

Empower Mathematical Equations Using Evolution Process Congruent Thinking

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ABSTRACT

Mathematics by themselves cannot wander towards a goal as they represent only inert symbols invented by humans with implied meanings, still residing in the human brains. The biological entities do have wandering goals, from virus to humans, to survive and keep on evolving. The wandering goal of the human engineered mathematical theories of physics is to help us understand the ontological reality by mapping the interaction processes in nature. This helps us become better innovative engineers and solve problems that enhance our survival goal while ameliorating threats to sustainability of the biosphere. Hence, we should systematically incorporate evolution process congruent thinking into our current epistemology of mathematical physics. The foundational vision of the overall human culture, including science and arts, should also be evolution process congruent thinking so that collectively we can become the master of consciously constructing, albeit wandering, our purposeful evolution. Humans have evolved to become a thinking species. We cannot remain stuck in the success-rut of materialistic evolution only.

1. Introduction

The FQXi has raised a remarkable set of enquiring questions, each one of which will still require years' of further research and publications of tomes of research papers and books to come to some form of consensus understanding. I very much appreciate that FQXi is playing this very important provocateur social role of getting us out of the present state of stagnancy in our scientific thinking. To be humble, as one of the one-seven-billionth entity of the human of species, I personally do not have any definitive answers to any of the raised questions. Accordingly, I will try to frame some more detailed questions, mixing casualty and teleology. This attempt, I hope, will lead us to another level higher than our current state of thinking. *The most important step towards intellectual evolution is the required persistence to extract our further ignorance out of the current successful understanding of a particular phenomenon.* Einstein's bold attempt to unify all theories under a single structure is still a valid and inspiring guide. However, first we need to define a single cosmic field of energy that is logically capable of giving rise to all the observable entities and all the rules of interactions [1, see Ch. 11]. Iteratively framing the right set of questions, and iteratively structuring the right set of integrate-able postulates, will help us keep on excavating (wandering towards) the right answer. At this stage of human evolution, promoting a working theory to an unchallengeable status is no different from accepting ancient religious dictum as our evolutionary guide!

Mathematics, representing self-consistent and strict logics by themselves, cannot wander towards a goal (see section 2). They represent only inert symbols invented by humans with implied meanings, which reside in the human brains or in documents as languages. A theory derives its "life" from the founding postulates. Wandering human minds, using evolving logics, help the theories to move towards the goal of capturing the ontological reality. But the limit is set by the postulates.

In contrast, the biological entities do have embedded goals, from virus to humans. They have been successfully wandering on towards the *unbounded goals* – a persistent desire to do better than the current best, not just survival (see section 3).

Similarly, our varied *interpretations* of the "working" theories have been wandering on and on towards the desired goal of understanding the ontological reality. Consider Newton's second law, $F=ma$ (Force = Mass x Acceleration). The concept of mass has been evolving from material content in a body to the assembly of stable elementary particles, representing "pure energy" in some form ($m=E/c^2$). However, we do not understand the exact nature and the origin of this energy. Interpretations of Quantum Mechanics is still wandering and evolving. Critical opinions published by Schrodinger and Einstein have actually gave birth to a completely new sub-field of *entanglement* with many engineering implications. Foundational equation has not changed. However, QM formalism does not guide us to directly visualizing the deeper interaction processes that give rise to the measurable data. Working equations are the "walking sticks" for us, the blinds. We have to keep on wandering through re-iterative

interpretations and then re-structuring the working theories to keep on moving closer and closer to the ontological reality (see section 4).

Applied mathematics in engineering makes us more pragmatic about logical possibilities in making our present life more pleasant and proactively ameliorate perceived problems, like that due to the accelerating Global Warming. Applied mathematics in physics, especially in Astrophysics, opens up our vision for successfully evolving through thousands of generations in the future. Solar Warming, the slow onset of our Sun becoming a Red Giant, will begin in a billion years. We cannot stop it. What technologies will assure the humans to become successful migrants (deep space travelers) to other livable planets in other stars?

