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Urgency of evolution process congruent thinking in physics

An advocacy to elevate the prevailing abstract physics-thinking towards a functionally useful reverse-engineering thinking.

Chandrasekhar Roychoudhuri
Physics Department, University of Connecticut, Storrs, CT 06269

========== **Slide #1** ==========

Abstract:
It is now generally recognized that physics has not been contributing anything ***conceptually fundamentally new*** beyond the century old Relativity and 90 years old Quantum Mechanics [1-4]. We have also started recognizing that there is an increasing rate of species extinction all over the world, especially since the last century [5]; and we are beginning to understand that the related problems are being steadily accelerated by human behavior to conquer nature, rather than understanding nature as is and living within its system logics [6,7]. We are beginning to appreciate that our long-term sustainability as a species literally depends upon proactively learning to nurture the entire bio-diversity [8-10]. Thus, humans must consciously become evolution process congruent thinkers. The evolutionary biologists have been crying out loud for us to listen [5,6, 8-10]. Social scientists, political scientists, economic scientists [13] have started chiming in to become consilient thinkers [6] for re-constructing sustainable societies. But, the path to consilient thinking requires us to recognize and accept a common vision based thinking process, which functionally serves as a uniting platform. I am articulating that platform as the ***"evolution process congruent thinking" (EPCT).*** Do physicists have any obligation to co-opt this EPCT? Is there any immediate and/or long-term gain for them? This paper argues affirmatively that co-opting EPCT is the best way to re-anchor physics back to reality ontology and develop newer and deeper understanding of natural phenomena based on understanding of the diverse interaction processes going on in nature. Physics is mature enough to acknowledge that all of our theories are "work in progress". *This is a good time to start iteratively re-evaluating and re-structuring all the foundational postulates behind all the working theories.* This will also consistently energize all the follow-on generation of physicists to keep on fully utilizing their evolution-given enquiring minds without being afraid by the prevailing culture of "publish-or-perish", requiring them to stay within the bounds of the prevailing theories as the final ones. Current physics thinking has been successfully driven by Measurable Data Modeling Epistemology (MDM-E); which is basically curve-fitting without demanding to understand the actual physical processes nature is carrying out. I am proposing to add an iterative repertoire, Interaction Process mapping Epistemology (IPM-E) over and above successful MDM-E. This will facilitate the physicists to become conceptual reverse engineers of nature. The gap between physicists and engineers will start melting down and our collective sustainability will be re-assured as successful engineers of nature.

Key Words: Methodology of thinking, Physics epistemology, Consilient epistemology; Evolution-congruent epistemology; Non-Interaction of Waves; Superposition Effect vs Superposition Principle.

========== **Slide #2** ==========

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========== **Slide #3** ==========

Preamble

How to channel our perpetual biological and intellectual desires to do better than our current best?

In our biosphere, all biological activities, and hence the evolution of all species, from virus to humans, is driven by the perpetual ***desire*** to do better than the current best that we have. For that, we should continue to humbly emulate nature; rather than telling her how she ought to behave based on human mathematical logics. Viruses invent molecular tools. Humans invent more complex technologies. At the molecular level tool making, viruses always out smart us. Viruses have been systematically over-riding our anti-viral medicines (molecules) within weeks' of introduction! Biological intelligence embedded within nature is far deeper than we have as yet accepted. All multicellular species, including humans, are still being nurtured by ten times more diverse bacteria than the parental genomic cells that constitute the body [6a]. Sustainable evolution is a deeply interconnected collective process. Diversity is not just a politically correct fancy word; it is at the foundation of sustainable evolution, be it the biosphere or the human thinking/culture. We need to pro-actively nurture that. We are better off by consistently trying to understand and emulate nature; rather than keep on trying to conquering her.

========== **Slide #4** ==========

Introduction

- Modern humans have evolved into a mind-driven culture-guided species with hard-wired "Messiah Complex" due to the necessary and successful Tribal Culture since very ancient times.
- Unfortunately, in the name of stability, our culture is lagging behind our aspiration to carry on our mental evolution – our thinking logics are not in tune with the natural processes of evolution.
- Our current state of physics knowledge clearly implies that the cosmic and the biospheric systems are perpetually evolving, following some steady and logical set of rules.
- Our culture must also proactively nurture the evolution of our enquiring mind, rather than preaching "working theories' as "final theories".

========== **Slide #5** ==========

Problems with paradigm-shift driven thinking!
Lack continuous debates have been slowing down our mental evolution towards seeking ontology!

