEED SUCH AN OVER-ARCHING CONSILIENT EPISTEMOLOGY?

Let us first justify the necessity of pondering over such an over-arching methodology of thinking when the human species appears to have conquered nature and no other species can threaten our competitive superiority for over at least 100 thousand years. It is good to start with a recognizable global problem - Global Warming. Luckily, a large majority of educated people have begun to acknowledge that we humans have accelerated Global Warming by virtue of our methods of generation and utilization of excessive energy, especially, over the last two centuries. But we still are paralyzed from taking any serious global actions to slow down the problem because we have become slaves to our own “successful” political and economic theories that have never accepted the stability of the biosphere in its dynamic equation. Interestingly, our scientific knowledge behind the complex and interlocked working processes behind the living and evolving biosphere is so limited that we do not even know how to completely reverse the Global Warming; and restoring it is beyond our current engineering comprehension. In other words we still have not learnt how to carry out sustainable terra-forming, as evidenced by our recent experiment called “Biopsher-2” [1]. Further, our global leaders are incapable of thinking outside the current political and economic boxes. *In-box thinkers are either self-brainwashed by their own research, or are afraid to speak*

out that the very foundation of our modern “successful” political and economic theories are at the root of threatening the extinction of the human species. The foundational principle behind the current “working” Capitalism is continuous growth. But the biosphere is a finite closed system designed to function through 100% recycling of everything. While it is somewhat easy to recognize the fundamental problems behind our current economic theory, there is a more serious and more profound problem behind our methodology of thinking (epistemology) that we have been developing over several centuries. Just as we can never challenge, by verifiable scientific experiments, the “successful” religions and their claim on the existence of a supreme creator of the universe, we have tacitly assumed that our “successful” theories on social, political, economic and scientific phenomena must remain unchallenged. The underlying assumption is that we will never be able to understand and visualize all the interaction processes behind the biospheric and cosmo-spheric evolution and develop an over-arching understanding behind the cosmic evolution. So we accept that the best we would be able to do is to create theories that can approximately predict only the outcomes that we can measure, not the physical processes that generate them. Surprisingly, even the scientific culture has adapted to this religious mode of thinking – successful theories are “untouchables” like religious doctrines and we can build new sciences based only on the foundations already built, as if the ultimate foundation of the scientific pyramid has been discovered for all future generations to come. They do not need to think out-of-box anymore, thus freezing the evolution of deeply enquiring minds. In view of such a narrow-minded scientific epistemology, it is not at all surprising that some powerful people and media are still trying to call Global Warming as a hoax. Perhaps they are actually wiser. They are eagerly looking forward to experience the “Armageddon” they have been eagerly waiting for [2]!

Over the last ten thousand years, as we succeeded in eliminating any serious threats from other species and as our political and social cultures, under the strong-hand guidance of the tribal rulers, succeeded in becoming a reasonable safety-net for survival and belonging to, we slowly started to deviate from the necessity of living in harmony with nature. Now we are irresponsibly over-riding our genomically programmed knowledge for such harmony. Let us quickly list a few of the issues from diverse fields that might convince the readers that human thinking has to change profoundly to undo the damages done by our non-harmonic behavior. We have yet to recognize that we must start fully utilizing our genomic gift, free-will, to intelligently construct a purposeful evolutionary path, rather than staying victims of our limited thinking, “survival only” epistemology. It is time to behave like adults and create a collective purpose for human evolution. We must start proactively taking care of the biosphere that sustains us, instead of behaving like babies who are driven to take all the immediate nourishments out of the mother irrespective of her health.

1.1. Cultures, Concepts and Theories contradict our sustainability

- **Limits of current economic theories:** “Successful” capitalist system is driven by continuous growth and exploitation & control of nature. But the biosphere is driven by punctuated sustainable evolution through cycling and recycling everything. Our economic system must learn to adopt and adapt to this 100% recycling system. The alternate is to court human extinction. We still have not fathomed the deeper working rules behind the very complex biospheric system. Our scientific and engineering knowledge is still very far from proactively creating and nurturing any alternate biosphere to keep us alive. We certainly have not mastered the terra-forming technologies. In the past, Capitalism meant control and management of finance capital to create profit for the owner of the capital by producing socially congruent goods and services. Thus, in spite of exploitation of human labor and natural resources (biospheric capital), there was a tacit understanding that Capitalism serves the overall greater good and collective well being of the human society. Now the key *purpose* of Capitalism has become maximizing the profit for the capital owners, not necessarily for the production of socially congruent goods and services. Supporting greater social good and promoting collective well being are no longer underscored in major business schools even though they are essential for our sustainable evolution. The “best and the brightest” are heavily incentivized to constantly invent and improvise newer “financial instruments” that are beyond the controlling laws in the Government books, while mocking at them with the motto “greed is good” with great pride!
- **Limits of current political ethics:** Socio-politico-econo system is still under the control of less than 1% of the tribal leaders just as it was 100 thousand years ago. Over the millennia, only the

- names of the ruling systems have been changing while the sophistication of the brainwashing methodology has been intensified to control the free-will of the human masses, starting from early childhood, beginning with parents, then schools and finally the socio-politico-econo system for survival. Private wealth, whether accumulated by force or by “Golden” rules enforced by the “Gold Owners”, is still controlling the governments around the world, just as it had in ancient times. Physical and mental well being of well over 50% of humans are challenged daily as they are forced to live on a subsistence level like animals through sustained daily toils without time to reflect on social issues as humans should. In a Knowledge Age, even business leaders will agree that this is a very unproductive use of many billions of potentially creative minds.
- **Limits of current social ethics:** Even though we have advanced ourselves into the Knowledge Age, globally more and more people are steadily falling into the group, “wealth and knowledge have-nots”, creating definite grounds for serious political disruptions and instabilities. Current terrorism is just a child’s play compared to what may come if we continue to believe that “might is right”. Asymmetric warfare is not winnable by exerting “political will” along the same line of philosophy that “our model” of socio-economic system is the “ultimate and best” system. Our evolution is collective at the very molecular root of DNA formation. Pure individualism or neglect of the well being of the masses is counter to sustainable evolution. The entire living biosphere is a collective and inter-dependent system.
 - **Limits in current model of battling infectious diseases:** Staggering financial successes behind all pharmaceutical industries lies dominantly with the philosophy of killing the bacteria. But many of these bacteria become resistant to any medicine we make within weeks. The very philosophy is counterproductive. We are ignoring that our body thrives symbiotically and synergistically with 100 trillion bacteria and microbes of different kinds, 10 times more in number than the number of our own human body cells! If bacteria, with 3.5 billions of years’ of maturity, were really “out to get us”, they could have done so long time ago. The epistemology of killing bacteria, while our own bodies thrive on symbiosis and synergy with trillions of them, is counterproductive epistemology. The focus of the current human culture, dictated by the system to make profits, is on diseases, not on promoting the knowledge on how everybody can live a balanced and healthy life naturally!
 - **Limits of current epistemology of Physics:** Purest of the sciences, physics has been focused for centuries just to model what we can observe or measure, rather than understanding and visualizing the invisible interaction processes that give rise to the measurable transformations. This epistemology has forced many to promote mystical concepts like springing up of “multiple universes” [3] after every quantum mechanical interactions, which are beyond verification by our current stretch of engineering imaginations! In spite of staggering advancements in our technologies utilizing knowledge created by physics, its century old epistemology will eventually slow down the progress of technology unless we focus our attention to model the invisible interaction processes. It is by emulating the processes behind natural phenomena that we create new technologies to assure our sustainable evolution.
 - **Limits of present religions in guiding societies:** Minority right-wings of all major religions are successfully wedging divisiveness among global population rather than bringing spiritual convergence and harmony, essential for our collective well being! Moderate majority is afraid of speaking out against the self-declared representatives of their gods. When we accept any human organized body of knowledge as the final and inviolable ultimate truth, whether meant for complex social engineering or nature’s technological engineering, we consciously court the freezing of our mental and material evolution. Such cultural behavior is not congruent with our sustainable evolution.
 - **Limit of the life of our Sun:** Our social strategies do not appear to be congruent with our desire to keep on evolving forever. We may delay the “Global Warming” by some changes in our behavioral economics, but the insurmountable “Solar Warming” is coming to dry up the earth in less than a billion years! We must learn to proactively nurture our biosphere now to buy time, while preparing for terra-forming other planets of our Solar system and then in other stars to assure continued human evolution in some other planets [4].
 - **Limit of purposeless evolution of humans:** The magnificent cosmo-sphere and the biosphere are evolving in a remarkably orderly and creative fashion. We are evolving inside these vast physical spheres but keeping our minds totally rapped under our limited, narrow-vision cultural spheres.

We raise our children to develop some specific purpose for their lives. But, have we ever defined a collective purpose for the evolution of the human species? Should we? Can we? Or, will we grow more divisive and become Knowledge Age Neanderthals? We cannot keep on evolving forever and become successful space travelers without a *collective endeavor guided by some collective purpose*.

In Section-2 below we demonstrate that the *epistemology behind modern physics* is not geared towards proactively supporting sustainable human evolution. The result is that we have been diverted in inventing elegant theories rather than discovering real interaction processes that are behind the cosmic evolution. In Section-3 we summarize our *core assumptions for this paper* that are analyzed further in later sections. In Section-4 we *analyze our visual perceptions* to underscore our genetically ingrained “subjective interpretation propensity” for evolutionary needs. Our brain “imagines” reconstructed images out of 2D impressions on our retina. We really do not “see” anything! So our minds need to be constantly vigilant to make objective analysis of our perceptions. Section-5 rationalizes that the rate of human *evolution due to cultural-selection far out-weighs that due to Darwinian natural-selection*. The importance of this understanding is that the tools that control a culture, control the political power. Section-6 defines the value and significance of our proposal, consilient epistemology, towards directing our evolution with a purpose.