2. *In spite of "Unreasonable Effectiveness of Mathematics in the Natural Sciences", it cannot wander towards desired goals by itself.*

To justify my critical introduction on the limits of mathematics, let me quote a couple of paragraphs from Wigner's paper [2,3], in italics below. It is highly instructive to read his article. Wigner's begins, with a tongue-in-cheek comment, as to how a Gaussian curve containing π , successfully relates to so many statistical behavior of humans, etc.! But, what does human behavior has to do with the circumference of a circle = $2 \pi r$)?

*"What is Mathematics? Somebody once said that philosophy is the misuse of a terminology, which was invented just for this purpose. In the same vein, I would say that mathematics is the science of skillful operations with concepts and rules invented just for this purpose. The principal emphasis is on the invention of concepts. Mathematics would soon run out of interesting theorems if these had to be formulated in terms of the concepts, which already appear in the axioms. Furthermore, **whereas it is unquestionably true that the concepts of elementary mathematics and particularly elementary geometry were formulated to describe entities which are directly suggested by the actual world, the same does not seem to be true of the more advanced concepts, in particular the concepts which play such an important role in physics.**" E. P. Wigner [2].*

*"The depth of thought, which goes into the formation of the mathematical concepts, is later justified by the skill with which these concepts are used. The great mathematician fully, almost ruthlessly, exploits the domain of permissible reasoning and skirts the impermissible. **That his recklessness does not lead him into a morass of contradictions is a miracle in itself: certainly it is hard to believe that our reasoning power was brought, by Darwin's process of natural selection, to the perfection, which it seems to possess.**" E. P. Wigner [2]. [Slanted emphasis by the author]*

Our current state of knowledge, about our deep past, and the projection into the deep future, of both the biological evolution on earth and those of the stars in galaxies, does indicate some persistent logical order in the evolving universe. This is why we have been consistently successful in modeling the measureable data, collected under diverse reproducible conditions, using strictly logical language of mathematical relations, set as cause-effect relating equations. We have thus developed high regards for the mathematical language as our best guiding tool to explore nature.

All of our mathematical equations consist of an assembly of letters from different languages and unique operational symbols, like \pm , \div , $=$, \geq , Σ , etc., etc. The equations embody causal expressions that equate observable effects with our subjective interpretation of the causes that exist a-priori in nature. The descriptions of these causes in human language, embedded in the founding postulates, are human inventions, just like the equations themselves. Human invented equations, containing these diverse symbols "**bonded**" by various operating symbols, cannot give birth to any anthropomorphic goals (aims and intentions). However, biological DNA molecules, consisting of diverse "**bonded**" molecules have given birth to goal-constructing human minds. The bonding between the constituent molecules of DNA, G-C and A-T, and their grouping, give rise to well-defined biological functionality. However, we do not always apply systematic meaning to the mathematical operators that connect the algebraic symbols in an equation. An equation does not have the power to evolve.

Consider when we apply the "+" operator between multiple algebraic symbols representing multiple linear waves propagating through the same physical region of a parent tension field (Superposition Principle). The physical implication of these "+" operators is no more than their co-propagation, **no interaction**. Recognition of this Non-Interaction of Waves (NIW) has been generalized in my book [1;

see notes after reference page]. NIW has deep implications in all branches of physics, including Astrophysics. Ch.11 of my book shows, based on experimental understanding of spontaneous and stimulated emissions in a gas laser, that optical Doppler Effect for moving source and moving detector are experimentally discernable. Although it is difficult to validate experimentally for Stellar objects; nonetheless, it is doable. I have proposed necessary experimental designs [4]. Recognition of this optical Doppler Effect also implies that the Cosmological Redshift is definitely not a Doppler Effect. Hence, the "Expanding Space" model rules the day. Does this hypothesis of expanding universe represent our final understanding of the ontological reality?