- Throughout ages since many millennia past, many advanced cultures in different parts of the world, were asking big questions (i) the meaning and purpose of human life, (ii) role of humans in the biosphere, (iii) where we come from and go, (iv) what is out there, etc., etc.
- Enquiring minds must have been built into our evolutionary biological impetus (biological intelligence), always trying to achieve better than the current best in all endeavors in our lives. Our cultures are driven by diversity of concepts and ideas. "Freedom of expression" is considered our "birth right". So, enquire we must.
- But, we must remember that each of our neural logical patterns inside each of our head is different. So, we frame our questions differently and extract different answers out of the same set of "observations". These ***"evidence based"*** individual explanations appear to be logically self-consistent; and hence, we individually think of them to be the most objective ones! And we ***fall in love with a paradigm and enforce on others*** *and sometimes, on the entire culture when we succeed in creating alliance with powerful knowledge gatekeepers.*
- Time after time, to get out of wrong paradigms and shift to better ones, human cultures have been periodically experiencing enormous sufferings. ***So, the best thing for us is to share our thoughts and develop collaborative views for early detection of incorrect postulates/concepts behind working theories (paradigms).*** This is why ancient Indians used to, and the current Buddhists still encourage, persistent debates over all knowledge systems; since nobody knows everything. [continued to next slide]

========== **Slide #6** ==========

Problems with paradigm-shift driven thinking! [contd.]

- The story of five blinds, modeling an elephant through their collective efforts of iteratively using their "sensorial evidences", says it eloquently! After all, evolution is collaborative, out of diversity of interactions (thinking).
- Even ***pure biological sustainability thoroughly relies upon symbiosis, synergy and food-chain-eco driven competition.***
- This is mutual dependence, not "doggy-dog competition". We need to get rid of our residual "doggy-dog" genes in managing our human societies, functionally expressed through greed, envy and use of deceptive and cunning skill sets [11,12, 12a]. Framing the questions by the enquiring mind of the collective science culture cannot be totally independent of the prevailing socio-politico-economic culture.
- Every multi-cellular species is still nurtured by the most "primitive" bacteria, usually numbering ten times more than the host body cells! This is real "food for thinking" for the Homo sapiens to advance to the next stage of our collective culture-driven evolution!
- Nobody has found the answer to the ultimate questions: For what purpose the humans have evolved on the Earth? We need to be more humble, yet ambitious in seeking out knowledge.
- Our information gathering and processing them into knowledge is based on material molecule based neural networks. All experiments, designed by nature or by us, are also material based interaction processes.
- Then, we do not have much choice but to become ***evolution process congruent thinkers to bring consilience out of divergences***; while assuring our sustainability. The fields of science, sociology, arts, economics, politics all need to be driven by the common purpose of our sustainability on our miniscule "pale blue dot" floating within the gigantic cosmic system.

========== **Slide #7** ==========

Is there really a connection between physics-thinking and evolutionary-process?

- Physics has given us astounding degree of understanding about nature – from the micro world of elementary particles to the macro world of billions of galaxies in our unfathomable cosmic system. We now understand that intelligent life producing planet is possibly rare in our galaxy in spite of our recent discovery that there are thousands of solar systems; extrapolate-able to uncountable billions in the whole universe!
- Yet, physics has been basically stagnant for almost 90+ years. Staggering volume of global publications in physics is still confined to accepting papers based only the foundational postulates of Relativity and Quantum Mechanics without questions. Alternate thinking are routinely rejected
- Implication: (i) We have already laid the found the edifice of physics. (ii) And/or, we are so confused in finding our way out that we stay happy with glorious anthropomorphic explanations!
- The first belief stagnates the evolution of our enquiring mind. The second belief dissociates us from the rest of the biological species, even though we are being nurtured by the most elementary lives – diverse bacteria that emerged on earth some 3.5 billion years ago!
- We now do have to acknowledge that all scientific theories are work-in-progress. The Creationists are correct when they say, "Darwinism is ***only*** a theory"! They are only inspiring us to keep on evolving in our enquiring minds.
- ***Scientific theorization is conceptual reverse-engineering of nature!*** We cannot afford not be reverse engineers. Projects towards reverse engineering the brain (and hence thinking) has already started!

========== **Slide #8** ==========

Is there really a connection between physics-thinking and evolutionary-process? [Continued]

