

Predictive Pointers in Fundamental Physics

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Abstract. It is recognized that foundational science is the key for the development of applied science and technology. In the final analysis, foundational science is the driving force for the progress and transformation of mankind. As a “compass”, four Pointers are proposed to validate any particular direction in foundational science research. The Pointers are: P1 (Philosophy and Mindset), P2 (Mankind as an Emerging Intelligence), P3 (The Principle of Fine Tuning), and P4 (The General Copernican Principle). The Pointers are subjected to a verification test in four specific foundational situations: fundamental nature of quantum laws, unification of fundamental forces, the string theory, and the multiverse theory.

The most important and transformative driving force for mankind’s progress remains Science & Technology. In its turn foundational science is the key for development of applied science & technology.

At the present time, in my opinion, foundational physics and cosmology show a certain degree of stagnation. Removal of some roadblocks would make foundational science sharper, more efficient and more credible with the general public on whose support science relies.

A body of foundational science is not isotropic. One should not assume that research in any arbitrary direction would provide an equal probability of scientific success. For example, here are two statements: “the present has no influence on the past,” and “the present has influence on the past.” Some scientists consider that both statements deserve an equal scientific attention. A “compass” helps in search of a correct fundamental scientific direction.

Here I propose four *Pointers*: P1, P2, P3, and P4, which can serve as the “compass,” as we shall see later.

Pointer P1: Philosophy and Mindset

In my opinion, Einstein philosophy remains the best guidance for theoretical physicists working on new foundational theories. Here are some quotation excerpts from Einstein:

“Physics is an attempt conceptually to grasp reality as it is thought independently of its being observed.”

“No matter how we may single out a complex from nature ...its theoretical treatment will never prove to be ultimately conclusive. ... I believe that this process of deepening of theory has no limits.”[1]

Science is a search for the whole truth about objective reality. We are still at the very beginning of this search. The theory is an imperfect reflection of objective reality. The reality is full of surprises. When mankind is ready, Nature opens its box filled with gems and offers some. Each new theory is more profound than the previous one. The new theory reflects a newly scientifically discovered aspect of objective reality hidden until that point. The reality is supreme – the theory is only an imperfect reflection. The objective reality of our Universe is independent of us as individuals and of mankind as a whole. Science has no limits and no end.

Surprisingly, Einstein, the most important scientist of the 20th century, broke his own rule – he refused to accept a certain aspect of objective reality which he could not force himself to believe in. In contemporary terminology, he rejected *non-local influences* (“action-at-the-distance”) as a property of quantum reality although he was one of the first who noticed the strong indication of wavefunction collapse in quantum mechanics as evident from his presentation at the 1927 Solvey Conference. The rejection of non-local influences was his tragic mistake. When a genius makes a mistake, it is usually of historic proportions. His denial of non-local influences as a property of quantum reality deprived him of a historic opportunity – to bring quantum mechanics to a deeper level.

Pointer P2: Mankind as an Emerging Embryonic-Stage Intelligence and Its Place in the Cosmos

We need an understanding of mankind’s place in the cosmos. For calibration purposes let us go through some numbers: our Universe originated 13.8 billion years ago in the Big Bang; our planetary system was formed 4.7 billion years ago; the first primordial bacteria originated 3.7 billion years ago; the first animal organism originated 590 million years ago; homosapiens emerged from the animal kingdom 2-3 million years ago; our direct ancestors, Cro-Magnons lived 50 thousand years ago; the first civilization was in existence ten thousand years ago; and science as an organized activity began 500 years ago. Based on such calibration, one cannot escape the conclusion that we humans are an emerging embryonic-stage intelligence. We should be proud of what we have been able to accomplish in such a short period of history. Our science is very young. For us to show impatience and declare that we are approaching the ultimate scientific truth, such as the Theory of Everything, is presumptuous and naïve.

How secure is our future in the cosmos? Our planetary system is located *in a habitable galactic zone of Milky Way* [2], far away from a hostile galactic center. Our Milky Way galaxy is located in a quiet cosmic corner, away from other big galaxies. Our Sun will proceed to the red giant expansion stage in about four to five billion years. However, if our Sun would have had a 20% larger mass, we would be already engulfed by its red giant expansion. Of course, in such case the present Earth orbit would be wrong for the origin and evolution of life.

Here is another fact to consider. We are well aware that the Milky Way is on a collision course with our neighbor, the large Andromeda galaxy. But the collision will take place only in about four to five billion years (such a coincidence!). If we were in

the middle of such a collision, then what? Cosmologists would say, "It is not a big deal! Even with two hundred billion stars of Milky Way proceeding on a direct collision with five hundred billion stars of Andromeda, it would be highly unlikely that a single head-to-head, star-to-star collision would occur." That is correct. However, it occurred to me that if we are really serious about *a habitability* issue in our Universe, then we should consider *planetary system-to-planetary system collisions*. A majority of stars have planetary systems which are much larger targets than stars for planetary system-to-planetary system partially overlapping collisions. For example, a cross-sectional size of the Solar system at the extension to the Oort Cloud is 10 trillion times larger than a cross-sectional size of Sun.