However, when we apply the "+" operator between $(\psi_1 + \psi_2)$ representing, say, the excited states of two quantum particles; the "+" operator now implies **real interaction between the particles** followed by real energy exchange, followed by physical transformations (changes in excited states). These transformations could give rise to measurable data if it happens inside a human constructed apparatus.

The limits in our discovering the ontological rules behind the biospheric and cosmo-spheric evolutions are not due to the equations alone; but from *what input and output physical meaning we assign to the starting mathematical symbols and the connecting operators*. We give the meaning using our rational mind. The mind is guided, nonetheless, by the subjective attitudes defined by the particular cultural epoch in which the mind is evolving. Many modern computer programs demonstrate their capability to achieve the preset goals when executed. However, those outcomes *are the intentions of the programmers' brains* written as multi-line programs. A human programmer embeds the input and output information in a software utilizing his/her intentions, or goals. The computer is not processing input information. It executes the very large number of sequential discrete zeros and ones and presents the intended output information. The intelligence resides in the totality of the software written by a human mind.

The aims and intentions, which are emerging out of human connectomes (neural network), are our subjective perceptions, widely varying from person to person. Some are now literally preparing to go to Mars and then to the Proxima Centaury; while some others are literally praying for early arrival of the Armageddon! The conflict between the *Knowledge Riders* and the *Knowledge Deniers* is literally threatening the very survivability of our socio-political structure. This is the outcome of at least ten thousand years' of tribal attitude of controlling their tribes by imposing various forms of conforming cultures. We now own the biosphere. Our collective attitude is still driven by *fighting* to win over nature, rather than *living in harmony* with nature. We are on the path to destabilize the biosphere along with the demise of the human species. Given our ignorance about the ultimate reality of the universe, *the physicists have important roles to play in bringing back the evolution process congruent thinking while recognizing that such a thinking brings physics closer and closer to ontological reality*.

3. How are the Biological entities wandering towards their goal of sustainable and enhanced states of evolution

For over 3.5 billion years, the biological evolution is wandering around towards the goal of survivability and enhanced evolution. However, we still do not understand the depth and the details related to the long-term *purpose*. By today's level of human knowledge, the structures of the DNA molecules of the bacteria and the humans are showing staggering similarity [5]. The multi-branched tree of evolution also shows a logically self-consistent and marvelous continuity. These DNA molecules, in all living beings, are at the foundation of the emergence of the complex biological functions behind the perpetual evolutions towards higher and higher forms of biological species. The present state of human connectome (cerebral neural network), sired by these DNA molecules, has been perpetually driving us to ask, at least since a few millennia past, the yet un-answered questions: What are the meaning and purpose behind this evolution, from the galaxies, stars and planets to the roles of humans in it?

Technologically, we are the highest form of complex biologically evolved system that has been successfully advancing the possible paths towards understanding and articulating (recording the knowledge of) the evolution of the universe from 13.5 billion years past to the indefinite future. However, from the standpoint of sustainable evolution in the biosphere, *are we really the most intelligent species?* Then, why a sizable percentage of our leaders are publicly denying the accelerating Global Warming

that can literally terminate the existence of humans; living the bacteria to rule the biosphere as it has happened in the past?

Physicists have a tendency to anthropomorphize some of the interpretations and meanings of the successful mathematical formulations, like quantum mechanics and cosmology. Let me go backwards from today to 3.5 billion years past, when the viruses and the bacteria just started evolving out of the inanimate atoms and molecules to the living species. Intense research activities are continuing to reveal the roots behind the emergence of biological intelligence, starting from bacteria, all the way to humans. Let me postulate that the driving force behind the evolution of biological intelligence (known generally as intuition) is due to iterative applications of the complex emergent **potentialities** (qualities) behind successful evolution: (i) **DESIRE**, (ii) **BELIEF**, (iii) **FAITH**, and (iv) **HOPE**, from viruses to humans. Biological intelligence defines the evolutionary goals.