2. IS THE EPISTEMOLOGY OF THE PUREST OF SCIENCES, PHYSICS, LEADING US IN AN EVOLUTION CONGRUENT DIRECTION?

In this section we will establish that even the epistemology behind immensely successful modern physics is seriously deficient in providing epistemological leadership to other branches of knowledge that use various logics as their foundation. Some readers with expertise in physics might question the very legitimacy of the question that heads this section. This will be especially true for those who believe that “science and arts are for the sake of science and arts” only. Fortunately, a majority of scientists and engineers will recognize that, as paid members of our society, we need to spend a significant portion of our time producing “scientific or artistic wealth” that is congruent with our culturally accepted definition of wealth.

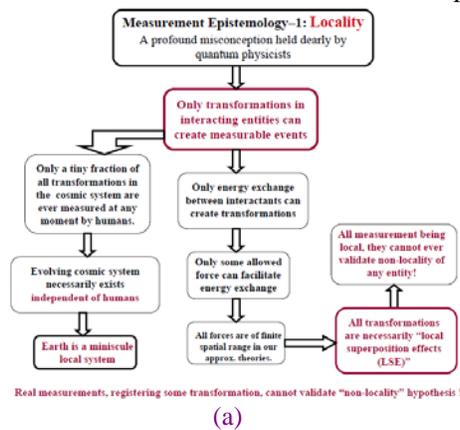
Scientific thinking is supposed to be perpetually enquiring. Could, treating current formulation of quantum mechanics as complete and inviolable just because they are working, threaten the evolution of our minds, our sciences, our technologies, and hence our very existence? It is worth pondering. Recall that during the last quarter of the nineteenth century and the first quarter of the twentieth century, all well known physicists put their best efforts to find out the limits of classical physics, which generated most of the critical foundational experiments and concepts that gave birth to quantum mechanics (QM) [5]. Within a few decades, a flood gate of new knowledge of the micro world became available to us through the application of QM. We have become so mesmerized with this staggering degree of successes that Copenhagen Interpretation essentially declared that QM represents a complete (final) theory of the micro universe. Even though the very foundation of our mathematical theory is rigidly causal, the inability of QM to explain the details of *interaction processes* in the micro world was simply covered up under a new Uncertainty Principle to enforce the theory on us as a complete one! The enquiring minds of multiple generations of physicists have been forced to concoct further non-causal concepts like non-locality of interaction processes, teleportation of particles, generation of multi universes, etc., to explain various superposition phenomena [6]. We have essentially forgotten that the purpose of physics is to discover, understand and *visualize the invisible structures of the interactants* and the invisible *interaction processes* between them that create the transformations leading to changes and evolution in the cosmo-sphere and the biosphere.

It is our successful and accelerated emulation and application of working laws of nature to create suitable technologies that are behind our rapid evolution to overcome competitions from other species. Ancient science was correctly focused on understanding interaction processes in nature. However, slowly, over the past several centuries, we have strayed into the mathematical comfort zone of modeling just the observables. Interpretations of working mathematical equations are becoming more and more mystical rather than objective and causal. Instead of humbly finding path(s) to refine our mathematical human logics towards actual cosmic logics, we are arrogantly declaring some of our successes as “God’s Equations” and telling nature as to how she ought to behave!

Current “mystical interpretations” in mathematical physics is already developing serious doubt about our long-term leadership capabilities! Clearly there is “Trouble with Physics” [7] as we have given up searching for reality for more than a century! Finally, well known theoretical physicists have begun to speak out through their books [8.9.10] that there are serious problems with the current paradigm, philosophy and direction of physics! Like Ptolemy’s time, when they were enamored with the spherical symmetry centering the Earth, we are now worshipping esthetically pleasing mathematical elegance, forgetting about discovering the *physical processes!* The author believes that this prolong cultural shift has taken place because of the absence of any serious and consistent measurement epistemology – how much information is available to an experimenter & how to structure that limited information into a causal theory, so we can iteratively keep on advancing towards creating better theories. Real cosmic logics behind the cosmic evolution may not be exactly the same as our current “successful” human logics (theories) imply.

2.1. Measurement/observation epistemology

2.1.1. All interactions are “local”: A self consistent measurement epistemology leads us to the following realizations. All interactions are local; or more accurately, they all are superposition effects taking place in a small region defined within the instrument. Measured transformations are produced by exchange of energy between the space-finite interactants guided by one of the four allowed forces that always has a well defined interaction range. As per Copenhagen Interpretation, quantum mechanical superposition effects between elementary particles, photons, atoms and molecules, are nonlocal. A significant portion of all activities in the biological world, including human thinking, is driven by molecular interactions guided by rules well formulated by quantum mechanics. Could we have been using our brains (thinking) independent of each other if all molecular interactions were nonlocal? It can be nonlocal only in the limited sense that atoms and molecules are not geometric point objects. They have finite physical extension and that they influence each other beyond their physical size, but limited to spatial ranges dictated by force laws they must obey. Fig.1a provides the logical flow diagram justifying *locality* of interactions as physical superposition of different interactants within their sphere of influence.



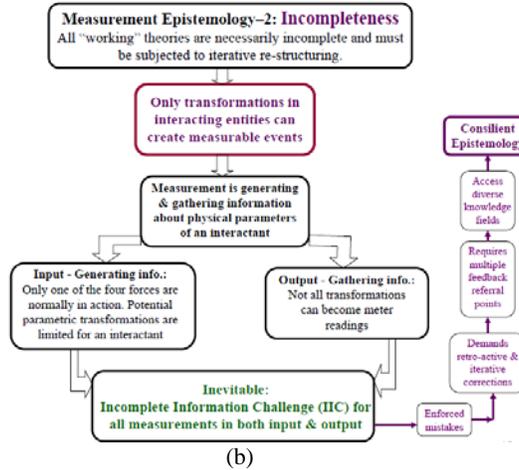


Figure 1. (a) Gives the logical flow as to why all interactions are necessarily local. (b) Gives the logical flow chart that underscores that all of our attempts to gather information through experiments have fundamental limits in gathering all the relevant information.

2.1.2. Incomplete Information Challenge (IIC): Let us now look into the incomplete information challenge (IIC). This is a well known and eternal challenge to human minds and the genius thinkers have been filling up this information gaps by wisely creating new hypotheses that make their new theories logically self consistent. But these hypotheses may not be the ultimate and the best, which our future research may elucidate. All experiments give incomplete information about the interactants under investigation. Thus, all “working” theories are necessarily incomplete and must be subjected to iterative re-structuring. The logical flow diagram of Fig.1b underscores the relevant points. Almost all of our experimental measurements are modeled with some imposed approximations as we usually judiciously neglect the effects of all the forces except one that is the strongest based on their ranges of influence. While this is probably the only way we can start a new theory, but we should remember that we had started with incomplete information about the interaction under study right at the very first stage of information *generation*. All the four forces, discovered so far, although have finite ranges, none goes to zero abruptly. Then, at the stage of information *gathering*, we are again information limited. This time it is due to intrinsic limitations of our complex instruments and their capability to transfer faithfully all the information related to the transformation we are studying. A simple example would be band-limited frequency response of all electrical circuits connected to photo detectors. Only way to overcome such fundamental incomplete information challenge (IIC) is to indirectly gather information about the same interactants but from very different fields of studies, which we are defining as a consilient epistemology [11, 12].

2.1.3. The NIW principle; Non-Interference of Waves: Propagating waves do not exchange energy with each other unless mediated by some material media to display the superposition effect. This is a universal principle followed by all propagating waves. We have missed it due to our blind focus on modeling only observables, ignoring processes behind the emergence of observable transformation, outcome of superposition effect.

Let us assume that you have dropped two small stones separated from each other by about one meter on a quiet water surface in a pond. You are watching the evolving circular wave packets propagate out. A segment of the circular arcs of each wave group will cross through each other and continue propagating out as if they have never experienced the presence of the other. This is the principle of Non-Interference of Waves (NIW) [see Fig.2a]. The phenomenon is true for all propagating wave forms, whether they are material based (string waves, sound waves, etc.) or “vacuum” based electromagnetic waves. Coming back to the two circular water waves – a careful observation will reveal that *during the temporal duration and within the physical domain* [note the locality], where the two wave groups were just crossing through each other, the water surface clearly displays enhanced and suppressed surface undulations resembling what we call “interference pattern” due to “local” and real physical superposition of the two wave groups. These patterns should be called *superposition effects*, rather than *interference patterns*, to underscore the simultaneous presence (superposition) of the two periodic surface undulations of different phases in the same “local” space and time volume. Only the presence of material media can display such superposition effects due to propagating waves. Since, light travels through the cosmic medium, or the cosmic tension

field [5], which we have not yet learned to make visible, we need to insert separate material substance, capable of simultaneously interacting with all the superposed wave groups to make the superposition effects observable (visible). If the detector can respond to only one frequency of the two frequencies of the two superposed waves, there will be no superposition effect.

