Towards a Deeper Understanding in Physics

Suresh Emre

Abstract: With expanded scientific coverage, specialization became a necessity for the professional physicist, amplified by the "publish or perish" culture in academia. Overspecialization lessens the chances of seeing connections between different areas of physics. Still, finding connections is key to a deeper understanding. This is relevant for theories that try to unify electromagnetism, nuclear forces and gravity. No single theory can achieve the unification of physical forces let alone unify biological and mental phenomena with physics. In order to have wider and deeper scientific coverage we need a conceptual framework that can integrate multiple perspectives. A perspective can be a theory, a model, an equation, a language or even a methodology. In this article, I discuss the scope of such a framework and various approaches that would be relevant in its construction. We should be on the lookout for abstract generative constructs that may have more explanatory power.

1. Introduction

We have built a civilization based on the manipulation of electrons, but we don't know what an electron is. Nobel laureate Frank Wilczek's essay titled "*What is an electron?*"[1] emphasizes this fact. Albert Einstein succinctly stated the importance of this subject by saying "*You know, it would be sufficient to really understand the electron.*" as quoted by Hans G. Dehmelt in his 1989 Nobel lecture. [2]

Gravity is another mystery. We operate airplanes and rockets, we send spacecraft to inter-planetary journeys, but we don't really understand gravity. We have theories of gravitation such as the Newton's theory and the Einstein's theory. With these theories we can predict the motion of objects with precision, but we still don't know what gravity is. According to Einstein's theory the mass curves the surrounding space-time. The smaller objects are attracted towards the more massive object because of the curvature of space-time. Why does the mass cause a distortion in the surrounding space-time? We don't know.

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> *Greater understanding of physics requires relating physics to life, mind and consciousness.*

What is the nature of space and time? What is dark matter? What is dark energy? What is charge? Why are there exactly 3 generations of fermions? There are million other questions like this, of course. There will always be new questions. While we are searching for answers to the new questions, we have to revisit and try to improve our answers to the old questions.

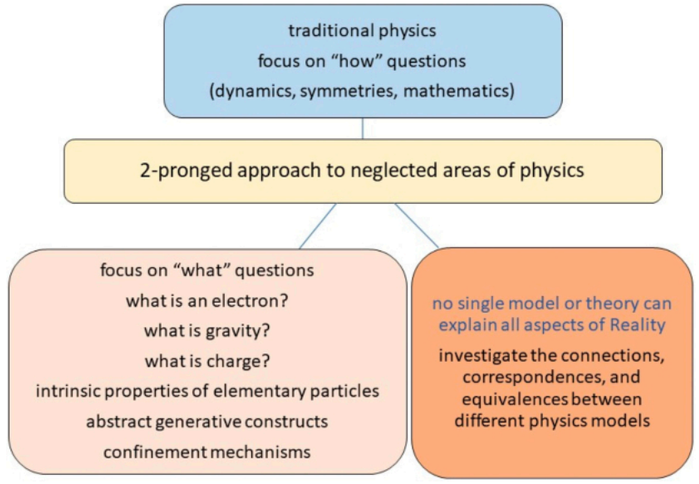
We have descriptions of relationships between various observables expressed in the form of mathematical equations. We call these equations physical laws. In addition to relationships, our equations also address dynamics by predicting how the observables change in time and space. This is great progress, but unfortunately, this is not true understanding. A deeper understanding will develop when we know more about the essence of those observables, not just their equations of motion.

In physics, an observable is any physical property that can be measured. Electric charge, quantum spin, invariant mass, position, momentum, angular momentum, energy are observables. The term "essence" refers a more fundamental construct that can explain several observables at once. If there is such a fundamental construct it could explain electric charge, quantum spin and invariant mass of an elementary particle at the same time. There are mathematically sophisticated theories such as the Quantum Field Theory and the String Theory that propose fundamental constructs such as quantum fields and strings; and other theories that propose information/computation as the basis. We should be on the lookout for abstract generative constructs that may have more explanatory power.