- (i) The innate biological **DESIRE** to do better than the current best, is systematically applied by the microbes at the "bottom" of the biological totem pole; and all the way to the multicellular humans at the "top" of the totem pole? Humans should note that the viruses have been systematically out-smarting our inventions of anti-viral molecules (medicine?). Statistically about one third of the viruses become successful in their desire to survive by over-riding the best of the latest antiviral molecules while re-organizing their own molecular tools! Who are the most intelligent? How should we define intelligence?
- (ii) The other biological quality is **BELIEF** that "I" should be able to reach the next higher desired level of "living", if I keep on asking "my mind" to discover the possible solutions while framing the perceived problem as "questions" in as many different ways as possible.
- (iii) The next biological quality to keep the **FAITH** alive all along, while repeatedly trying to achieve the desired goal in spite of my repeated failures. This is simply the biological quality of persisting in attempts until successful.
- (iv) And, finally, in spite of repeated failures, a biological entity keeps the **HOPE** ("pray" is the human approach) alive so that the nature (creator?) will, somehow keep "us" alive for another day to find another opportunity.

We can now raise the following question. Are the mindless DNA molecules have been wandering around for over 3.5 billion years to discover accidentally the mind only in the human form? This cannot be right. Because our deeper studies of both plants and animals are showing that, they do act out some form of intelligence in their desire to self-propagate and defend themselves collectively, while actively protecting their offspring. *Could this imply that the bacteria always had the built-in **potential** and the necessary urge to promote the emergence of a mind out of a larger assembly of themselves that would be able to articulate self and learn about the cosmic rules?* Have they proactively facilitated the emergence of multicellular organisms to allow the emergence of complex functionalities? Is that why they are still playing a major nurturing (mothering) role in every multi cellular organisms? About one hundred trillion symbiotic and synergistic bacteria are nurturing every single human body consisting only ten trillion cell human cells. We already know that this microbiota in our body facilitates a wide range of our body functions, including moods! Are the colonies of different forms of amoebas actually mothering us? Are my intentions joint emergent properties of the Holobiont human body [6, 7]?

Let us now extend the above concept of *potentiality* of DNA molecules to give rise to the mind to its constituent non-biological molecules. Then extend this potentiality to the constituent atoms, then to the constituent protons, neutron and electrons, and then, all the way to the cosmic space, say, a Complex Tension Field (CTF) that sustains all the observables as its diverse excitations giving rise to the observable universe [1, Ch.11]. Is the cosmic space nurturing the magnificent evolution as a mindless mathematical entity, or as a thoughtful and purposeful consciousness? These are very difficult questions to frame as mathematical equations. This is why I am promoting that we should consciously train ourselves to be persistent evolution process congruent thinkers. Our mind will then evolve towards the necessary intelligence. We will learn to promote the evolution of our enquiring question to be re-framed repeatedly. Framing the question determines the answer.

However, *we are facing an existential threat out of our own unconscious and unguided evolution!* What are the goals of the human Holobionts? Is the intention is to use the mathematical tools to engineer the right spaceships, along with controlled and recyclable echo systems, and then emigrate to various

other livable planets in different stars before the Solar Warming engulfs us? However, a decent percentage of the human population are praying for early arrival of Armageddon! The global socio-political structures are steadily leaning away from evolution-guided thinking. Which desire will win out? *Can the physicists facilitate the re-direction of our collective social thinking to become congruent with the biospheric and cosmo-spheric evolutions?* Who know the evolutionary life times of the earth and the Sun better than the Physicists do?