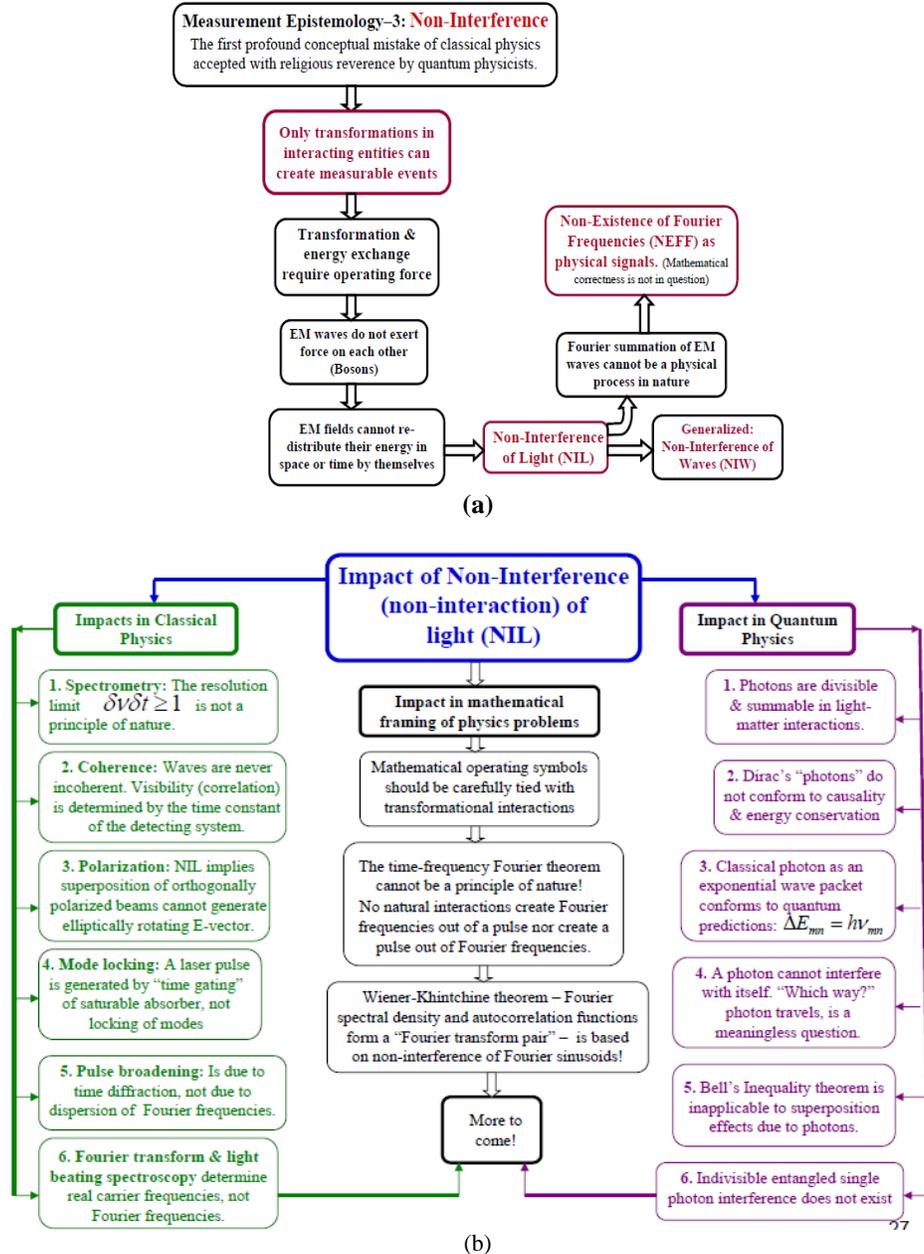


Figure 2. (a) Shows the logical flow diagram to appreciate the principle NIW (Non-Interference of Waves) and non-existence of Fourier frequencies (NEFF) since conservation of energy dictates that monochromatic waves existing in all space and all time logically impossible. (b) Shows long lists of consequences of non-interference of light in both classical and quantum optics.

We can hear each other even in a very crowded place because the sound waves generated by my friend's mouth arrived unperturbed into my ears in spite of being crossed by innumerable other sound waves. We image many distant stars on our retina as separate spots unperturbed by each other even though

their light beams have crossed though each other while forming independent images on our retina and also crossed by light beams from billions of other stars during their journey through the vast cosmic space. The same NIW principle enables us to clearly recognize a desired face unperturbed by innumerable other crossing light beams generated by surrounding sceneries. We have been neglecting this NIW principle for centuries perhaps because our current culture of mathematical formulation does not pay attention to the physical processes that is the key behind generating measurable transformation. This is a profoundly important conceptual mistake of classical physics. Quantum physicists accepted this wrong notion of “interference of light” with religious reverence to classical physics, which has forced them to keep on promoting and believing in a wide variety of unnecessary mystical interpretations of QM mentioned earlier [5].

Readers familiar with time-frequency Fourier theorem will recognize that the NIW principle demands that we must not use this widely used theorem as a *principle* of nature. We are now mathematically deriving “superluminal” velocity of light pulses while propagating “monochromatic” Fourier frequencies as real waves with real frequencies [13,14]. This should have been obvious to us from the law of conservation of energy - no waves can exist in all space and for all times. A list of important impacts in classical and quantum optics is given in Fig.2b as a consequence of neglecting the NIW principle. These issues have been discussed in several earlier papers by the author [5, 15].

2.2. Fusion of reductionism and emergentism

Descartes reductionism from 1600’ still is the driving force behind modern Physics. We are still trying to build up PEN’s (Protons, Neutrons and Electrons) out of undetectable Quarks and Gluons. Most successful mathematical models are comprised of wave and field theories. We have known that so-called “impenetrable” masses are not immutable objects in nature, $E=mc^2$. Under suitable conditions, some of them can be completely transparent to other “material” particles. They are convertible to energy as is demonstrated by our energy producing nuclear reactors and fusion bombs. We know that framing the question determines the answer we generate and since the answers are always incomplete, we never know whether the current “correct” answers will withstand the test of time as our knowledge advances further. So, while emulating a success model does bring more successes, it could eventually leads us into a mathematically elegant but wrong path. A theory can become very successful only if it has grasped some real cosmic logic. But, because, all successful theories, by definition, are incomplete theories, it is worth periodically challenging the foundational hypotheses of the most successful theories. Discovery of any breakdown point will lead us to deeper understanding of reality.

Energy is at the root of everything that is manifest in our observations and measurements. It is more fundamental than electromagnetic waves and particles. So it is worth employing emergentism [10] to model the emergence of PEN’s out of the field that permeate the cosmic volume, the cosmic tension field (CTF) [5, 16], instead of only seeking “mass producing” elementary particles [17]. Most likely, we will need to iterate back and forth multiple times between reductionism and emergentism to find another major breakthrough in physics (Quantum Physics) as we have experienced during the second half of 1920’s after systematic challenges to various aspects of the then most successful physics, now known as Classical Physics.

General Lessons:

- Same physical problem can be modeled “correctly” by different mathematical logics. No logic or theory is unique or “final”. This is truer when we model a small segment of a vast complex logical system.
- Correctly structured mathematics is never wrong. But correctness does not assure that it represents *the* reality of nature, or it has captured *the* cosmic logic behind the phenomenon.
- Mathematics must be structured to map the interaction processes in nature, not just the measurable transformation.
- Quantum mechanics, being enormously successful, it has more realities built into it than the Copenhagen Interpretation has allowed us to extract out of it. Enquiring minds should be nurtured to ask more probing questions: What are the processes going on in between the preparation & detection of the transformation produced by the quantum entities?
- Equations cannot speak for themselves; humans do. Our thinking is dominated by evolution-congruent subjectivity rather than scientific objectivity [see Section-xx]. So, no interpretation should be taken as the final truth.

3. FOUNDATIONAL ASSUMPTIONS AND CHALLENGES

Let us now summarize the key logical assumptions behind the paper. Human species has reached the stage of evolution to understand that we are a very fragile species and our biosphere with moderate temperature, even if we slow down the current Global Warming, will succumb to extreme heat as the Solar corona keeps on expanding with its age, which will happen well within a billion years [18]. Of course, if we think along the time-line of our “best and the brightest” running the “Wall Street” culture of maximizing every quarterly profit, this article can be considered a sheer waste of time. However, I am certain that deep in our psyche, most of us are genetically programmed with a stronger desire to *live forever through our follow-on generations*. So we must learn to think how to proactively construct a purposeful evolutionary path for ourselves on earth and then on other planets, supported by our science and engineering [4].

3.1. Causal Cosmic System: Based on our broad successes in understanding diverse simple and complex phenomena of this universe using pure human logics, and logical mathematical theories, we have reasons to assume that the cosmic system is a causally evolving system. In other words, inter-related and inter-connected *cosmic logics* are inseparably behind all interaction *processes* that are creating incessant changes supporting the cosmic evolution. Our objective is to discover and understand this complex system of cosmic logics, while visualizing the invisible interaction processes using *diversity of human logics and approaches*. By iteratively refining “working” theories to better model nature, our human logics will be incrementally refined towards actual cosmic logics. The correct path to refinement is guided by our successes in creating new technologies by emulating nature’s rules and processes, which are essential for our sustainable evolution. We do science for our purposeful and successful evolution, not just for the sake of doing science alone.

3.2. Cosmic Complexity Challenge (C³): It constitutes two fold challenges. Everything influences everything in this universe somehow or other and that more complex and/or large a system, more complex emergent behavior they display, which cannot be described by equations guided by our current reductionist epistemology [10,17]. Two of the four forces, weak and strong nuclear forces, are of rather short range, confined within the nuclear dimension. The other two, Gravitational & Electromagnetism, are of very long range. After all, the galaxies are influencing each other! Can the stars, and the atoms in them, be completely free from influencing each other just because they belong to different galaxies? Regarding emergentism [10,19] even though MRI images of the brain indicate that human thinking is based on molecular interactions and transitions, our current quantum mechanics is not good enough to write down an equation for the emergence of our intelligent and creative consciousness (thinking). Thus, we must acknowledge that (i) the logical elegance of a theory, and (ii) its capability of correctly predicting wide variety of experimental outcomes does not assure us that the theory has reached the level of being the ultimate “God’s Equations”, albeit the fact that it has correctly captured some segments of cosmic logics behind the interaction processes that are being modeled. Then, how can one keep on correcting and advancing a “working” theory to higher and higher levels of capturing cosmic logics?

3.3. Incomplete Information Challenge (IIC): This point has already been discussed in Section-2.1 in the context of discussing measurement epistemology. None of our theories can be complete because they are necessarily built upon conjectures based on incomplete information. Limits of these imprecise conjectures must be identified by pushing all “successful” but provisional theories to their limits and open up platforms for the development of new theories.