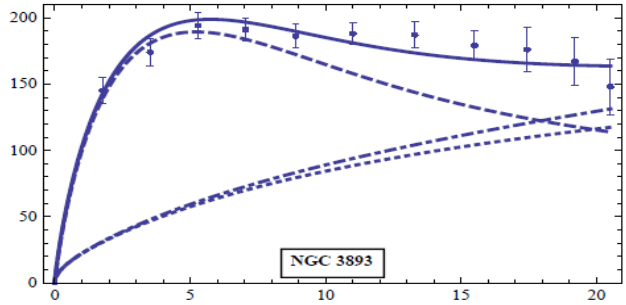
- Then, the lesson from the current stagnancy is that we need a better thinking methodology to seek out nature's ontological reality, the ***interaction processes*** behind biospheric and cosmo-spheric evolutions. ***Explaining and visualizing these processes are the responsibility of physics.***
- ***Why?*** Today humans have reached the height of the evolutionary ladder because of their technological supremacy through collective engineering innovations and system thinking since the earliest primitive stage. Innovation is successfully putting together nature allowed processes to make new functional tools and technologies. We do not have to have the final correct theory. We never do, anyway! ***So, physicists must learn to work with innovative system engineers to facilitate new innovations that are essential for sustainable evolution and overcome current Global warming and Solar Warming, coming in a Billion years in future!***
- Our current physics paradigm is Measurable Data Modeling Thinking (MDM-T); which is evidence based science. Currently, we are not focused on interaction process visualization and understanding.
- Cosmic & biospheric ***evolutions*** are taking place through diverse ***interaction processes.*** So we propose a "back to the future" paradigm of Evolution Process Congruent Thinking for all human endeavors, not just physics thinking! This is along the line of consilient thinking promoted by E. O. Wilson ("Consilience") [6,7,11]. ***Evolution congruent thinking provides the necessary common platform towards achieving society-wide consilient thinking and hence sustainable future for all of us***.

========== **Slide #9** ==========

Raising questions about the limitations of current physics

"The Trouble with Physics" – Lee Smolin [2]

- *Why the Huygens-Fresnel diffraction rule is only a **PRINCIPLE**, while Newton's rule for Gravity is a **LAW**? Both are a little over 300 years old!*
- The HF-rule is still the "bread-n'-butter" for optical engineers for modeling all optical instruments.
- Yet, we have been neglecting to explore the deeper, physical processes behind the concept of Huygens' secondary wavelets and the concomitant source of energy (or the field) that can generate these secondary wavelets everywhere, including the entire cosmic space.
- Newton's gravity is in flux. Even Einstein's General Relativity that is supposed to be a better model than that of Newton's , is being challenged. Ad hoc hypotheses like "Dark Energy", "Dark Matter", etc., have become necessary to understand motions of stars.
- Do we really understand what the **physical process is** behind the gravitational attraction between distant objects? What physical properties does the intervening medium possess?



An excellent example of successful data modeling epistemology and limitation of evidence based science. Measured and expected rotational velocity distribution of stars in the galaxy NGC 3893, from its center to the outer edge. The dashed curves represent different theories. The solid curve corresponds to the Conformal Gravity theory as proposed in [18], which does not require the hypothesis of Dark Matter. The solid circles represent measured data.

========== **Slide #10** ==========

Crisis in physics thinking as perceived by great contributors

1. *"For the mind of man is far from the nature of a clear and equal glass, wherein the beams of things should reflect according to their true incidence, nay, it is rather like an enchanted glass, full of superstition and imposture, if it be not delivered and reduced. For this purpose, let us consider the false appearances that are imposed upon us by the general nature of the mind."* **Francis Bacon**, Idol

2. *"It is the theory which decides what we can observe."* **Albert Einstein**.

3. *"The basic trouble is that many quite different theories can go some way to explaining the facts. If elegance and simplicity are … dangerous guides, what constraints can be used as a guide through the jungle of possible theories? … The only useful constraints are contained in the experimental evidence. Even this information is not without its hazards, since experiment "facts" are often misleading or even plain wrong. It is thus not sufficient to have a rough acquaintance with the evidence, but rather a deep and critical knowledge of many different types, since one never knows what type of fact is likely to give the game away."* —Nobel laureate **Francis Crick**; this is also quoted by Nobel laureate **Philip Anderson**.

4. *"How can we understand the world in which we find ourselves? How does the universe behave? What is the nature of reality? Where did all this come from? Did the universe need a creator? Most of us do not spend most of our time worrying about these questions, but almost all of us worry about them some of the time. Traditionally these are questions for philosophy, but philosophy is dead. Philosophy has not kept up with modern developments in science, particularly physics. Scientists have become the bearers of the torch of discovery in our quest for knowledge."* **_Steven Hawkins and Leonard Mlodinow.**

5. *"… Such crude anthropic explanations are not what we have hoped for in physics, but they may have to content us. Physical science has historically progressed not only by finding precise explanations of natural phenomena, but also by discovering what sorts of things can be precisely explained. These may be fewer than we had thought."* **_Steven Weinberg**.

[14] See Ch.12 for citation details in "Causal Physics: Photon Model by Non-Interaction of Waves", Taylor & Francis, 2014.

========== **Slide #11** ==========

Why are we facing the crisis?

The crisis in our epistemology has appeared because modern humans, specifically of last thousand years, have been trying to ***conquer nature***, rather than humbly ***live with the nature*** while understanding the ***physical processes*** behind all the different phenomena that constitute the biospheric and cosmo-spheric evolutions.

Our past, present and future successful evolution, all had required; and will require engineering thinking and innovations of tools and technologies! System engineering thinking is critical for our sustainable evolution.