Even a small disturbance of the Oort Cloud (and also the Kuiper Belt) would cause an avalanche of debris, including large and giant meteorites and chunks of ice, to travel into the inner space of the Solar system. It would produce a spectacular phenomenon of hundred of thousands comets and real "late bombardment" of surfaces of the planets.

In addition, during the collision, the Milky Way galactic habitable zone would be distorted and our planetary system would end up traveling in an arbitrary direction. It might find itself in a hostile high density star region in the proximity of potential super novae and obscure visibility into the universe. As it is, mankind does not need to worry about the collision with Andromeda. Long before such event mankind would have reached the advanced stage of intelligence and would have freed itself from cosmic constrains and inconveniences. We thus have about four billion years of stable existence on our planet.

The real and more immediate risk to mankind is a potential collision with large asteroids and meteorites wondering into our planetary space. Here we really have to be concerned. Such collisions have happened in the past many times. The last collision with a large asteroid took place 65 million years ago. It was destructive. It eliminated many species including dinosaurs and by chance, or maybe not by chance, opened room for the rapid evolution of mammals. Surprisingly, Earth was able to recover from such injury. It just shows how resilient our planet is.

We must proceed with a sense of urgency with the development of a plan on how to protect our planet against harmful asteroids and meteorites.

Pointer P3: The Principle of Fine Tuning

Let us conceptually put on a table all known fundamental physical constants, such as velocity of light, gravitation constant, Planck constant, mass of electron, etc. Then we get the impression that all those physical constants are totally random with no seemingly interrelationship among them. There is also a strong indication that any change, however slight, in the value of any physical constant brings our Universe from a habitable state to an inhabitable one and cannot be compensated by any adjustment of any other constants. Values of physical constants cannot be derived theoretically. They have to be obtained experimentally.

The collection of physical constants is unique and, in my opinion, represents a *sharp definition* of our Universe, making it habitable [3].

At the present time we have no explanation why such fine tuning exists. Fine tuning is a fact which cannot be denied. I call it *the Principle of Fine Tuning* as an alternative to *the Anthropic Principle* which is somewhat obsolete. Fine tuning is everywhere: in cosmology, in elementary particle physics, chemistry, anatomy, microbiology, the evolution of life, and massively everywhere around us. Should I mention God? I think not. Science and religion do not mix. The invocation of God by scientists shows a sign of desperation. Religion should be left for private use.

One might say that fine tuning would make our Universe deterministic. Not so. Fine tuning is only one factor. There are other factors, such as irreducible quantum randomness. Both factor (and others) drive the development and evolution of our Universe in a creative way.

It would be highly desirable for the scientific community to undertake a systematic research of fine tuning by establishing a specialized branch of science. The alternative is the denial of the law of fine tuning based on a dubious philosophy and rigid mindset. In the final analysis, one cannot deny objective reality of fine tuning, at least not for very long.

Pointer P4: The General Copernican Principle

In objective reality no one entity is assigned an exclusively unique position either in space, time, or substance [3].

This is my contemporary formulation of the General Copernican Principle. It has a tremendous predictive power as we shall see later.

Pointers Testing

Let us select a few examples from foundational physics and cosmology and subject those to Pointers test just to see to what extent Pointers help foundational scientists and philosophers to find a firm ground under their feet.

Test #1. “Our Universe is governed by quantum laws”

For almost ninety years since the time of the founding of quantum mechanics, no substantial progress has been made on its foundational issues. The Copenhagen interpretation still remains the best but together with all other interpretations it is trapped in a deficient paradigm. As a result, quantum mechanics is encapsulated into an epistemic probabilistic theory.

Most quantum scientists and philosophers are convinced that our Universe is governed by quantum laws. If that were true, then here we have an example of the “ultimate statement”. It is in conflict with Pointers P1 (*Philosophy and Mindset*) and P2 (*Mankind as Emerging Embryonic-stage Intelligence*).

If you believe that our Universe is governed exclusively by quantum laws, then you have to believe that the paintings of great masters, classical music, and human emotions all are a product of quantum processes. You also have to believe that

consciousness of living forms of matter including humans, is governed by quantum laws.

Historically, there is nothing new about such “ultimate” claims. Only 250 years ago during the epoch of classical mechanics scientists were convinced that the universe was governed by mechanical forces. In other words, if one knew the position and momentum of every particle, one could predict the future of the universe. Scientists of that epoch believed that the universe was deterministic and functioned like the clockwork. That was “the ultimate scientific truth declaration” and mindset for that epoch.