3.4. Subjective Interpretation Challenge (SIC): Section-4 will elaborate this point. Successful biological evolution has given us hardwired genomic programs to make quick and subjective interpretations of our sensorial inputs. The objective realities, the laws of nature, are to be extracted out by using our evolutionary gift of free-will, provided we are conscious about our hardwired subjective interpretation propensity, which still pervades our modern epistemologies.

3.5. Pre-Adaptive-State Challenge (PASC): Our current scientific culture accepts successful theories as final ignoring the challenges, C³ & IIC, mentioned above. We have also noted in Section-1 the limits of the foundational assumptions behind a good number of well organized bodies of knowledge due to their incongruence with our sustainable evolution. Can this incongruence be attributed to any common epistemological root? Could it be that our scientific thinking is driven by the Darwinian pre-adaptive-state model? In Darwinian DNA evolution, the current “successful” state, achieved through previous natural

selection, becomes the pre-adaptive-state (PAS) for the next level of natural selection. The bio-genomic evolution is forced to make advancements and improvements only pro-actively, not retro-actively, because the molecular foundation has already been permanently set by the structure of the DNA helix. So DNA can evolve in consecutive steps building upon the available “current” pre-adaptive-state. Since it does not know the distant-future state for natural-selection, it adopts the optimum changes to acquire the traits suitable to overcome the current adversity. This adoption may appear not to be the best choice in the distant future, but it cannot make any changes in the DNA *retro-actively*. It can improve upon what it already has. The DNA evolution is stuck by the pre-adaptive-state-challenge (PASC) at every step of its evolution. Is that why we develop next generation theories by building upon the foundation of the previously “successful” theory because even our free-will suffers from this genetic challenge, PASC, like our DNA? Human free-will has developed the capacity to connect information from distant-past and distant future (like the death of the Sun) using our theoretical predictions. So, we should feel comfortable to retro-actively correct our past “successful” theory to conform to newer understanding rather than taking it as the correct foundation for the next higher level theory.

3.6. Retroactive Iterative Corrections (RIC) must be applied to all working theories to overcome inherent limitations imposed on human logics by the cosmic challenges, IIC & C³, and by the genomic challenge PASC. But we need an unchanging referral “guiding polar star” for reliable feedback for iterative improvements on our conjectures. We are proposing that the diverse *interaction processes* in nature should be used as our “guiding polar star”. Nature being causal, iterative corrections on our conjecture and mathematical logics will help us make increasingly better visualizable models of the *interaction processes* and steadily reduce the gap between the actual cosmic logics and our human logics. The gap will always exist due to the challenges IIC, C³ and PASC. Conscious exercise of human free-will will help us liberate ourselves from these challenges and completely re-build theories from a new foundation, whenever necessary, rather than just improving upon the current “pyramid of science”.

3.7. Human evolution is now dominantly driven by cultural-selection rather than the Darwinian natural-selection: The role of Darwinian natural-selection on the rate of human evolution due to environmental pressure and competition has become insignificant compared to the pressures produced by our concepts (knowledge) driven human cultures. The dominance of cultural-selection, of course, started when humans (i) outsmarted competition from all other animals and (ii) technologies behind agriculture, animal husbandry and skills of house building assured our physical survival on an even keel. There was no more serious environmental pressure for any need of physical evolution. Tribal leaders realized that sustainability of their leadership now depends upon controlling their minds by delivering right kind of pleasure, pain and fear supported by justifiable concepts or social theories. Socio-political or cultural conflicts began to accelerate, and ever since, our mental evolution is being driven by pressures from intra- and inter-cultural pressures. This discussed further in Section-5.

3.8. Evolution is a collective endeavor: The core survival mechanism and the biological evolution are managed collectively by the four musketeer molecules GACT (Guanine, Adenine, Cytosine and Thiamine) through their hydrogen bonding [G-C and A-T] to create DNA's, which are protected inside a double helix chain. So evolution is a collective endeavor. This is further discussed in Section-5.

3.9. Consilient Epistemology (CE): The power of Retroactive Iterative Corrections (RIC) will be significantly enhanced once we realize that all the challenges mentioned above can be broached if we proactively accept that the different bodies of knowledge (biological and social sciences) and their knowledge gathering processes can be of immense help to hard sciences, and vice versa. For social and biological sciences only emergent complex behaviors are observable, even though, in the final analysis, only complex atomic and molecular interactions are at the root of all emergent properties, including human minds. Obviously, our immensely successful reductionist theories are as yet unable to precisely model these emergent properties. Just as the living biosphere thrives on diversity by proactively leveraging potential symbiotic & synergistic inter relationships between everything and every specie, so will human epistemology thrive by proactively looking for symbiotic & synergistic inter relationships between all of our knowledge systems as one science, irrespective of how we have been characterize them so far, as hard or soft sciences. *Just as intra- and inter-species interactions have been advancing the evolution of the living biospheric, so will the diverse concepts behind diverse fields of knowledge, when treated as “living concepts” will assure our collective evolution driven dominantly by our cultural-selection.* Of course, to respect various concepts behind human cultures as “living specie”, they must, at their very foundation, be congruent to our sustainable evolution through inventions of higher and higher levels of technologies. Such

an approach will be the key to developing a mutually beneficial Consilient Epistemology (CE) [11]. This is one of the main higher level potential possessed by the humans compared to all other species.

4. SUBJECTIVE INTERPRETATION PROPENSITY & BUDDHIST EPISTEMOLOGY

Careful thinkers know that our mental propensity veers towards quick subjective interpretation of observations we make that is most conducive to our survival! We also know that logics behind framing a question determine the answer we can extract out of nature. In fact, those, who try to find over-arching solutions to complex problems by asking questions driven by emotions, tend to veer towards religious solutions. Those, whose questions are spiritually inclined, create secular philosophy. People who try to understand and visualize interaction process in nature, become technologists and engineers. And those, who keep on seeking logical connections between diverse observations, create science. As if the same cosmic logic that gives birth to a specific observable, can be modeled differently by different beholder!

Our subjective interpretation propensity derives from our hardwired genomic programs associated with our bodily sensors - vision, hearing, smell, taste, touch, kinetic balance, etc. Our various genomic programs have evolved to help take quick actions based upon subjective judgments about various sensor-originated signals to assure our biological survival, not for making objective scientific analysis. No species has the capability, including humans, to fully understand and consciously guide the life sustaining molecular processes at every moment of their lives. Genomic programs are guiding and carrying out these functions quite intelligently. Even humans are at the early stage of understanding how diverse molecular interactions are behind all biological processes. Of all the bodily sensors, our vision is the most important faculty for scientific exploration and theorization. So, it is critically important for us to appreciate the functional processes behind the faculty of vision. Our vision system plays a very dominant role in making us prone to make subjective interpretations out of objective realities without our recognizing this propensity. The eye-brain combination comprises our vision system [20]. It is one of the most sophisticated light-energy-triggered information processing systems, far superior to any of our current vision related technologies. In the human species, the maximum amount of brain material, almost a third in volume, has been dedicated to visual perception. Other sensors like hearing, smell, taste, touch, physical balance during locomotion, etc. all occupy much smaller segments of the brain. Our vision sensor is so dominant in our survival and for other activities in our daily life that we now firmly believe that “seeing is believing”. This is in spite of the fact that modern experimental psychology has clearly established that “we see what we want to see”. The reason is twofold. First, we have evolved with hardwired genomic program to “see” things that makes us very efficient surviving specie. It has not been designed to make scientific (objective) interpretation of the world out there. Second, even the segment of cerebral software accessible to us as our free-will, is normally subservient to the hardwired programs to enhance successful evolution. However, this free-will software program is accessible to change by our family culture, social culture, education and our own critical thinking (if any left after our high school graduation!). Empowering the children to maintain freedom to write and re-write the free-will software by applying continuously critical thinking has become the biggest challenge for the survivability of the human species.

Let us analyze a few examples of facts vs. perception (interpretation) of our visual interpretation process.

4.1. Color perception. There is no objective characteristic or a physical parameter as color in the real world. It is a completely arbitrary criteria manufactured by our genome, inherited through evolution over several billions of years. Its purpose has been to simplify our survival by quickly recognizing friendly vs. unfriendly animals, foods, environments, etc. Light energy that generates the color perception, does not possess any physical attribute we identify as “color”. The objective property of light that triggers the color interpretation is the frequency of oscillation of light waves. We generally possess three different kinds of retinal molecules selectively sensitive to three different bands of optical frequencies (red, green and blue) covering the visible range we are sensitive to. There is apparent common agreement amongst all of us as to what color a particular object possess. This is due to closely identical structures of our retinal molecules. However, there are subtle perceptual variations from person to person (color-blindness) due to variations in our retinal composition. At a deeper level (after very precise optical frequency analysis of light from objects), we can establish that we all suffer from differential “subjective” interpretation propensity. Our color or subtle hue perceptions are rarely identical, which we attribute to our “color blindness” even though light itself has no color! Humans are dominantly tricolored. However, some women are tetra-colored for they may possess a fourth retinal molecule that allows them to discern more subtle colors. So some women

are privileged to “objectively” claim that men are color-blind! Unfortunately, color interpretation itself is a “subjective” criteria invented by our genome!