Evolution

It is the highest force behind the perpetual changes in the bio-sphere and the cosmo-sphere. We have not yet learned the engineering and science of "Genesis". It is better to follow the path of a reverse engineer.

Nature's evolution as causal engineering processes

The interaction processes that empower evolution, albeit being invisible to our eyes, are causal, repeatable and reproducible. Interaction processes represent our access to nature's ontological reality. Hence, Physics-thinking must be anchored to interaction process visualization (mapping). Our epistemology must try to emulate nature as a superb engineer, and not as an abstract mathematical logician, or a mystic with multiplicity of appearances to keep us at bay from understanding her.

========== **Slide #12** ==========

Biological evolution is driven by engineering skills of tool making process

In the biological domain, the desire and pro-active drive to do better than the present best started as early as ~3.5 billion years past when the viruses and bacteria started evolving. They make molecular tools and they are still smarter than us in countering our anti-viral medicines! Anthropologists assure us that human evolution was accelerated when we started making complex tools, and eventually technologies to make our life better.

Survival of the human species will be dictated by system engineering successes!

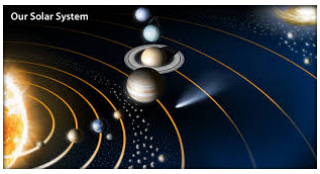
It is our agricultural technologies that are keeping our 7+ Billion people alive today. Global Warming is an urgent problem. A major portion of our scientific efforts must empower the necessary geoengineering technologies. Solar Warming is coming to wipe out the earth, albeit a Billion years in future. We need to put serious efforts in becoming space-faring engineers; abstract theories will not help. For the survival of the human species beyond the Solar Warming, our ***fundamental scientific thinking must be evolution process congruent.*** Then our engineers can work hand-in-glove with the scientists in making technologies that are necessary for our collective well-being (survival), not to make the maximum profit by the current quarter. Invention of new necessary technologies requires the engineers to carry on various permutations and combinations of allowed processes in nature; they do not need to know the final theories; which we are far from, anyway! We do not know what photons and electrons are (being explored by this conference). But our engineers have ushered in the Knowledge Age by making the world a Global Village through the internet. The internet runs on engineering management of (i) generating, (ii) modulating, (iii) propagating and (iv) detecting electrons and photons!

========== Slide #13 ==========

System engineering minded humans will be forced to become a spacefaring species due to Solar Warming; provided we succeed in overcoming the Global Warming through necessary geo-engineering technologies. [Photos borrowed from the web]

Billions of galaxies

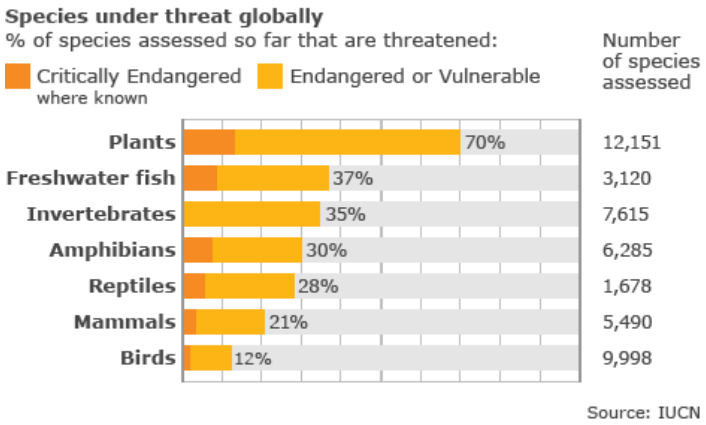
Our Milky way Galaxy



Our Solar system

"Pale blue dot"

Troubled polar bears



We are threatening our very long-term survivability due to our ignorance of the science of sustainability (mutual dependence), while blindly driving un-sustainable economic growths within a limited biosphere.

========== Slide #14 ==========

Identifying the root causes behind the current crisis in thinking!

I. **The prevailing culture in physics asserts that the foundation of the edifice of Physics has been firmly laid by the twentieth century theories of Relativities and Quantum Mechanics; which is supported by staggering "advancement" provided by them.**

II. **We have fallen in love with our successes: Today we firmly believe that we have understood both the micro world of elementary particles and the macro world of the vast cosmic system.**

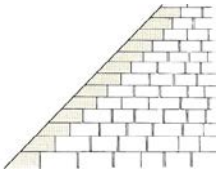
III. **"Evidence based science" , based upon the prevailing Measurable Data Modeling Epistemology (MDM-E), has been, so far, the best approach.**

IV. **We are not trying to emulate nature herself as a system engineer; even though we do not have choice but to learn to live within her engineered system.**

========== **Slide #15** ==========

I. The foundation of the edifice of Physics has been firmly laid

- If I really believe this; then I am proactively urging my enquiring mind to ***stop evolving*** any further.
- Since the paths to exploring and understanding nature have already been discovered; the only option remaining for me is to discover some natural stones; or burn some new bricks; whose shapes are such that they will conveniently fit into the current edifice of Physics.
- I am reverting back again to engineering, devoid of asking fundamental questions. Discussions related to QM reveal the conceptual fracture. "Nobody understands Quantum mechanics". "Just compute." ***No further enquiry is encouraged***!