The other promising avenue is the construction of a conceptual framework that can integrate multiple perspectives of physical reality. No single model or theory can explain all aspects of physical phenomena. No matter how sophisticated the symbology is, no text, no picture, no diagram, no mathematics can represent the truth fully. Besides, the representation (text, picture, diagram, symbol, mathematics) requires interpreting minds and agreements among those interpreters on the meanings of the symbols. Therefore, a single theory of everything is not possible. Integrating different physics models in a conceptual framework will be more productive.

In more practical terms, my proposal is a two-pronged approach: 1) focus on the "what" questions, particularly on the "what is an electron?" and "what is gravity?" questions. This will lead to a deeper understanding of the invariants (intrinsic properties of elementary particles) and 2) develop a much better understanding of connections, correspondences, and equivalences between different physics models.

Greater understanding of physics also requires relating physics to life, mind and consciousness. I will expand on this in Section 17.



2. A Few Comments On "Understanding"

Large Language Models (LLM) can process information, summarize known facts and mimic human conversation but they do not understand what they are saying. Human understanding encompasses internal as well as external processes. This is the distinction between subjective (intuitive) and objective (mechanical) understanding. LLMs exhibit mechanical understanding only. Human beings too develop mechanical understanding first. Insights come later.

The term "insight" refers to the intuitive understanding which involves a mental process that relies on the accumulated personal knowledge on the subject matter. The mind connects the dots and sees a mental picture. This is primarily an internal process aided by external factors. For example, in physics we learn the mathematics of the physical laws (equations and their solutions in various potentials) first. This is mechanical understanding. We then hear commentaries about those equations from our teachers, philosophers, forums, blogs and even LLMs. The peripheral information in the form of commentaries help us internalize those equations.

The conceptual framework integrating multiple perspectives will externalize some of the internal processes of understanding. The "framework" will help us connect the dots.

3. Connections

If one of the requirements of deep understanding is to have multiple perspectives. The corollary is to know the connections between the perspectives. Each perspective by itself is not going to be satisfactory. The collection of these perspectives as a whole must provide higher explanatory power. This is only possible when we understand the connections.

In physics terminology the "connections" are also known as "correspondences" or "dualities". One famous example of correspondence is the "equivalence principle" in the context of gravity. Einstein noticed that it is impossible to distinguish gravity from acceleration. Starting from this empirical fact Einstein was able to construct his theory of gravity, which later proved to be more accurate than Newton's theory of gravity. Here, there are two perspectives, and they are equivalent: (1) gravitation can be seen as acceleration in flat space or (2) as curvature in curved space-time.

Sometimes it is possible to find a transformation that maintains the form of the equation while the physical quantities are exchanged by their duals. We can think of this as switching the perspective. For example, the laws of electromagnetism are summarized in the form of Maxwell's equations. If one ignores the sources, or adds magnetic sources, Maxwell's equations are invariant under the switch: $\mathbf{E} \rightarrow \mathbf{B}$, $\mathbf{B} \rightarrow -\mathbf{E}$ where $\mathbf{E}$ and $\mathbf{B}$ are the electric field and the magnetic field, respectively. Such a transformation means that we are switching the electric charge with its dual (magnetic charge).

The magnetic charge has not been observed so far but this technique may still be useful. If it is difficult to solve the equation for a particular physical quantity, we may switch to the dual perspective and solve the same equation for the dual quantity and then convert the solution back to the original perspective. This may make the calculation easier and increase understanding as well.

PERSPECTIVES

- point particles
- strings
- twistors
- waves
- wavefunction
- quantum field
- it-from-bit
- it-from-qubit
- spin network
- knots
- causal sets
- physics dualities
- entanglement
- events

- cognitive/creative
- confinement/liberation
- abstract generators
- axiomatic
- recursive
- operational
- geometric
- algebraic
- simulation
- hypergraph
- emergence
- code theoretic
- information theoretic
- cognitive cores

- 7 realms (loka)
- 5 factors (bhuta)
- tanmatra
- 5 layers of the mind
- 3 binding principles
- cittanu
- interial/exterial
- subject/object
- cosmic mind
- involution/evolution
- primordial fabric
- 4 chambers
- microvita
- soul

"The term insight refers to the intuitive understanding which involves a mental process. The mind connects the dots and sees a mental picture. This is primarily an internal process aided by external factors."