4.2. Seeing objects. We need to pay serious attention to the fact that we do not “see” anything even though we are not blind in the traditional definition. The eye-ball creates a 2D retinal image and the brain constructs and projects a mental image of the object approximately where it really exists. Those who wear eye-glasses can figure out with careful observation that the location of the projected image, although very close to where it is physically located, changes slightly with or without eye-glasses. The brain figures out how to compute the relative distance and apply that in the projected image. Such images are not precisely identical for different people, especially for those who have some refractive errors in their eye lenses. This point is more obvious when we view objects through more complex imaging systems like binoculars and microscopes. We tend to ignore that what we “see” is just a very intelligent mental projection by our visual cortex created from a 2D pixilated image on our retina. In this context, the reader should also note that all images formed on our retina, are inverted as they are created by a flexible convex (positive) lens. However, our brain projects the image as an erect one to reassemble the reality as closely as possible. The images we see, are forward projections, which conforms to the property that light propagates essentially in straight lines (subtle diffraction is unimportant for our routine visual needs). This is another hardwired genomic program. This is why we see the reflection of an object as if it is coming from behind the mirror. So, babies and animals have to utilize their free-will software program to “recognize” that the projected image actually exists in the front side of the mirror, not behind, as the hard wired program tells us.

4.3. Seeing objects as three-dimensional. This is again a genomic hardwired program in our visual cortex. The image information formed on the retina is a 2D pixilated array of signal. But for our survival, we needed to derive the depth perception very accurately. The two spatially separated eyes do help us appreciate a 3D object by virtue of two “parallax” images. However, our real 3D perception is derived from various subtle information about the image, such as, focusing depth, variations in illumination, shadows, etc. One can easily appreciate this by closing one of the two eyes; the depth perception does not vanish. That our 3-D vision is an interpretation by our hardwired program can be appreciated from the enjoyment we derive while watching old fashioned movies on a 2D screen even without modern techniques like projected orthogonally polarized images while wearing complementary polarized eye-glasses. Many artists have learned to exploit this hardwired program and confuse us with apparent 3-D pictures and structures that are impossible to exist in the real world. Some of the 3D paintings could be so “realistic” that we fail to perceive them as only 2D images even if we consciously try using our free-will logics.

4.4. Vision and motion. Seeing moving object is again another marvelous creation (interpretation) by our genome. Our brain cannot process infinite amount of information that are really behind any moving object. But the brain takes a series of snapshots at intervals of small fraction of a second and then makes us happy by generating the perception of continuous motion that exists in the real world. In fact, we have learned to exploit this hardwired program to entertain ourselves by movies and videos, which, in reality, consist of a series of stationary snapshots.

4.5. Vision and emotion. This is the most complex interrelation ship between our visual cortex, and other segments of our brain, including the emotional right brain. We cry seeing the same movie repeatedly even though the free-will brain knows that we are watching only a series of stationary snapshots on a 2D screen. The reader may now appreciate that when we “look” at the real world we selectively identify or “see” only those objects, which are most relevant to our purpose of living. Such selections, of course, are “colored” by our culture, education and the degree of critical thinking we apply. Thus, a real murder scene, observed by multiracial audience, will generate under oath distinctly different description about what has happened.

Just like light does not have the objective property we perceive as “color”, molecules do not have any objective property called tastes or smells. The objective property is the specific mechanical shapes of the molecules that can match up with complementary molecular sites on our tongues and in our noses. And we are genomically tuned for our survival to identify a specific set of molecules as good or bad having distinguishable smells or tastes. One can search literature to identify in how many thousands of ways we routinely “fool” ourselves regarding tastes and smells by taking evolution driven cerebral interpretations as objective information about nature. Unless we are consciously and proactively vigilant about our own thinking, we may fail to distinguish between the real objective properties and the cerebral interpretations of natural entities.

Let us now consider two cases of visual interpretation of observed “facts”. The case of “Ptolemy vs. Copernicus” underscores that a prevailing scientific culture can bias all most any analytical scientific mind

to develop an elegant and self-consistent human logic (mathematical theory) that may not map actual cosmic logic. The case of “rainbow” underscores that for some natural phenomena are just emergent phenomena, which can exist only on the image plane of an imaging device. The observer or an instrument can play a major role in creating some observed artifact out of nature, which does not exist in reality (as it appears), even though there are objective and reproducible rules behind the generation of the particular phenomenon.

4.6. Ptolemy vs. Copernicus. Both recognized the apparent “wiggle” motion of a couple of our visible planets observed over consecutive nights, reproducible through the years. Ptolemy, stuck by the then successful dogma of Geocentric universe and the mathematical concept of “spherical harmony”, explained the wiggle motion as a second small circular orbital motion around a theorized center, besides its orbit around the Earth. Mathematically, there is nothing wrong with this theory. Centuries later, Copernicus arrived at a very different interpretation, even though he used the same visual “wiggle” motion. He proposed a heliocentric planetary system with the Sun at the center of all the planets. Even when the mathematical theory is logically self-congruent, visual image (experimental records) alone cannot guide us to frame the correct theory to capture the real cosmic logic behind the observed phenomenon.

4.7. The rainbow. Most of us have seen live and brilliantly colorful rainbow with great emotional joy! Now, recall that color is purely an “imagination” hardwired in our genome. Next, recall that anything we “see” is really a projection of the retinal image by our brain that assumes rectilinear propagation of light. Does a colorful rainbow really exist in the cloud? The image of the rainbow exists only on our retina created by the eye lens, or on the image plane of a color camera formed by its lens. But the *process* by which the colorful image is formed is based on objective laws of nature. The sunlight enters into every water droplet in a cloud suffering first one dispersive refraction, then a reflection from the back of the water droplets and then a second dispersive refraction. Different optical frequencies are now coming out of the water droplets at uniquely different angles due to two dispersive refraction steps. When the eye images them on the retina, the water droplets are imaged as spatially separate colored sources. So the brain projects out a multicolor image on the cloud. This is why one never finds a pot of gold at the end of the rainbow even when it appears to touch the horizon! There really is no rainbow in the cloud! It is a subjective perception. It is just a projection of our mind based on some specific stimulation on the retinal molecules. The objective information constitutes the refractive and reflective properties of the just-right-sized water droplets.

4.8. The Buddhist Epistemology

The above discussions are meant to underscore the following. We must consciously learn to overcome our genomic and cultural training that “seeing is believing”. The hardwired genomic program, which is at the root of our successful evolution, is now holding us back from creating perfectly objective models of reality. We must learn to overcome our subjective interpretation propensity by using our inquiring free-will. It is vitally important for us to appreciate that we really are all “blind” in a deep sense! We “see” our brain-projected image, not the original object itself! Interpretations of such sensorial inputs are our only “knowledge”. Even that knowledge is incomplete because our retinal molecules can neither gather all the information there is to know about light, nor can it send absolutely all the signals generated by light on them. That is why we still have not been able to figure out exactly what photons are [5]. Further, our mental interpretations are subject to subjective interpretation propensity! How do we then assure objectivity? There is no proven method! We have to consciously attempt to create one. Should we follow a brilliant lone “blind” man using only bodily sensors & personal mathematical models as guides? Or, should we follow a group of “blind” men who relies only on logical imaginations without having any direct experience in experimentations? Or, should we follow a closely collaborating group that uses a judicious balance between logical imaginations & multiple sensorial (experimental) inputs, while iteratively refining them again and again from the foundation up? The author proposes the last approach, which has been underscored in Section-3.6 as Retroactive Iterative Corrections (RIC).

This epistemological approach has been defined very well some 2500 years ago by Goutam Buddha by re-interpreting ancient Indian Vedic science (logic). Buddha’s advice (allegorical story) for us is to develop our ability to “see or construct the objective reality” about the invisible and complex “cosmic elephant” by accepting as many diverse sensorial (experimental) inputs as possible, as blind people would. Then we should try to develop an over-arching theory after carefully discovering and/or hypothesizing conceptual continuity among the diverse sensorial inputs and then by imposing logical congruence among them. We will succeed in visualizing the invisible processes going on in nature only when we are mentally liberated enough to accept that in reality we are all blind. We send the sensorial inputs to our brains. It is

the genomic brain that defines for us, for convenience of our survival, what we should ‘see’, ‘smell’, ‘taste’ and even ‘think’! This is why we need to nurture a culture that demands the development of mental power by all social members to consciously manage their free-will, rather than allowing it to be hijacked by the propaganda of the tribal leaders.

5. DARWINIAN NATURAL-SELECTION VS. HUMAN CULTURAL-SELECTION

In Section-3.7 we have briefly introduced the concept that the evolutionary pressures for changes in human behavior are now coming from pressures due to inter-cultural and intra-cultural conflicts as a result of diverse types of human generated concepts (collectively, a culture) trying to shape our collective behavior in favor of the concept generating groups. Accordingly, human mind has been changing perceptibly under our cultural pressures and conflicts and we are calling the process cultural-selection to rhyme with Darwinian natural-selection. Various human concepts that constitute a culture are products of our minds guided by our neural network constructed by our genome. Thus our culture could be considered as a repository of collective genomic soup cooked by us and drunk by us for our continued growth. So, it is our keen responsibility to assure that all the concepts that are driving or added to, our culture are definitely congruent with our sustainable evolution.

5.1. Evolution and entrepreneurship are an inseparable collective enterprise.

Let us briefly review the modern understanding of DNA [21] that is at the root of both the Darwinian natural-selection and modern cultural-selection. At the fundamental level, starting from about 3.5 billion years past, the evolution has been a marvelously creative and collective enterprise, not an individualistic one. As mentioned earlier, the DNA double-helix has been invented by “four musketeers” GACT (Guanine, Adenine, Cytosine and Thiamine) [Fig.3a]. Note that any identifiable gene is simply a collection of a set of permutations and combinations of only two molecular pair bonding G-C (or C-G) and A-T (or T-A), which are chemically identified as the weakest possible molecular bonding known as Hydrogen-bonding. The evolution, as we know now, is driven by the DNA’s. We are then forced to conclude that at the very foundation, evolution has originated as a *collective effort* by the GACT’s. While the weakly bound GACT’s have protectively enclosed themselves within the central region of the double-helix, the outside molecules in the neighborhood are easily chemically accessible, through the mostly open helical structure, so they can get hold of them and process them to send out new information, and/or to organize new desired molecules, effectively creating a wide variety of “wealth” for their purposeful evolution. Note also that to survive against adverse and changing environment, DNA-codings must be accessible to advanced programming (various re-arrangements). This is why the G-C and A-T bondings have been chosen to be chemically weak for ease of change while being protected inside by the double-helix to prevent un-desired and un-authorized changes. The uncoil-able and replicate-able double-helix provided the platform to invent sex, which provided the platform for selecting the best positive evolutionary traits and acquire them through the choice made by the copulating individuals or by a pollinating bee. Thus, individualism is only a means to achieve collective well being faster than individuals can achieve through very slow gene mutations. We may say that, at the very foundation, life is truly a miraculous creation by the four-letter word GACT! We have been carrying on the wisdom of 3.5 billion years’ of evolution without paying explicit attention to this heritage.