[Photos borrowed from the web]

Only the complete pre-knowledge of the final design of an edifice can allow the construction of an appropriate foundation! Civil engineers know that!

- We certainly do not know the complete design of the very complex cosmic edifice.
- Hence, by definition, we could not have succeeded in laying the foundation of the edifice of physics.
- Unfortunately, science and engineering now being a global economic enterprise, the management of this enterprise is afraid of "rocking the boat" by allowing new foundational questions.
- Fortunately, in spite of the dominance of such a belief as "the foundation has been laid"; the strong undercurrent of perpetual scientific enquiry is still alive and well. This conference is a one of the many such examples.
- More examples: The Copenhagen Interpretation of Quantum Mechanics keeps on insisting that QM formalism is complete. However, papers challenging this positon have been steadily trickling in!
- The reason is as follows. QM is an excellent measurable data modeling theory; which correctly predicts a wide variety of measured data. This is its fundamental limitation! Besides, at this stage of human evolution, all our theories are work in progress!
- QM was not designed to explain the ontological processes of nature. QM's foundational postulates did not explicitly enquire about the physical interaction processes behind the emergence of measurable data. Unlike the necessity and the emergence of classical statistics out of basic causal rules; QM formalism is useful only as a statistical theory, or ensemble average. QM needs to reformulated from a deeper bottom and then up.

========== **Slide #16** ==========

II. We have fallen in love with our own successes

Today we firmly believe that we understand both the micro world of elementary particles and the macro world of the vast cosmic system

a. Emulation of a validated success path generally brings more successes more rapidly, in the beginning; then it slows down as we get stuck in our success rut. Then we spend more time admiring the "success rut", rather than questioning the limitations of the fundamental postulates behind the original theory.
b. Our highly "successful" scientific enterprise does not let you dare to question whether our thinking logic has matured enough to accept the prevailing mode of thinking as the final path to our scientific enquiry.

c. A tiny sub-section of a very large system can be modeled using many different sets of self-consistent logical rules; none of which may exactly map the rules behind the large system. This is known in the field of complexity mathematics.
d. We have now started imposing our working models for the structure of the universe even before succeeding in making a proper unified theory for what we understand.
e. Our failure to unify them is still not encouraging us to question the foundational postulates behind the working theories. We keep on employing more and more mathematical tricks as if the current state of mathematics represents the logics of the creator; albeit being invented by limited human neural network over the last couple of millennia!

We have failed to remain as objective scientists. We have become anthropocentric; as if the universe has been designed for just US!

========== **Slide #17** ==========

III. Evidence (Measurement) based science is the best approach for us. But, it provides insufficient thinking tool to connect with nature's magnificent system engineering activities

"Measurement Problem" cannot be wished away by elegant mathematical theorems!
It is a perpetual Information Retrieving Problem

- **1. The Measurables Are Transformations:** We can measure only physical transformations.
- **2. Preceded by Energy Exchange:** There are no transformations without energy exchange.
- **3. Guided by Forces of Interaction:** Energy exchange, and consequent transformations, must be guided by an allowed force of interaction.
- **4. Must Experience Physical Superposition:** Interactants must be within each other's sphere of influence to be able to interact under the guidance of an allowed force to exchange energy and undergo transformations. Thus, all **interactions producing transformations must be "local**"!
- **5. Through Some Physical Interaction Process:** The understanding & visualizing the invisible interaction process anchors us to inch towards understanding cosmic logics (reality).
- **6. Always Requires a Finite Duration:** Transformations in the interactants from one specific state into another specific state requires "compatibility sensing dancing period" before accepting the transition.

➢ **Corollary 1: Impossibility of Instantaneous Interaction-free Transformation:** Superposed waves cannot interfere to re-distribute their energy since there are no forces of interaction between them in the linear domain. Hence, I am trying to revive the **NIW-property** (Non-Interaction of Waves), known for centuries; but not recognized explicitly. Waves by themselves cannot carry out the accepted recipe for energy re-distribution – the square modulus of the sum of all the complex amplitudes! There are two distinct steps buried in this recipe – (i) resonant amplitude stimulation of a detector; (ii) detector absorbing a quantity of energy correctly given by the square modulus math.

We can never gather all the information about anything through any set of experiment since the details of none of the interaction processes and those of the interactants are completely known to us, as yet. But the rules (cosmic logics) behind interaction processes are invariant, which we are after!