Michael Atiyah's review article[3] on the dualities in mathematics and physics is very educational.

Discovering connections between different branches of physics improves our understanding as well. Discovery of the Brout-Englert-Higgs mechanism[4] of particle physics was based on the discoveries in superconductivity research in condensed matter physics.

The mental activity of finding connections is very different from the mathematical or the algorithmic thinking. Finding connections is also very different from answering "how," "why", "what" questions. As scientists develop their intuitive faculty, more connections will be found.

4. Emergence

The integrating framework will hopefully establish the connections between the laws of the microscopic world and the laws of the macroscopic world. The integrating framework will also provide a better understanding of emergence.

For a comprehensive but dense philosophical examination of emergence, the SAP (Stanford Encyclopedia of Philosophy) article titled "Emergent Properties"[5] can be studied. A more readable review of emergence is in IEP (Internet Encyclopedia of Philosophy)[6]. Interestingly, neither article mentions the work of Roger Penrose[7] and Howard H. Pattee[8], whose ideas have been very helpful for a clear understanding of the closure problem of emergence.

Examples of weak emergence in physics are described in Phillip W. Anderson's classic article "More is Different"[9]. Other examples of emergence can be found on the website of the Dutch Institute for Emergent Phenomena[10]. More examples can be found in the publications of the Santa Fe Institute which has been very effective promoting emergence as a unifying theme[11].

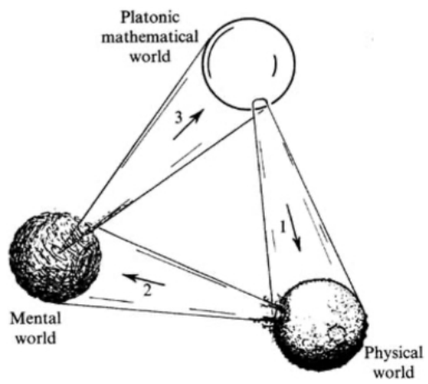
In weak emergence, as demonstrated in condensed matter physics, the models developed specifically for the emergent level have more explanatory and predictive power. Here, there is no claim about the ontological distinction of the emergent level but there is an admission of explanatory weakness of the models of the base level. The explanatory weakness is assumed to be due to lack of computational power or lack of information about the initial conditions. The explanatory weakness is sometimes attributed to an undiscovered law of nature.

In the strong version of emergence, the emergent realm is ontologically distinct. Therefore a new theory is needed to explain the emergent behaviors. Organic life is emergent. If you are arguing for strong emergence, you are claiming that organic life

is ontologically distinct, therefore subject to different laws of nature. If you are arguing for weak emergence, you are expressing your hope that biology can be reduced to physics someday.

5. Closure Problem of Strong Emergence

"Platonic-mathematical, physical, and mental – has its own kind of reality, and where each is (deeply and mysteriously) founded in the one that precedes it (the worlds being taken cyclically)"7.



3 worlds and 3 mysteries of Roger Penrose[7]

Individual minds emerge from the physical realm but they cannot be completely explained by physical processes. This is the closure problem of strong emergence.

The biological world (organic life) is not shown in Penrose's picture. The biological world is assumed to be part of the physical world. Penrose is discussing a cyclical relationship among the three worlds. That's why he uses the term "preceding" instead of "lower" when he refers to three worlds.

The reader might also be interested in the debates[12] of Mark Alford, Max Tegmark, and Piet Hut. Their debate was inspired by the "3 worlds and 3 mysteries" of Penrose.

Howard H. Pattee[8] argued that the closure problem can be solved by proper theory construction in the domain of biology. His proposal is to treat rate-independent memory structures and rate-dependent dynamical laws as distinct categories and study their interactions. This is known as semiotic closure. Pattee originally referred to semiotic closure as "semantic closure." The term "semantic" connotes with "meaning". The concept of semantic/semiotic closure applies to systems that enclose their own meaning. If the system contains the definition of itself, in other words, if there is self-reference then the system can replicate itself. This opens the gates of biological evolution. Pattee's solution was inspired by the discovery of the DNA structure and its function, which is an example of how a system can enclose its meaning within itself.