Collectively, the choice of this unique set of parameters and characteristics by the GACT’s to build the DNA helix, comprises one of the most far-sighted and the most creative invention and entrepreneurial venture in the universe, so far, known to humans! Entrepreneurial drive to create wealth for survival is built into every single species, starting from bacterium to human. Thus, the active participation of all individuals in the wealth creation process is far deeper than just a birth-right; it is our evolutionary right and responsibility that began some 3.5 billion years back. Wealth creation is not an invention of modern Capitalism. In fact, Capitalism has hijacked this intrinsic creativity latent in every human being to ensure “tribal” control over all the created wealth through easily controllable monetization of wealth, controlled by financial institutions. Finance capital is a secondary factor behind the wealth creation processes and its importance derives from modern method of controlling the real useable wealth through its monetization as “paper” or “digital” symbols. Primary drivers behind the creation of real goods and services are (i) entrepreneurs, (ii) workers and (iii) managers. Accordingly, with due respects to our GACT’s, our knowledge-age economic system should be called Entrepreneurism, and the primary drivers behind our wealth creation process should be given far more freedom than they now enjoy compared to the controllers

of paper or digital wealth. In a healthy society, real wealth creators should be empowered and incentivized much more so than those who create more digital wealth by manipulating others digital wealth, which the various working classes are eventually forced to pay up.

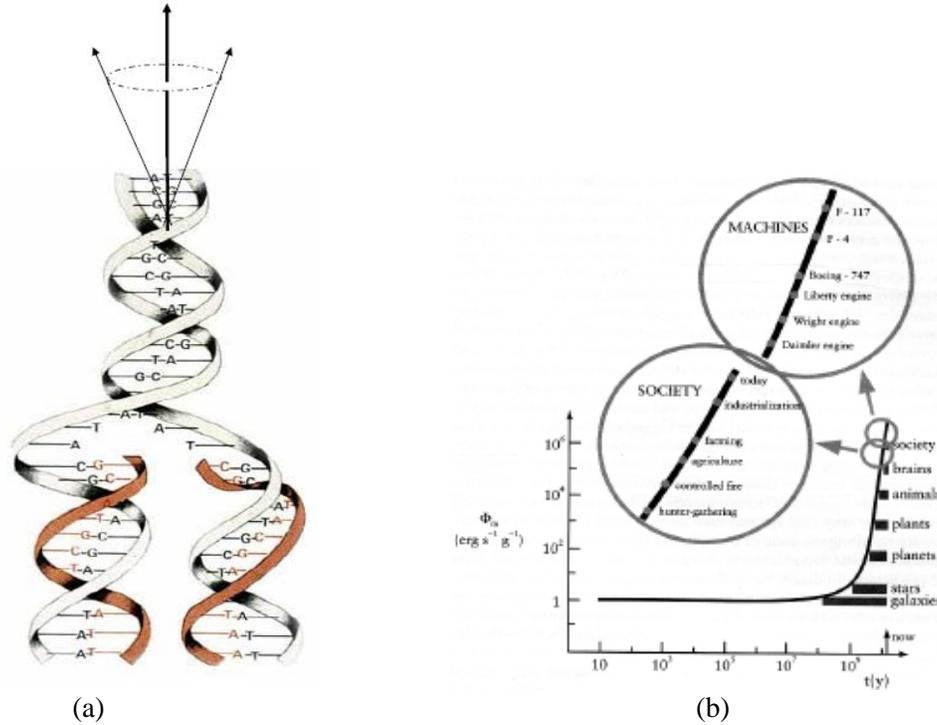


Figure 3. (a) (Modified from a web picture) Universally present DNA of the same fundamental structure in all specie connects us all together. The DNA helix incorporates staggeringly powerful flexibility and changeable programming capability for evolution. The straight vertical arrow at the top indicates a conceptual vectorial direction of our evolution towards higher planes of energy-efficient information processing capability. The dashed ellipse recognizes the astounding amount of creative flexibility built into the DNA only through two pairs of weak hydrogen bonding between four molecules GACT as G-C and A-T. (b) Demonstrates that human brain is quite high on the energy utilization efficiency per unit mass per unit time [copied from Ref. 22].

Demonstrated diverse wealth creation propensity of human DNA can be safely identified as two groups: (i) Material and technical wealth and (ii) spiritual wealth. The first one covers all material wealth producing activities including complementary science and engineering activities. The second one corresponds to processing and analyzing information to understand the meaning and the purpose of the evolving universe, which can provide the long-term guidance to the first wealth creating groups so that the *means* for our evolution (production of material wealth) does not become the *end* of our purposeful evolution. Human minds are continuously evolving to higher planes of understanding the complexities behind the evolutionary processes by becoming more and more efficient in processing information with steadily enhancing efficiency, expending less and less energy per unit mass per unit time, as shown in Fig.3b. Does it imply, at least scientifically, that there could be a vectorial direction of biological evolution – towards higher levels of information processing capability with increasingly higher energy efficiency to become capable of understanding the ultimate meaning and the purpose behind the cosmic evolution?

Human tribes had to evolve under some organized methods of wealth creation. Tribal rules and means of production had to be controlled by the top tribal leaders to maintain successful social order for collective survival and hence evolution for the long run. But the root of wealth creation was inventions by a limited number of creative inventors of the tribe, who logically and/or intuitively, distilled down the rules of nature and emulated them to create new useful technologies for the material well being of the tribal members. We should appreciate that this kind of entrepreneurship to create tools and technologies were not exclusive domains of the human species, even though we have now excelled all other species, and hence rule the

biosphere. Inventing tools to gather and/or hunt for food beyond the body-tools is quite common in many other “lowly” species. However, if we dig down at the very root of “intelligence” that ultimately gives rise to successful evolutionary advancements, we can appreciate that the ultimate entrepreneurs are the four gene generating molecules, the GACT. Thus entrepreneurship dates back at least to 3.5 billion years. All species use this trait to survive and evolve. Only humans have begun to take it to the level of potential self destruction for failure to appreciate mutual dependency.

5.2. Evolution is a collective endeavor for all species

So called “lower species” may not be the products of their stunted evolution. They have been, most likely, deliberately designed by the collective wisdom of the GACTs to systematically fill the diverse biological niches to make biosphere sustainable for the evolution of more and more complex biological systems whose information processing capability becomes energetically more and more efficient. This information processing capability or intelligence engenders the capability to reverse engineer the processes behind the evolving material universe and create technologies to accelerate the very evolution itself by developing further information processing capabilities. The microbes and bacteria were the original living species first to acquire the genomic capability of “faith” and “belief” to initiate independent lives and activities some 3.5 billion years ago on the earth. The self-declared “most intelligent” species, the humans, cannot survive without the symbiotic and synergistic support from 100 trillion microbes and bacteria in every human body, which itself is built out of only 10 trillion “human” cells! Actually all complex species are also supported by such symbiotic and synergistic microbes and bacteria! The “most intelligent” human species has a lot to ponder about who is the most intelligent, who is driving the evolution and who is calling the shots. Recall that widely diverse kinds of bacteria have been demonstrating their genetic “intelligent” superiority over our “best and the brightest” pharmaceutical engineers, by acquiring the traits of “drug resistance” in matter of weeks of implementing any new bacteria-killing drugs. In fact, drug resistant bacteria is a serious problem in every modern hospital because of our evolution-counter epistemology, “kill the bacteria” behind our modern medicine. Successful evolution is a collective responsibility and endeavor for all species working together. Should not our epistemology behind our biological science and engineering research be geared towards understanding how all the diverse species have been extending their *hands and minds* towards such a collective evolution going on for 3.5 billion years?

Stable occupation of different niches in our biosphere by different species needs to be critically evaluated. We have not observed any serious evolutionary mobility from lower to higher species over the last few millions of years. Is that because a period of a few millions of years is too short for any significant evolution? Or, is it because humans, by effectively taking over the management of the biospheric habitat, have removed serious evolutionary pressures? Or, is this an equilibrium that is now proactively maintained by the collective wisdom of the GACT’s of all species, with assumption that humans will take care of the sustainability of the biosphere? Or, do the 100 trillion microbes and bacteria, living symbiotically and synergistically in each human body, have the wisdom that when a single one of us succeeds in becoming a space traveler and arrives at another planet, they can happily provide support in creating a whole new living biosphere?