========== Slide #18 ==========

IV. A system engineering approach – Evolution Process Congruent Epistemology

- If direct measurements can never give us complete information about anything, then we must figure out how to indirectly access nature's ontological reality.
- We posit that nature is causal. The cosmic (ontological) rules behind cause-effect driven interaction processes can be accessed if we accept that interaction processes are driven by the causal cosmic rules.
- Then we add to the prevailing Measurable Data Modeling Epistemology (MDM-E) an additional mode of thinking, Interaction Process Mapping Epistemology (IPM-E). That is system engineering thinking.
- We can now utilize our evolution-provided faculty of imagination to visualize the invisible interaction processes. In general, it would be rare to correctly visualize the ontological processes behind a specific measurement in a single attempt, even when the theories are properly validated by the prevailing MDM-E approach.
- So, we propose a repetitive, iterative approach. Keep on creating different visual process models that gives the best conceptual continuity between different related phenomena, while imposing cause-effect congruence that can be given by the best MDM-E theory. This IPM-E recipe requires challenging the foundational postulates behind all existing theories; irrespective of their "cultural" dominance. We need different imaginative map conceived by different people. We need collaborative research.
- IPM-E, along with MDM-E, will be our best epistemological thinking tools towards discovering the ontological cosmic rules; until we find an even better one!

========== Slide #19 ==========

Biological intelligence still dominates the biosphere "Problems" behind the assumption of our superior intelligence!

(a) (b) (c)

[Photos borrowed from the web]

(a) Is the about-to-fall-down human brain of a basketball player calculating all the necessary initial conditions to throw the ball into the hoop that will follow Newton's parabolic path for his projectile?

(b) Is the miniscule archer-fish brain gathering similar initial conditions related to its own motions and those of the hovering dragon fly on a twig above the water so that its projectile of water will follow Newton's law and hit the dragon-fly and become its hunted food?

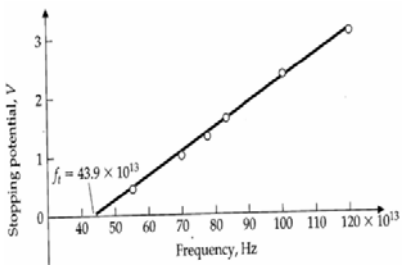
(c) How do the plants, without any neural network, calculate how many clock-wise and how many anti-clock-wise turns of its tendril should create while growing to avoid tearing of its tendril fibers, after it has already anchored its free-tip on to something sturdy?

Does human invented current mathematics represent the ultimate tool for science? Emergent conscious human intelligence is only a very small component of the total biological intelligence of our own body.

========== Slide #20 ==========

Examples of applying IPM-E on to successful MDM-E derived photoelectric effect to better understand Superposition Effect

Visualizing the interaction processes behind the photoelectron emission; which Einstein did not attempt to model or describe!



Millikan's experimental validation of Einstein's photoelectric effect can be presented by the Eq.1, and by the plot on top [p.113, in 17]. The stopping potential V reflects the kinetic energy of the released photo electron. It is a "book-keeping" method to balance the energy budget. As has been the prevailing tradition, the interaction process was not mapped by Einstein's original equation.

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

$$<h\nu> \;=\; <|\psi_{res.}|^2> \;=\; <\left|\sum_q \chi(\nu_q)E(\nu_q)\right|^2> \;=\chi^2 <\left|\sum_q E(\nu_q)\right|^2> = <\phi_{work\ fn.} + (1/2)m\mathrm{v}_{el.}^2> \quad (2)$$

Now, let us try to imagine, or map the interaction process, Eq.2. All photo electrons are bound by quantum mechanical forces inside the solid materials. So we can only measure ensemble averaged energy (released electrons plus their kinetic energies), $<\phi_{work\ fn.} + (1/2)m\mathrm{v}_{el.}^2>$, and the optical frequency $<\nu>$ and hence the total absorbed energy $<h\nu>$. These two modified terms in Einstein's equation are further expanded by IPM-E mapping process. The bound electron, before release, forms a dipole with a positively charged site. It is stimulated (forced to oscillate) by the electric vector of the incident light. Using the concepts of QM, the energy transfer process is modeled as $<|\psi_{res.}|^2>$, ***ensemble average of the square modulus of the excited dipole,*** a three-step functional process**.** This can be written, using the linear polarizability of the dipole while stimulated by many wave packets (experimental reality) as, $<\left|\sum_q \chi(\nu_q)E(\nu_q)\right|^2>$. The process mapping forces us to recognize the presence of many wave packets and a material dipole holding the electron. QM tells us that the electron's binding energy is definitely quantized. But their release does not automatically prove that the EM waves are "indivisible quanta". This is very important new information compared to Einstein's antiquated "indivisible quanta"!