Semiotic closure insists on the causal closure of the physical. Semiotic closure cannot be achieved if there is strong emergence. The underlying assumption of semiotic closure is the belief that Nature records the code (laws) of the emergent behavior on a physical substrate. By proper theory construction the "code" can be deciphered and its activation logic detailing how this code gets realized in space-time-matter can be explained. As long as the code (laws) of the emergent level is implemented on a physical substrate, the causal closure of the physical is achieved. This seems to be a good argument in the biological world. But, can we generalize this? Does Nature always record the code of emergent behaviors on a physical substrate? My answer is no…not always.

Many mathematicians and physicists sense that there is an abstract realm. They have clues that the physical realm emerged from the abstract realm. Roger Penrose, Max Tegmark and many others call the abstract realm the Platonic mathematical world. In the Eastern philosophies we find very sophisticated discussions of the abstract realm and its various subtlety levels. The abstract realm is currently a complete unknown to science. Regardless, if science discovers someday that the physical world emerged from the abstract realm, then scientists will no longer be able to claim that the individual mind is an epiphenomenon of the physical brain.

Here's why. Not all aspects of the emergent realm can be explained by the characteristics of the preceding realm. Some aspects of the emergent realm may be expressions of the prior realms in the progression. The individual mind emerges from the physical realm but it cannot be completely explained by the physical processes because the physical realm itself emerged from an abstract realm in the first place. The individual mind must have some elements exhibiting the characteristics of the abstract realm. Therefore, the individual mind is not entirely physical.

6. Symmetries

There must be thousands of articles and books about the importance of symmetries in the description of physical reality. I recommend the PNAS article[13] written by David J. Gross for an overview of the role of symmetry in fundamental physics.

Discovering the symmetries or arguing that a particular symmetry appears to be broken now but it was in play in an earlier epoch was a successful method in physics. The low-hanging fruits were picked by this method. The high-hanging fruits will require other methods.

Another point often ignored: let's assume we eventually find a symmetry group large enough and capable enough to cover all elementary particles. We then have to explain why and how this wonderful symmetry was broken to produce the differences observed in elementary particles.

7. New solutions of the physics equations

Discovering the laws of physics and writing them down as mathematical equations is one thing and finding the solutions of those equations is another. It took Einstein a decade to formulate the law of gravitation in terms of an equation. It took a century and hundreds of physicists to find all the mathematical solutions of that equation in different physical settings. The same goes for the Dirac equation. It took Dirac only a year to come up with his famous equation for the relativistic motion of an electron. People are still applying the Dirac equation and finding solutions in the presence of various external fields. Finding solutions can be more difficult than formulating a law of physics in terms of an equation. Every new solution improves our understanding. For example, the specific solution of Einstein's General Relativity equation pointing to gravitational waves. The eventual detection of them on Earth showed us that space-time is a physical entity. That's a dramatic improvement of our understanding.

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8. Geometric approach

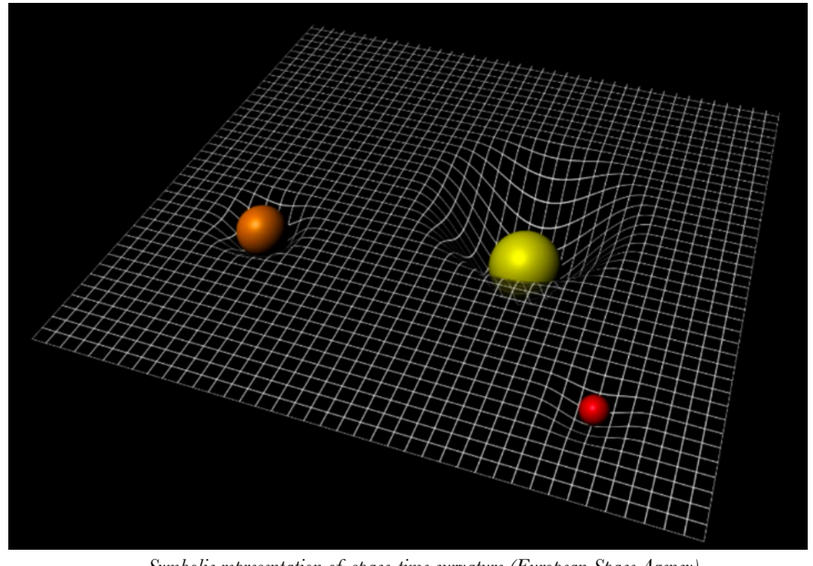
There are many physicists who believe in the idea of explaining all physics using geometric concepts. Einstein was a true believer in geometric thinking and he influenced many others. Theories of physics with geometric interpretation are easier to internalize because humans are primarily visual thinkers. Geometric explanations allow us to visualize the forces.