5.3. Darwinian natural-selection vs. cultural-selection

That the slow Darwinian natural-selection due to pressures of habitat has been taken over and is being accelerated by our cultural-selection, is apparent from the following dichotomy. From the standpoint of evolution of the human species, our militarism has been obsolete since we can only eliminate ourselves by waging wars. Organized fight or militarism is a smart genomic program for all species that are still evolving by natural-selection due to various habitat pressures, foods and related competitions. Humans have won the competition against all other species, probably, a few hundred thousand years ago. But we still have not given up this trait because we still are victims of our hardwired genomic program to fight and kill when we perceive a mortal threat. Careful analysis shows that *cultural propaganda* by the rulers has been refined and re-refined over the millennia to such a degree that many of us are now hardwired to perceive mortal threat and carry out massive murders when our religious and/or economic dogmatic belief systems are challenged, even though these are not real threat to our physical survival. This is because, being a social specie, our cultural identity has become our personal identity. Some of us now feel compelled to fight to death when our concepts driven culture is threatened, whether real, imagined or artfully propagandized by some tribal leaders. Collective evolution of all species has been such a strong genomic trait that time and again common masses, using their collective wisdom and cultural pressures, thwarted “ethnic cleansing”. It is thus essential for us to proactively nurture our enquiring free-will by continuously refining our cultures so as to promote selectively those thinking traits that are congruent with

our collective and sustainable evolution. *Freedom of Expression* for those concepts that are clearly against the collective wellbeing, are rightly curtailed by the judges of our Supreme Courts.

It is important to recognize that the GACT's in our DNA have invented a physical and a mental process, the combination of which gives us a powerful tool to accelerate our evolution towards a better quality of material and spiritual life without the need to wait for the slow genetic mutations. The first one is the sexual exchange of DNA components containing preferred survival traits. The second one is the creation of a culture which is a collective repository of our genome created concepts contributed usually by all members of the society, but restructured by the tribal leaders to conform to their ruling order. In fact, effectively, even the sexual selectivity has also been co-opted by the culture. Thus, the speed of our mental evolution is now dictated by the pressures of our cultural-selection, rather than the Darwinian natural-selection. Thus, those few who can dictate the culture enjoy the privileged position to dictate the direction of our evolution. Because our genome dictates collective evolution, most social members naturally conform to the culture allowed by their ruling class. Some members of the society are even genomically ordained to give their lives to protect their culture, even though their physical survival has not been challenged.

In reality, almost all species has culture for their collective well being. Obviously, because of highly developed diversity of means of communications, human culture is the most matured one of all specie. In fact, over the last few millennia, evolution of human mind (information gathering, analyzing and organizing) has been dramatically accelerated through the cultural pressures. We have not undergone any serious physical evolution over the last few million years, including the size of the brain. The scientific component of our culture has advanced to the level that we can now model, reasonably well, our biological past to some 5 billion years, and our cosmological past to almost 14 billion years. As we model our future, we see clear termination of the biological evolution on earth for most of the specie in about one or two billion years. Physical models for the evolution of stars, supported by registered data for a good number of supernova explosions, imply that our Sun would die in another 4 to 5 billion years. Well before that time its excessive heat will dry up the earth causing the termination of our biosphere as we know it.

Since culture is a product of our genomic thinking (concepts), it also dictates the allowable modes of thinking, or our epistemologies, to develop further concepts, which must conform to the well being of the ongoing culture! To over ride the stagnancy our cultural evolution, our DNA has also invented a substantial amount of free-brain to assure positive evolution through our traits of enquiry and debate. And the ruling classes have always recognized the power and threat of this free-brain and developed the counter force to co-opt them by permeating the society with well structured educational and "public" media systems to make the members conform. But, as we have underscored in the beginning, due to shortsightedness and focus on immediate gains, the current epistemologies behind most of cultural forces (dominant concepts) are incongruent with our sustainable evolution. Fortunately, the collective wisdom of the GACT's has succeeded in creating the unusual trait in a limited set of members who can never be completely brain washed by the rulers of the society. History bears this out. Rulers have never succeeded in brain washing all the people, all the time, all over the world. Such few thinkers and philosophers time and again helped the masses to identify whether the ongoing cultural (ruling) concepts are congruent with their sustainable collective evolution.

The physical evolution of human species is almost negligible compared to our mental evolution during the last couple of millions of years. This is clearly reflected in the degree of evolution of our cultures. Our cultural identities are now so strong that an appreciable percentage of members belonging to a specific culture, unhesitatingly give their lives to save their culture even though their physical well being are not threatened. However, our current thinking process (epistemology) is still dominated by hardwired genomic programs acquired over 3.5 billion years of biological evolution for physical survival. Perhaps, anticipating this coming dichotomy, and to ameliorate the problem, the human genome has helped evolve a significant amount analytical information processing neural network, the free-will component of our mind. We are supposed to use this analytical free-will to generate, evaluate and accept those concepts in our culture that are congruent with our sustainable collective evolution. Since ancient times, our tribal leaders recognized the existence of this free-will, along with the traits of faith and belief, in every human being and have successfully utilized them by saturating their minds with dominant tribal concepts to organize, manage and rule their societies. We should recognize that the complex traits, faith and belief, are gnomically hardwired in the genes of all species, from bacteria to humans. Without the faith in nature, even a bacterium would not have the courage and will to struggle for life under the pressures of persistent threats it has to experience. Without the belief in self, the bacterium would not display the confidence that it can win the struggle to get to the food and eat it too and live for another day! Human traits of faith and belief are

magnified by virtue of powerful free-will. Of course, great messiahs recognized the existence of these traits in human beings and adeptly utilized them to help create independent religious concepts and implanted great ongoing experiments in *social engineering*. So, we cannot just “preach” to throw out all religions. We must learn to filter and protect all those useful concepts out of all religions that are congruent and sustainable with our biospheric evolution.

As the number of members in the tribes started increasing to the level of modern nations, so did the techniques and extent of enforcing the dominant concepts conducive to the ruling nation. A careful analysis of even the most “democratic” modern communication messages will reveal that the “Golden Rule” still dictates the “propaganda concepts” however benign they may appear on first sight. This is clearly out of fears of development of newer and better concepts that could eventually over-rule the “Golden Rule” in favor of rules for collective and sustainable evolution for all. Balanced food and good education are beyond the reach of half the global population. Yet, the education system and cultural propaganda system tell us that we are living in the best of times in the human history. This is correct only if we think in terms of the absolute number of people who are now privileged. However, it is still the same dominant top 1% of the tribal rulers and their immediate supporters who are enjoying the access to all the benefits of advanced science, technologies, medical benefits, etc.

Fortunately, collective human genomic property is such that no culture can brain wash all the people all the time all over the world. This is now evident from the availability of low-cost global internet system, albeit, built for profit by the big businesses to access global market. The same internet has now become the global dissemination medium for all possible concepts, besides those desired by the ruling tribes. This is, of course, healthy because now the masses are beginning to learn to utilize their free-will, which is a critical component for our mental evolution through cultural-selection. They are now beginning to challenge their own faith and belief traits to refine their objective thinking. Perhaps within this century we will see the realization of the desire: “Blessed are common folks, for they shall inherit the Earth”. We should note here that it is the collective wisdom of common folks, which are at the root of sustaining our rich and evolving human cultures. Since ancient times, ruling tribes, employing different ruling concepts, have come and gone, but the culture, enriched at every stage, has been kept alive by the common folks.

We have clearly reached the watershed event in the history of human evolution. We must explicitly recognize that our culture is dictating most of our functions. However, as a species, we still must conform to the Darwinian living biosphere because of our subtle but essential physical interdependency with all other species through the biosphere. Besides, a dominant segment of our body function, thinking and interpreting, is still dictated by the hardwired Darwinian program. So we must become conscious of our current limits and new responsibilities. All of our old concepts (scientific and social) must be retroactively and iteratively modified and corrected to make them conform to the sustainability of our biosphere. Over the last ten thousand years, as our cultures started becoming stronger and stronger and impervious to any obvious threats from other species, we started to deviate from the necessity of living in harmony with nature. Unfortunately, we have started to over-ride our genomically programmed knowledge for such harmony.

5.4. Nurturing our concepts to assure sustainable cultural evolution.

We would like to propose that we must now learn to accept and appreciate that diverse human concepts in the global human concept-sphere are equivalent to diverse species in our bio-sphere. We know that it is the mutual interactions between the diverse species, from all bacteria to all plants and animals, which have been assuring our sustainable evolution, even though we do not yet know the exact detail steps and processes by which the living biosphere is carrying this out. Similarly, we do not yet know all the detailed processes by which different competing concepts from different cultures are facilitating the evolution of new and better concepts for our future well being. But we do know that cross-cultural intercourse have been beneficial for us to generate new beneficial concepts for human societies, whenever they were not enforced by military or economic might with clear intentions of “killing” specific concepts. Colonization over the past several centuries and now rapid globalizations are perturbing the slowly evolving cultures, which is creating inevitable serious conflicts.

Some historians and political leaders are branding these natural conflicts of concepts as “Battle of Civilizations”. Such characterization only promotes the evolution of more advanced concepts in militarism, which are not congruent to our sustainable evolution. Of course, militarism is still effective, but for temporary wins only. In spite of a good number of major “Battle of Civilizations” over the last few millennia, almost all the important concepts are still living in the books, historic edifices and collective

minds of the common people irrespective of who defeated whom. Modern militarism, driven by some temporary dominant cultural concepts, is good only to perpetuate same kinds of “tribal rules” that effectively slow down the collective human evolution. The history of most military adventures has been repeating itself by bringing in more sophisticated bondages on the common masses, sometimes in the name of democracy. Only rare military victory has ever assured overcoming the real plight of common masses. Deep in the genomic codes, we have the “evolutionary vector” that drives our desire to keep on evolving forever. Collective wisdom of common people has been preserving the deeper knowledge in our cultural genomic soups. Wars are misguided adventures causing damages and slow-down the progress of human evolution. But the cultural “Battles of Civilizations” in the modern world could become the ultimate deciding factors whether humans are going to annihilate themselves in the name of Gods or Capitalism, or common people will eventually invent a collective-leadership methodology and become the “inheritor of the earth”. What are the real road-blocks against this highly desirable future transformation?