========== Slide #21 ==========

The quantum cup of a stimulated dipole can be filled up by many energy contributors, not just by an "indivisible quanta"

- Notice the third term of Eq.2 (above) represents the sum total dipolar stimulation by all the incident light waves. So, the "quantum cupful" of energy is absorbed by the dipole from many different waves, not a single "indivisible quanta". Besides, ***the QM theory has never demanded a postulate, correctly so, that all quantum transition must be triggered by a quantum donor having the exact quantum cup of energy to donate.***

========== Slide #22==========

Process map differentiates between Superposition Principle of amplitudes without any mutual interactions vs. Superposition Effect as experienced by a detector after energy exchange!

$$E_{res.}(\nu) = \sum_n E_n(\nu) \tag{3}$$

Eq.3 implies simultaneous superposition (propagation) of n-wave packets through the same physical volume. The summation in Eq.3 represents the Superposition Principle of wave amplitudes. They are linear excitations of a parent tension field. Hence, they can cross propagate or co-propagate without modifying each other's energy. This is Non-Interaction of Waves (NIW). The waves, by themselves, do not re-organize their energies in the space or in the time domain in the absence of resonant detecting dipoles. They always emerge unperturbed out of their volume of superposition as dictated by their individual Poynting vectors [14]. Only material detecting dipoles with linear polarizability can sum the effects as joint dipolar stimulation $\chi_n(\nu_n)E_n(\nu_n)$, where χ_n represent the linear dipolar polarizability of the detecting molecules and hence their quantum properties. For a very narrow band of frequencies, χ is a constant, as per existing mathematical rule, it can be taken out of the summation sign as in step three of Eq.4. This mathematical rule has been confusing us to believe that wave amplitudes can sum themselves even in the absence of detecting molecules.

$$\psi_{Res.Stm} = \sum_n \chi_n(\nu_n)E_n(\nu_n) = \chi\sum_n E_n(\nu) \tag{4}$$

The energy exchange and quantum transitions take place only if the frequency is allowed by QM transition rule.

$$\left|\psi_{Res.Stm}\right|^2 = \left|\sum_n \chi_n(\nu_n)E_n(\nu_n)\right|^2 = \left|\sum_n \chi E_n(\nu)\right|^2 = \sum_n \chi^2 E_n^2(\nu) + 2\sum_{n\neq m}\left(\chi E_n(\nu)\right)\left(\chi E_m(\nu)\right)\cos 2\pi\nu\tau_{mn} \tag{5}$$

Notice that every single beam contributes to the quantum cupful of energy, $\Delta E_{pq} = h\nu_{pq}$, the subscripts p and q denote the energy levels under consideration. ***The assumption that only a single indivisible photon from one of the beams carry out this quantum transition is inconsistent with our accepted mathematical logics!***

The total energy is derived from sum of the square modulus of all the dipolar stimulations $\chi E_n(\nu)$ out of all the waves. For the case of a two beam superposition, the math is much simpler; the energy is drawn from each of the two stimulating beams:

$$\left|\psi_{Res.Stm}\right|^2 = \chi^2 E_1^2(\nu) + \chi^2 E_2^2(\nu) + 2\left(\chi E_1(\nu)\right)\left(\chi E_2(\nu)\right)\cos 2\pi\nu\tau_{12} \tag{6}$$

Notice that in Eq.5 and 6, the recorded energy distribution appears to be sum of DC signals plus cosine oscillatory (plus, minus) signals. This is the result of currently working human mathematical logics. In reality, the detector array gives us an ensemble of "zeros" and "ones", or black and bright dots. Sum total energy absorbed is varying but always positive, never negative! Even though the complete representations of Eq.5 and 6 match the overall data; we should not try to create physical meaning out of separate terms in the right-hand-side. One can now appreciate the ***subtlety behind the invisibility of interaction processes***. This is one more observation to underscore that our current human mathematical logics have not reached its ultimate stage. Prevailing MDM-E cannot extract all there is to know about any particular interaction process. ***All theories are work in progress.***

However, our mathematics is still a powerful tool with diverse capability. Eq.5 and 6 correctly represent measurable data. So, one can convert the data into a mathematical curve and then mathematically remove the "DC" part of the signal. One would get a new curve that is an "AC" signal varying cosinusoidally. But, from mathematical theorems, one knows that the Fourier transform of a cosine function yields a delta function. In fact, this brilliant insight by Michelson helped him invent Fourier transform spectroscopy; a technique developed into modern instrument is invaluable for all engineers involved in studying molecules. But, note that the same "AC" signal can also be expressed as many other suitable chosen polynomial functions. Thus, the success of a particular mathematical approach does not imply that we have discovered the ultimate truth of nature.