Among the geometric concepts used in physics, curvature concept is the most popular. Einstein's equation for gravity is an example of a theory that uses the curvature concept.

In the geometrical approach to fundamental physics, the primary strategy is to extend the definition of space-time. If the space-time has additional spatial dimensions at the microscopic scale, then certain characteristics of elementary particles might be explained by this microscopic structure. That's the idea. Two problems: 1) So far there is no experimental evidence for this hypothesis. 2) Even if we find evidence for extra spatial dimensions, it will be very difficult to determine the shape and size of these manifolds.

9. Algebraic approach

Algebraic approach to physics differs from the geometric approach by its emphasis on quaternions, biquaternions, and octonions. Algebraic theories of physics are less popular because they are less visual



Symbolic representation of space-time curvature (European Space Agency)

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therefore more difficult to internalize compared to the geometric theories.

Geoffrey Dixon[14] and Cohl Furey[15] followed the footsteps of Feza Gürsey[16] and Murat Günaydın[17] and made progress in terms of algebraic approaches to particle theory. Along these lines, I pointed out that golden biquaternion can represent fermions[18]. Speaking of the algebraic approach, relativistic quantum mechanics can be formulated in such a way that each point in space-time is represented by a biquaternion[19]. Biquaternions also form the core of the "algebrodynamics over complex space" paradigm discussed by V.V. Kassandrov[20].

10. Algorithmic Approach

The Algorithmic approach to physics includes information and computation theoretic approaches. Algorithms are clearly different from geometry or algebra. Algorithmic thinking is also very different from the mental activity of finding connections. Algorithmic thinking is difficult to internalize. This did not stop physicists from developing theories based on algorithmic thinking, however.

For a review of information/computation theoretic approaches to physics, see[21] and the references therein. Among the computational approaches to physics, Stephen Wolfram's hypergraph theory[22] is the most developed.

There is another perspective related to information/computation. According to this hypothesis the fabric of the universe is a network of primordial qubits connected to each other by quantum entanglement. Space and time emerge from this qubit network. The ontological status of the primordial qubit is not resolved.

Note that the "qubit network" perspective is very different from the "universe is a simulation" perspective. In the "qubit network" perspective, physicists are talking about the emergence of space-time-matter from the primordial sea of qubits. Once the emergence takes place, the space-time-matter evolves according to its own laws. In the "universe is a simulation" perspective, everything happens according to the logic of the simulation code which can be very complex. The logic of the "code" is not necessarily expressible in terms of laws.

An important contrast between the "simulation" and "hypergraph" is that the rules of the hypergraph are presumed to be very simple. In the hypergraph universe the complexity emerges from repeated application of the simple rules. In the simulation universe the complexity does not emerge. Complexity is built in.

11. Depth = Breadth

The ideal theory is expected to be simple, predictive and explanatory. These are high ideals. Typically, we value the predictive power first and the explanatory power second; simplicity is just a dream. An advanced theory may not be simple. Some people also value the mathematical elegance of the theory. That may be just a dream as well. I suggest yet another criterion: the depth of the theory. How deep is the theory in the sense of how fundamental it is? A deeper theory is not a reductionist theory. On the contrary, a deeper theory will explain a wider range of phenomena. The term "fundamental theory" should be defined as the theory that has the widest coverage.

Since the current theory of elementary particles (Standard Model) cannot explain mental phenomena, let alone biological phenomena, we cannot argue that the Standard Model represents a deeper understanding of Reality. The Standard Model is just one of the perspectives.