4. Articulating the limits of the prevailing approach - the Measurable Data Modeling Epistemology (MDM-E)

The physics community has recently postulated the existence of Dark Energy and Dark Matter [8]. This is based upon various observations, specifically, the wide variations between the curves depicting the velocity distributions of stars, from the center of the galaxy to its edge, measured for hundreds of galaxies. Neither Newtonian, nor Einsteinian formulation of gravity can resolve the problem. However, our prevailing scientific culture is not inspiring the younger generations to challenge and re-frame the foundational postulates of the current working, albeit limited, theories. Has the foundation of edifice of human scientific knowledge already been finalized by QM and Relativity? Then all the follow-on generations should ignore their deep enquiring minds; and focus on inventing new “bricks”, or discovering proper-shaped “stones” that will retrofit into the current foundation! In fact, the Knowledge Gatekeepers of most highly regarded journals systematically reject papers that challenge the foundational postulates of these two major theories. Therefore, this FXQi platform is very inspiring!

Each theory, represented by a mathematical relation, equates observable effects driven by postulated cause. Because of the strictness of mathematical logics, essential in the first place, for their unreasonable effectiveness, the original set of postulates behind a working theory may not be the root cause behind newly observed effects or phenomena. However, we have been still trying to retrofit new observations by introducing new ad hoc postulates within the framework of the old theories.

While evidence based science is the best approach to explore nature, *no amount of experimental data can assure us that we have succeeded in exhaustively gathering all the data relevant to an unknown entity participating in interactions in our instrument.* First, we design our instruments to register a parameter whose concept has already been pre-defined by the theory under consideration. Then we set it up to register interaction between a desired set of entities driven essentially by only one of the four known forces. We do know that all particles are susceptible to all the four forces, in the most general sense. So, all of our experiments are approximate. Further, we also know that we have not yet succeeded in designing any instruments that have 100% fidelity in displaying the interaction-generated data.

However, we have been trained to accept the current theories as the final ones based upon repeated experimental validations without regard to the limitations articulated above. I call this approach as the *Measurable Data Modeling Epistemology (MDM-E)*. However, we cannot abandon this immensely valuable MDM-E approach. We have not yet discovered any general method to observe directly the interaction processes that give rise to the data in our apparatus. However, it is not leading us towards the ontological reality of nature, our prime goal. For example, our brilliant engineers, over the last half century, have succeeded in revolutionizing the human technological society by ushering in the Knowledge Age through the implementation of global internet systems. The systems are based upon four basic engineering functions: (i) Generation, (ii) modulation with information, (iii) propagation and (iv) demodulated detection of the communication signal. The communication signal constitutes, at different stages, *only two entities* that physicists call (a) photon and (b) electron. In spite of thousands of data gathering experiments, and multiple Nobel Prize winning theories, nobody can give us definitive explanations as to what constitutes photons and electrons!

Clearly, the prevailing MDM-E approach, in spite of its staggering success records, is failing to get us closer to ontological reality. What can we add to MDM-E that will direct us towards ontology?

5. A synthesizing an approach to iteratively move towards our GOAL of understanding ontological reality – add Interaction Process Mapping Epistemology (IPM-E) to the prevailing MDM-E

Let us first appreciate what we are missing that is remaining hidden behind the successful MDM-E approach. The founders of Quantum Mechanics (QM) identified it as the Measurement Problem while developing the interpretation for the newly framed QM formalism (Copenhagen Interpretation). The "problem" was then solved mathematically along with elegant interpretation(s). However, the reality is that it is not a Measurement Problem. It is a permanent information retrieval problem. We cannot recover unknown information by elegant mathematics alone; it can only give us some guidance through its inherent logical congruency. Let us follow the experimental measurement steps [1, see section 12.6]:

- (i) **Measurables Are Transformations:** We can measure only physical transformations.
- (ii) **Preceded by Energy Exchange:** There are no transformations without energy exchange.
- (iii) **Guided by Forces of Interaction:** Energy exchange, and consequent transformations, must be guided by an allowed force of interaction.
- (iv) **Must Experience Physical Superposition:** Interactants must be within each other's sphere of influence to be able to interact under the guidance of an allowed force to exchange energy and undergo transformations. All forces display a finite range of effectiveness. Thus, all interactions producing transformations must be "local" since all forces are distance dependent.
- (v) **Through Some Physical Interaction Process:** The understanding & visualizing the Invisible interaction process anchors us to inch towards understanding cosmic logics (reality). The interaction processes are a step closer to ontological behavior of nature compared to the registered data alone.
- (vi) **Always Requires a Finite Duration:** Transformations in the interactants from one specific state into another specific state requires "quantum compatibility sensing dancing period" before accepting the transition.