The operator "sigma' in $\sum_n E_n(\nu)$ does not represent any physical operation in Eq.3. It implies only that linear wave amplitudes can co-propagate and cross-propagate through the same volume of the parent tension field in the absence of any other resonant interacting entities. But, the same operator "sigma" in $\sum_n \chi_n(\nu_n)E_n(\nu_n)$ of Eq.4 does implicate a real physical interaction process. A detecting dipole is simultaneously oscillating (summing) due to all the stimulations provided by all the waves present simultaneously on it. In other words, superposition effect is *local*!

========== **Slide #23** ==========

"Unreasonable effectiveness" of the formalism of quantum mechanics

The unusual success of QM formalisms derives from its ability to guess the 3-step correct recipe to model measurable data as the (i) ensemble average (ii) of the square modulus (ii) of the stimulated wave function. The recipe has embedded in it the interaction process that nature follows in two steps. First, ψ represents amplitude stimulation of our desired entity induced by another controlled entity that interacts with its own phase-dependent property. When this phase dependent amplitude-amplitude stimulation finds that a quantum rule allows them and to carry out a resonant transition, then only the energy is exchanged. This results in a physical transformation leading to a measurable datum. When the data is gathered for a sufficiently large ensemble; we get the validation of QM prediction $\langle \psi | H | \psi \rangle$.

Notice that by applying the Interaction Process Mapping Epistemology (IPM-E); we have interpreted ψ as real physical *amplitude* stimulation. We have dropped Born's interpretation of ψ as abstract mathematical probability amplitude!

This is one more example that we can extract more realities out of QM by the application of IPM-E than by applying Copenhagen Interpretation!

[15] U. P. Wigner, "The Unreasonable Effectiveness of Mathematics in the Natural Sciences", Communications on Pure & Appl. Math., VOL. XIII, 001-14 (1960).
[16] Jason Scott Nicholson, A Perspective on Wigner's "Unreasonable Effectiveness of Mathematics", Notices of the AMS, Vol.59, No. 1, p.38.

========== **Slide #24** ==========

Summary

1. We have argued that physics is stagnant for over many decades; the view supported by many famous physicists.
2. Then we presented various problems behind our current thinking methodology, which is Measurable Data Modeling Epistemology (MDM-E). We tried to convince you that the evidence (measurement) based science, albeit being the best approach, is fundamentally incomplete; because no measurement can provide complete information about anything. So, interpret data without complete information.
3. ***We also argued that nature appears to be a marvelous system engineer; and our successful evolution is being driven by engineering thinking and innovations. So, physics thinking must be re-organized to become evolution congruent as reverse engineers have been for millennia.***
4. For Physics, we should introduce Interaction Process Mapping Epistemology (IPM-E). The idea is to visualize the invisible interaction processes and apply the technique iteratively over and above MDM-E. Iterative application of IPM-E helps us overcome the "incomplete information" problem built into MDM-E. This is also complementary to system engineering thinking.
5. Then we have given a couple of examples related to photoelectric effect and Superposition Principle to show that we can extract more physics out of quantum phenomena when we iteratively apply IPM-E, over and above MDM-E.

6. ***Physics is after understanding and explaining the cosmic rules behind the incessant interaction processes that are driving the biospheric and the cosmo-spheric evolutions. We can access the relevant information about the cosmic rules only through studying the light-matter and matter-matter interaction processes. The best approach to understand these processes is to become hands-on and conceptual reverse engineers.***

========== Slide #25 ==========

CONNECTING IT ALL TOGETHER!

- **<u>Perpetual Enquiry:</u> The "cosmic elephant" is too complex for us to fathom in all its details. We will require perpetual re-enquiry, repeated iteration, of the foundational postulates behind all latest theories. Today's epistemology will be obsolete by tomorrow's advanced knowledge. Framing a question today determines the intermediate answer we can extract. It is the *purpose of today*, accepted or pre-supposed by our neural network, which dictates the inherent structure of our enquiring questions. *Our biological and intellectual purposes, "live forever and prosper through our progenies", must now converge to evolution congruency in all of our engineering and intellectual activities!***

- **<u>Inseparability of Diversity and Sustainability:</u> Society wide Consilient Thinking [7] will emerge automatically; when everybody is engaged in looking after their long-term wellbeing, synergistically strengthened by an environment of overall collective wellbeing. The root causes behind the various ideological differences will automatically melt away in the long run. In fact, the necessary healthy diversity towards sustainable culture will evolve when our individual motto becomes, "Consciously Constructing a Path for Purposeful Evolution". *Consciously nurturing the emergence of diversity of healthy concepts will be our safety.* Because nobody knows the final answer. A working social or scientific model could lead us towards self-destruction if it is not assured to be congruent with the complex cosmic rules of evolution!**

- **<u>New/Revitalized Research Institutes:</u>** ***We need to organize new and re-vitalized research institutions for all major fields of investigations with explicit mission to assure sustainable evolution through Evolution Process Congruent Thinking.***