12. Meta-theory

Physics theories are models of physical reality. We perceive the physical reality around us through the nervous system. The physical interaction is translated into electrical pulses in our sensory nerves. These pulses are then converted into an information package by the brain and finally the information package is interpreted by the mind. Physics theories are interpreting the perception. If we call the perception itself a model, a physics theory is a model of a model. A meta-theory then is the model of a model of a model. Meta theories are important for a deeper understanding in physics. A meta-theory would be a theory that explains the theory itself.

13. Time

The integrating framework has to improve our understanding of time. This is crucial for progress in physics. In the introduction, I mentioned two fundamental questions that require our urgent attention: 1) what is an electron? 2) What is gravity? The "what" questions will have better answers when we understand "time" better.

"Time" is treated differently in Classical Mechanics (CM), Quantum Mechanics (QM) and Statistical Mechanics (SM). In classical physics we model the continuous motion in space and time and hope that the measurements (snapshots) conform to the model. Quantum Mechanics, on the other hand, was developed by modeling the measurement results (snapshots). The time evolution of the quantum system as described by the Schrodinger equation is an add-on. Developing a movie from snapshot

Can we relate physics to the theories at the "consciousness is everything" end of the spectrum? This would only be possible by investigating the transformations of Consciousness.

pictures is done in cinema, of course, but in the physics of the microscopic world, developing a movie from snapshots is extremely difficult. At each measurement the quantum mechanical wavefunction collapses and yields a single state of the system. Stitching together the quantum states to come up with dynamical behavior of the system is problematic. In QM, the concept of "motion" is replaced with the concept of "evolution of quantum states" (quantitatively expressed using the Schrodinger equation or the Dirac equation). The "evolution" refers to the change in the probability of ending up in one of the possible states assuming there is no measurement or no disturbance during that time interval.

In the Newtonian picture of CM, we can predict the motion of a particle in space and time. In QM, assuming no disturbance, we can predict the evolution of the probabilities. In both cases, we are speaking of a single particle. And, in both cases the equation of motion/evolution is time-symmetric. CM and QM allow us to traverse the motion/evolution backward in time (let's ignore the fact that in QM this is tricky). In SM, however, there is an arrow of time. This is related to the fact that we are dealing with a collection of particles and an empirical law known as the second law of thermodynamics. Remember, in isolated systems the entropy tends to increase. This manifests as the arrow of time.

It is quite possible that the arrow of time exists for elementary particles as well, but the equations do not reflect it. I strongly urge physicists to look into this.

14. ToE

Among the professional physicists the term ToE (Theory of Everything) is used in a narrow sense. ToE refers to a theory that unifies the four known forces–electromagnetic, weak nuclear, strong nuclear and gravitational. Despite heroic efforts, such a theory does not exist yet.

In 1865 James Clerk Maxwell unified electricity and magnetism under the theoretical umbrella of Maxwell equations. In the 1970's physicists were able to construct a single theoretical framework for the unification of the electromagnetic force with the weak-nuclear force. But physicists failed to unify the electroweak force with the strong-nuclear force. Physicists also failed to unify gravity with other forces. Einstein spent a lifetime trying to unify gravity with electromagnetism but failed. Other physicists did not have any luck either.

Note the difference between "force" and "field". Electroweak theory unifies forces not fields. According to Quantum Field Theory (QFT) each type of particle has its own field. There are only four forces but many fields. There is electron field, muon field, tau field, etc. In general, there are matter fields and force-carrying fields. For example, there is the matter field for the electron and there is also the force-carrying field known as the electromagnetic field. The quanta of these fields (electron and photon, respectively) interact. QFT does not unify the electron field and the electromagnetic field. Rather, QFT describes the interaction between the electron and the photon.

I hope physicists work towards unifying the fields, but unfortunately nobody talks about UFT (Unified Field Theory) these days. The unification of the fields is more difficult than finding a unified description of the interactions among the quanta of those fields. With QFT we are able to explain the interactions between electrons and photons, but we are unable to explain what an electron is or what a photon is. If we could unify the electron field and the electromagnetic field, we would then have a unified description of electrons and photons.