Corollary 1: Impossibility of Interaction-free Transformation: This leads to better understanding of optical superposition effects. There is no known force of interaction between EM waves in the linear domain in the absence of some material medium. Thus, propagating light wave amplitudes cannot interfere to re-distribute their energy without the mediation of some interacting material dipoles (classical bulk or quantum, photo detector). I have separately proposed this as the universal NIW-property (Non-Interaction of Waves) [1].

Corollary 2: We are interpreters, not the observers. We cannot observe the actual interaction processes between the interactants in our instruments. We are the interpreters of the limited data that we can gather. In addition, we all perceive and interpret things differently. Only focus onto visualizing the invisible interaction, processes will help us steadily advance towards ontological reality.

We can only register the instrument-limited data. Nature has challenged us with a permanent *information retrieval problem*, not a measurement problem. This is where the brilliance of the creative minds of our great scientists come into play. They fill in this information gap by creating a set of rational postulates and construct a causal mathematical theory by equating the measured effect equal to the invented but rational cause. Such postulated cause, even though working as per experimental data, does not help us understand the physical processes behind the emergence of the force of interaction. Hence, the human invented emergent cause may not be identical with the cause embedded in the cosmic logics. *This is a major epistemological limitation of all modern working theories.* We are unable to visualize the details behind the physical interaction processes that give rise to the measurable data. So, our current approach to science has been characterized as *MDM-E*. Further, the set of postulates that broach the information gap, in spite of their great successes, and in spite of their being logically self-congruent, are, nonetheless, product of subjective human brains. We now know from complexity theory that multiple but self-congruent logic sets can explain the emergent properties of many very small subsystems, out of a very large complex system; none of which may exactly match with the real logic-set belonging to the full complex system. We can only rationally tie the different sets of data from different sensors designed to promote only one of the known four forces on the interactants in an instrument. Developing many general working laws of nature out of such diverse compartmentalized data are a remarkable feat on the part of our great thinkers.

However, our attempts to derive a unified field theory, is not yet successful because we are unwilling to first reconstruct a self-congruent set of foundational postulates out of which all the separate theories can be re-constructed. We are still trying to force fit all the existing postulates, developed at different epochs of human thinking philosophy, into one theory! A guiding suggestion is first to re-formulate the foundational postulates behind all the separate working theories that will facilitate the visualization of the invisible interaction processes behind all the diverse phenomena. Then use this set of postulates to formulate a new unified field theory out of a single universal field. All successful separate theories have indicated that the observable universe consists of diverse emergent properties out of a single but complex field-like entity [1,9,10].

6. Conclusion

My proposal is to incorporate the *Interaction Process Mapping Epistemology* (IPM-E) in physics thinking to empower the prevailing MDM-E approach. This will further empower our engineers to become more creative in bio-engineering the biosphere to sustainability. Hence the title of the essay "Empower Mathematical Equations Using Evolution Process Congruent Thinking" [9].

We need to organize new and re-vitalized research institutions for all major fields of investigations -- the explicit goal is to assure sustainable evolution through continuous and iterative Evolution Process Congruent Thinking [9]. The Revolutionary Paradigm Shift model is now obsolete [11,12], as it is too slow in allowing corrections to our "theory driven" society in view of the "Sixth Extinction" [13]. We must consciously promote more frequent challenges to our working theories, whether meant for Nature Engineering (physics, chemistry, biology, etc.), or Social Engineering (politics, economics, religions, etc.) to assure that we are not getting trapped on our old success rut that have become incongruent with our sustainable evolution.