6. THE CONSILIENT EPISTEMOLOGY

The more we analyze our understanding about the biological and the cosmological evolution, the more we find logical orders and inseparable connectivity in every direction. Naturally, it is safe to assume that working principles behind all evolutions are logically congruent to each other. So, we should not face serious conceptual difficulties in discovering deep logical connection or congruence or consilience between different fields of human knowledge that maps different aspects of evolution. This should also be obvious from the fact that we humans are products of natural biological evolution; our thinking is engineered by our brain based on incessant molecular interactions driven by precise laws of physics and chemistry. We can model and write down equations for simple molecular reactions, however, we still cannot carry out such modeling for our emergent behaviors, like our thinking, which is a product of our complex neural network, even though they are based on molecular interactions. It is safe to assume that we cannot do any better than thinking like reverse-engineers until we figure out all the cosmic logics. Let us then take the liberty of classifying human thinkers as Simplicity Engineers (SE) and Complexity Engineers (CE).

Simplicity Engineers of hard sciences deal with the understanding and modeling of the most foundational cosmic rules that governs the *interaction processes* behind the material universe of atoms and molecules, built out of stable elementary particles, PEN’s (protons, electrons and neutrons). Their approach, so far, has been to use the epistemology of reductionism [23]. The fruits of their efforts constitute: First, the rapidly advancing technologies that are based on emulation of the rules of nature, which are essential for the survival of more than six billion humans today within the thin biospheric shell. Second, the modern science that provides us with the preliminary understanding of the rules behind the cosmic evolution, which alerts us that our Sun has a finite life and our desire to continue living “for-ever” through our progenies will require us to invent new technologies (i) for terra-forming other planets and (ii) for deep space travel that are much more sophisticated than what we have now.

Complexity Engineers identify and model emergent rules of behaviors of complex and large (animate and inanimate) systems built out of very large numbers molecules and/or sub-systems. The examples are: sustainability of the living biosphere, global climate, individual and collective human psychologies, politics of social governance, laws of economics, rules of industries, management of human social interactions through religious morality, etc. The epistemology of complexity engineers can be characterized as emergentism. Emergentism identifies self-consistent behaviors of complex systems and models them to understand and predict further behaviors of these systems. Even though the emergent rules of behavior of complex systems, on a fundamental level, are built out of simple assemblage of atoms and molecules, we are, as yet, unable to construct any theoretical continuity equations for a direct interface between simple and complex systems [19]. However, we can safely assume that the same set of cosmic logics (laws) is behind both the simple- and the complex-systems.

The reductionism and the emergentism, both these schools of epistemologies are finding the limits in their progress. We now need to develop logical steps to discover conceptual continuity and logical congruence between the two epistemologies. In the living biological world, genetic and DNA engineers are beginning to help us bridge the gap by discovering the steps through which simple molecular association and/or dissociation between GACT give rise to the most complex “coding properties” of DNA-complexes guiding the entire biological evolution. In the inanimate world, physicists with deep knowledge of heat-flow, thermodynamics, fluid dynamics, etc., are beginning to model very complex long-term global climate

and the future implications of global warming. While such scientific approaches are essential for our further progress, we should accelerate the process by imposing the following three over-arching guiding concepts:

- (i) **Purposeful evolution:** We raise our children to help them create a purpose for their individual lives. This helps them to keep on asking the right questions to find the right solutions, which keep them always moving towards their life-long goals while keeping them as happy participants in human society. Then they perceive different, and even divergent, purpose for life among different social members, as healthy. Let us define the purpose of human evolution is to develop a complete understanding of all the cosmic rules that will help us guide our human evolution. Then the followers of reductionism and emergentism will be inspired to collaborate, rather than disregard each other. Diversity of approaches to understand the same complex system is the best scientific approach.
- (ii) **Sustainable evolution:** If we are truly inspired by the concept of perpetual human evolution, then we must figure out how to emulate the behaviors of both the simple and complex natural systems to create all the necessary technologies and ideas (concepts) that can assure our sustainable evolution. Simplicity and Complexity Engineers must collaborate.
- (iii) **Visualization (understanding) of invisible interaction processes:** Our modern scientific methodologies have essentially been geared towards modeling the outcomes (in the complexity world) and experimental results (in the simplicity world). We have not been paying focused attention to appreciate the “invisible” interaction processes that are giving rise to the final outcomes or results. In physics, our result-driven mathematical model fools us to accept superposition principle as a mathematical principle rather than as an interaction process between multiple superposed beams and a detector that can simultaneously respond to all the superposed beams. As a result, we have missed the fact that superposed waves do not “interfere”, but they can generate *superposition effect* if there is an interacting intervening material medium. Similarly, modern economic theory of the complexity world is stuck on “beating the drum” of Capitalism (control and management of the finance capital, easily controllable monetized wealth), while the real wealth creating *process* is carried out by entrepreneurs (and inventors) in collaboration with workers and managers, where the role of finance capital is secondary. Unfortunately, since economies are dictated by controllers of the finance capital, we have developed an unsustainable Capitalist Economy around the world. Attention and respect for the real physical processes behind all phenomena will not only stabilize the society, it will also bring the Simplicity and Complexity Engineers closer to each other.

7. CONCLUSIONS

Global warming is a timely warning to us by our biosphere. Eventual demise of the biosphere due to the aging Sun is inevitable. We must accept the reality that we are mortals and that our body-mind is subservient to the material laws of the universe. However, we have the gift of the biological evolution, analytical and critical-thinking free-will, to become outstanding reverse-engineers. Our desire to live indefinitely has to be through our progenies. Then we must hand over to them a sustainable biosphere for the time being and a technologically and spiritually driven culture of *consilient epistemology* for them to thrive. Then they will have the opportunity to become reverse engineers of the highest capacity and will succeed in uncovering the complex rules behind the evolving universe and then develop the technologies to travel to distant planets and then terra-form them as their new habitat.

Continued and *SAFE* human evolution lies with collective organizational efforts to develop socio-cultural interaction processes and nurturing systems that assure Self Actualization For Everybody (*SAFE*)! So, we would like to propose that all cultures build their own versions of *SAFE* organizations and actively work towards *PEACE* (Purposeful Evolutionary Achievements with Collective Efforts)! Of course, we will have to learn to leverage our hardwired genomic programs of fear, faith and belief from current culture of *controlling* people to *empowering* people. Let the *fear* of eventual demise of the biosphere due to dying hot Sun be the uniting force and let this knowledge energize us to work together to become space travelers. Let our united *faith* on the indefinite evolution potential of biological lives and our collective *belief* on our enquiring mind (free-will) guide us to over-ride all obstacles just as we have done over the last 3.5 billion years.

REFERENCES

1. Biosphere 2: http://en.wikipedia.org/wiki/Biosphere_2. See also: <http://www.biospherics.org/>
2. Armageddon: <http://en.wikipedia.org/wiki/Armageddon>.
3. D. Deutsch, "Quantum mechanics near closed time-like lines", *Phys. Rev. D* 44, 3197 - 3217 (1991)
4. S. Brand, *Whole Earth Discipline: An Ecopragmatist Manifesto* (Viking Adult, 2009). See also Dennis Overbye, "Setting Sail Into Space, Propelled by Sunshine", *NYTimes*, Tuesday, Nov.11, 2009.
5. C. Roychoudhuri, "Inevitable incompleteness of all theories: an epistemology to continuously refine human logics towards cosmic logics", Ch.6 in *The nature of light: What is a photon?* Eds., C. Roychoudhuri, A. Kracklauer & K. Creath, CRC Press (2008).
6. C. Roychoudhuri, "Locality of superposition principle is dictated by detection processes", *Phys. Essays* 19 (3) (2006).
7. L. Smolin, *Trouble with Physics* (Houghton Mifflin, 2006).
8. R. Penrose, *Road to Reality*, Alfred Knopf (2005).
9. P. Woit, *Not Even Wrong* (Basic Books, 2007).
10. R. Laughlin, *A Different Universe: Reinventing Physics from the Bottom Down* (Basic Books, (2006).
11. E. O. Wilson, *Consilience, the Unity of Knowledge* (Alfred Knopf, 1998).
12. H. Hermann, *From Biology to Sociopolitics: Conceptual Continuity in Complex Systems* (Yale University press, 1998).
13. R. Boyd, "Slow and fast Light", Ch.6 in *Progress in Optics*, Ed. Emil Wolf (Elsevier Science, 2002).
14. C. Roychoudhuri, N. Tirfessa, C. Kelley & R. Crudo; "If EM fields do not operate on each other, why do we need many modes and large gain bandwidth to generate short pulses?" *SPIE Proc. Vol.6468*, paper #53 (2007).
15. C. Roychoudhuri, "The NIW (Non-Interference of Waves) principle removes wave-particle-duality and "spooky" conjectures", invited paper at the conference, "Quantum Theory: Reconsideration of Foundation-4" (Vaxjo, Sweden, 2009).
16. C. Roychoudhuri and C. V. Seaver, "Are dark fringe locations devoid of energy of superposed fields?" *Proc. SPIE Vol. 6285-01* (2006).
17. F. Wilczek, *Lightness of being: Mass, ether and unification of forces*, (Basic Books, 2008).
18. See web videos: http://video.google.com/videosearch?q=Death+of+the+sun&oe=utf-8&rls=org.mozilla:en-US:official&client=firefox-a&um=1&ie=UTF-8&ei=BtcBS6fwIMy2lAefo_iTCw&sa=X&oi=video_result_group&ct=title&resnum=4&ved=0CBgQqwQwAw#
19. S. A. Kaufman, *Reinventing the Sacred* (Basic Books, 2008)20. Vision book
20. A. Valberg, *Light Vision Color* (Wiley, 2005),
21. Richard Dawkins, *The Evidence of Evolution, The Greatest Show on Earth* (London: Transworld Publishers, 2009).
22. E. J. Chaisson, *Cosmic Evolution* (Harvard University Press, 2001).
23. T. S. Kuhn, *The Structure of Scientific Revolutions*, 3rd.Ed. (University of Chicago Press, 1996).