In the context of ToE, "string theory" is often mentioned. The main idea of the "string theory" is that the elementary particles are not point particles but vibrating strings or membranes vibrating in 10-dimensional space-time. Over the course of the last forty years different types of string theories were theorized. There is no experimental evidence for string theories yet.

15. Axiomatic, Recursive, and Operational Explanations

The Integrated Information Theory (IIT)[23] [24] and the Assembly Theory (AT)[25] emphasize axiomatic, recursive, and operational explanations with strong emphasis on path-dependence.

Recursive explanations involve feed-back loops referring to self (life in the case of AT, consciousness in the case of IIT). In AT and IIT, life/consciousness is the axiom – the starting point. AT assigns primary ontological status to "life", IIT to "consciousness" and investigate what must have happened in the past for life/consciousness to emerge. These theories place more emphasis on the operations/functions on the substrate rather than the substrate itself.

Both AT and IIT put a lot of emphasis on path-dependence. Standard theories of science emphasize the laws (equations, regularities, mechanics, dynamics). AT and IT say that "history" (the specific path taken) is more important than the laws. The specific path (individual history) taken in the course of evolution eliminates a countless number of other possibilities and selects for a narrower space of future possibilities.

AT and IIT do not deny the dynamical laws, but they do not assign primary importance to them. They seem to pay attention to the conservation laws (constraints), however. Otherwise, they could not explain the evolutionary selection – the elimination of future possibilities based on the specific path taken.

In AT and IIT the explanatory factors are functions/operations rather than the building blocks themselves. For example, in this view, life/consciousness can be based on carbon or on any other chemical or electronic substrate as long as the functions/operations result in life/consciousness.

16. Microvita

> *"In 1986, Prabhat Ranjan Sarkar introduced the subject of microvita for the first time in a discourse 'Microvitum—the Mysterious Emanation of Cosmic Factor.' He explained that microvita are subtle, sub-atomic living entities that move throughout the universe, creating minds and bodies, and also spreading diseases. He said that there are positive and negative, as well as neutral, varieties of microvita, and they have three different levels of subtlety. They move through physical and psychic media, and play various roles in the evolution of life and mind."*[26]

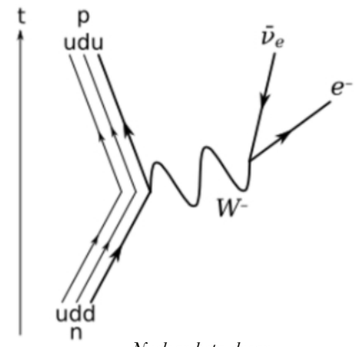
P.R.Sarkar's discourses on microvita were published in a book form under the title "Microvitum in a Nutshell"[27] in 1988.

It is beyond the scope of this article to review microvita research. I encourage physicists to consider a wide range of ideas presented in references[26 28 29 30 31 32 33].

The microvita hypothesis suggests that an atom is composed of billions of microvita. This implies that microvita play a role in the confinement mechanisms and the formation of elementary particles.

Richard Gauthier[34] discussed the possibility of microvita release in nuclear decays. There are theoretical reasons to believe this is the case. Nuclear beta decays are facilitated by the weak-nuclear-force. During beta decay, a down quark within the neutron emits a W− boson, transforming into an up quark, and the W− boson then decays into an electron and an antineutrino.

(unstable nucleus) neutron → proton + electron + antineutrino



Nuclear beta decay

The weak-nuclear-force is also responsible for the transformation of a neutrino into an electron. A neutrino hitting on a neutron may transform into an electron while the neutron turns into a proton. For this to happen, the neutrino has to have more energy than the mass-energy of the electron. Solar and reactor neutrinos have enough energy to create electrons.

Energetic neutrino + neutron → proton + electron

We should also note that the weak-nuclear force plays the key role in the production of solar neutrinos.

(fusion) proton + proton → proton + neutron + positron + neutrino

As can be seen in these reactions, the weak-nuclear-force (mediated by the W− boson) effectively manipulates the electric charge.

If microvita play the primary role in confinement mechanisms in general, and the formation of the electric charge in particular, then it would be possible for microvita to manipulate the electric charge. This is very similar to the function of the weak-nuclear-force. Microvita may have the ability to turn on or off the electric charge via its control over the weak-nuclear-force. This may be related to Gauthier's suggestion[34] that radioactive atoms release microvita. This is also consistent with Towsey's suggestion[29] that microvita enhance or suppress propensities (charges).