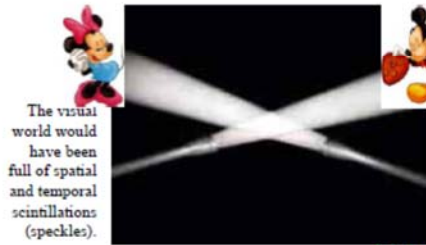
REFERENCES

1. C. Roychoudhuri, *Causal Physics: Photon Model by Non-Interaction of waves*, Taylor & Francis, Hardbound, 2014; Paperback, 2017.
2. Eugene P. Wigner, "Unreasonable Effectiveness of Mathematics in the Natural Sciences", *Comm. On Pure and Applied Mathematics*, VOL. XIII, 001-14 (1960). Free copies are easily available from the web.
3. Jason Scott Nicholson, "A Perspective on Wigner's "Unreasonable Effectiveness of Mathematics"", *NOTICES OF THE AMS VOLUME 59, NUMBER 1*, p.38, Jan.2012.
4. C. Roychoudhuri, "Could space be considered as the inertial rest frame?" *Proc. Conf. SPIE Paper #9570-30* (2015). Most of the papers by this author can be down loaded from the site, <http://www.natureoflight.org/CP/>
5. Martin Jones, *Unlocking the Past: How Archaeologists Are Rewriting Human History with Ancient DNA*, Arcade Publishing, 2016.
6. Thomas C. G. Bosch and David J. Miller, *The Holobiont Imperative: Perspectives from Early Emerging Animals*, Springer-Verlag Wien, 2016.
7. Ed Yong, *I Contain Multitudes: The Microbes Within Us and a Grander View of Life*, 2016.
8. Richard Panek, *The 4 Percent Universe: Dark Matter, Dark Energy, and the Race to Discover the Rest of Reality*, 2011.
9. C. Roychoudhuri, "Urgency of evolution process congruent thinking in physics", *Proc. SPIE Vol. 9570, paper #7* (2015).
10. C. Roychoudhuri and M. Ambroselli, *Could space be considered as the inertial rest frame?* *Proc. SPIE Vol. 9570, paper # 30* (2015).
11. C. Roychoudhuri, "Replacing The Paradigm Shift Model In Physics With Continuous Evolution Of Theories By Frequent Iterations", Chy.10 in *Death and Anti-death: Sixty Years after Albert Einstein(1879-1955)*, Vol.13; Ed. Charles Tandy, Ria University Press, 2015.
12. Thomas Kuhn, *The Structure of Scientific Revolutions*, University of Chicago Press, 50th anniversary publication, 2012.
13. Elizabeth Kolbert , *The Sixth Extinction: An Unnatural History*, 2014.

Notes on Non-Interaction of Waves

Common sense observations of Non-Interaction of Waves

In the linear domain, all waves pass through each other unperturbed. Different harmonic undulations of the same tension field cannot exert any force of interaction on each other. Otherwise these observations would not have been possible?



Light

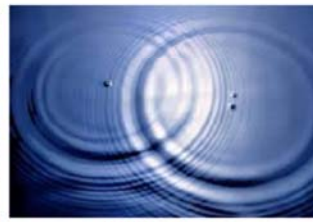


waves

"Hubble deep field galaxies". Expanding universe, indicated by Doppler shift, would not have been measurable.



Sound waves



Water waves

Water waves pass through each other unperturbed.

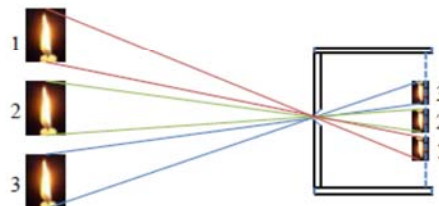
We have been ignoring the absence of any physical interaction process (force) between waves!

Alhazen experimentally noted in his book that light beams pass through each other unperturbed. It was around 1080, or earlier!



~965-1040

Alhazen's experiment



Light beams freely pass through each other!
Unperturbed, inverted images are formed, even though different candle light are crossing through each other at the pinhole.