17. Life, Mind and Consciousness

The difficulty of relating physics to life, mind and consciousness is primarily about modeling subjective experiences in objective terms.

In a book length open-access article[35], Robert L. Kuhn surveys (categorizes and summarizes) a bewildering number of theories of consciousness. There are omissions, however. P.R. Sarkar's spiritual philosophy is not included.

Kuhn's survey covers a range of theories from rigid physicalist views claiming life, mind and consciousness are epiphenomena of the physical, to the views claiming everything derives from Consciousness (Consciousness with capital "C"). How can we relate physics to these theories? The physicalist end of the spectrum is based on the known physics, so the real question is: can we relate physics to the theories at the "consciousness is everything" end of the spectrum? This would only be possible by investigating the transformations of Consciousness.

The theories mentioned in Section 15 (AT and IIT), take life/consciousness as the axiom and investigate what must have happened in the past, in terms of the possible historical paths, for life/consciousness to emerge from the physical realm. This is very promising approach but it seems to me that the stages between the unqualified Consciousness and the physical (qualified Consciousness) are ignored. AT and IIT focus on the physical stage only.

The other approach would be to limit our focus to the transition between the pre-physical stage and the physical stage. In other words, understand the abstract generators of space-time-matter first. Then after significant progress in that area, take another bold step to study the genesis of the abstract generators themselves. This would be a never-ending scientific journey.

18. Abstract Generator

As mentioned in Section 5, Roger Penrose, Max Tegmark, Mark Alford, Piet Hut and many other scientists argue for the existence of the abstract realm, they call it the mathematical reality and claim that the physical reality emerges from the abstract realm. Similar cosmogonies are found in Eastern philosophies.

What are the facilitators of the emergence of space-time-matter from the abstract realm? What are the candidates for abstract generators of the intrinsic properties of the elementary particles?

In Stephen Wolfram's hypergraph[22] approach, the abstract generators are known as "rules". According to this theory, the repeated application of the "rules" generates the effects we observe in the phenomenal world.

In a theory proposed by David Deutsch and Chiara Marletto[36], a "constructor" is an entity that can cause a transformation without being affected by that transformation. Their "constructor" is a type of abstract generator.

More examples of abstract generators can be found in code-theoretic or information-theoretic approaches to physics. Elements of the Penrose mathematical realm, causal sets, Nima Arkani-Hamed's geometrical or combinatorial principles belong to the category of abstract generators as well.

The golden equation ($g - 1/g = 1$) mentioned in18 and the two fundamental factors (confinement/liberation) mentioned in[37] are other examples of abstract generators.

In the most general sense, we can think of the abstract generators as codes implemented on the pre-physical substrate (primordial fabric). Various archetypes are abstract generators as well.

19. Microvita and Abstract Generators

Microvita could be considered as abstract generators too. I think that the cittanu (mind atom) concept of P.R. Sarkar should be part of this discussion as well. This is a neglected area. I don't see any significant discussion of the relationship between cittanu and microvita in the works of microvita researchers.

The term "cittanu (mind atom)" can be used to refer to the ultimate abstract generator. In this sense, "cittanu" includes all possible abstract generators.

Microvita may have a role in the activation as well as the modification of the abstract generators. Once activated, abstract generators manifest the physical effects. It is possible to think of this as projection into the physical realm, or codes being expressed, or primordial fabric transforming into physical.

20. Long Road Ahead

There are multiple proposals for abstract generators. Wolfram's hypergraph is the most developed one. The research on the abstract generators belongs to the first prong mentioned in Section 1, namely the research trying to answer the "what" questions. This type of research is in very early stages.

The second prong which is about understanding the connections, correspondences, and equivalences between different physics models is not actively pursued. There are no incentives for this type of research in academia. On the contrary, the academic institutions encourage specialization. Nicholas Ahmann's article[38] is a thoughtful examination of the unification efforts in physics.

The article with its complete references is available at the journal web pages theneohumanist.com.