During the last 250 years science has discovered so many amazing things in cosmology, life sciences, physics, chemistry, microbiology, the evolution of life, and more. Just to list even the most important scientific discoveries would take several pages. Science has been totally transformed. We, an emerging embryonic-stage intelligence, are only at the very beginning of scientific progress. By qualitative linear extrapolation, we should expect a similar total transformation of our science in the next 250 years.

Test #2. “Unification” of the Fundamental Forces of Nature

Theoretical physicists identified four fundamental forces (interactions) in our universe: strong, electromagnetic, weak, and gravitational. Physicists are pursuing with great vigor the theoretical unification of those forces. The Grand Unified Theory (GUT) is a theoretical model for unification of strong, electromagnetic, and weak forces. Unifying gravity with three other forces would provide a Theory of Everything (TOE) [4, 5]. Is such direction for developing GUT and TOE viable? Let us subject this question to the Pointer test.

Obviously, TOE is considered the ultimate fundamental theory in physics. Once it is accomplished, not much is left to do but the application. TOE is the ultimate statement and as such is in conflict with Pointers P1 (*Philosophy and Mindset*) and P2 (*Mankind as Emerging Embryonic-Stage Intelligence*).

In 1860s, Maxwell developed a theory of electromagnetism, a remarkable scientific achievement. That was a beginning of epoch of electromagnetism. Some scientists believe that Maxwell theory is an example of unification of electricity and magnetism. Really? It is not a unification. Electromagnetism is one force. It is expressed in the properties of photons. There is no such thing as the electric photon or the magnetic photon. It is always the electromagnetic photon at any energy. No “break of symmetry” is required.

Another example of unification of electromagnetic and weak forces is still debatable and not settled yet. It requires an experimental confirmation of existence not just of a Higgs particle but of a Higgs boson of the right kind.

Regardless of Higgs boson situation, Pointers tell us that electromagnetic force and weak force shall remain separate forces, independently of the scale of energy and are not unifiable.

The unification of fundamental forces would lead to the ultimate theory in Physics. Pointer P1 (Philosophy and Mindset) tells us that the ultimate theory is not

achievable. Pointer P2 (Mankind as Embryonic-Stage Intelligence) tells us that we, humans, are at the very beginning of understanding the objective reality of our Universe even to talk about “ultimate” .

Test #3. The String Theory

The string theory was discussed in detail by its two vocal critics, Lee Smolin [6] and Peter Woit [7]. Here I offer only a philosophical statement consistent with Pointers.

Our Universe is three-dimensional on all levels: cosmic space, galaxies, stars, planets, living forms of life including humans, microbiological entities such as DNA, macroscopic and microscopic objects, elementary particles, and quantum entities. The objective reality outside of our Universe may have more than three spatial dimensions but we, humans, are trapped in the three-dimensional universe.

The human brain is three-dimensional. The human imagination is three-dimensional. The human visualization is also three-dimensional. Each of us can visualize a three-dimensional cube, which can be stretched or twisted in our imagination but even those with an exceptional IQ cannot visualize a four-dimensional cube. Here is the problem – the string theory is based not on three but on ten spatial dimensions including seven hidden ones. *Progress in natural sciences is not possible without human visualization.* With no progress in natural sciences, evolution of humans from the present embryonic stage of intelligence toward an advanced level is not possible and thus is in conflict with Pointer P2 (*Mankind as Embryonic-Stage Intelligence*).

But evolution is a law of nature supported by the Principle of Fine Tuning (Pointer P3).

The string theory drives development of theoretical physics toward an impasse, providing no visualization, no explanation, no predictions, no applications. It is nothing but exotic mathematics possibly understandable only to a small group of string scientists.

Test #4. Multiverse Theory

Cosmologists have produced several multiverse theories (for example, see [8]). Surprisingly, paradigmatically there is not much difference among them. For my purpose, it is sufficient to consider an original multiverse theory invented by Andrei Linde called Inflationary Multiverse [9]. The driving force in the inflationary multiverse is eternal chaotic inflation which keeps producing an “infinite” number of three-dimensional “pocket” universes with random physical constants and random governing laws, at an ever increasing rate in a four-dimensional space. By definition, all those universes are not suitable for life, they are sterile.

How does the multiverse theory explain that the only universe, our Universe, which is available for studies and observation, is fine-tuned and habitable? The only explanation given is that if you have an “infinite” number of universes, then perhaps one of them could look like ours. But then, it contradicts the General Copernican

Principle (GCP) by presenting our Universe as exclusively unique, thus failing the Pointer P4 test (*the General Copernican Principle*).

The GCP (Pointer P4) also predicts that our habitable planetary system is not exclusively unique – there must be other habitable planetary systems in our Universe. Our habitable spiral galaxy Milky Way with its galactic habitable zone is not the only one habitable galaxy in our Universe. There must be others. In fact, the galactic habitable zone can perfectly accommodate other habitable planetary systems and serve as a “nursery.” Furthermore, the GCP predicts that humans, an emerging intelligence, are not exclusively unique either. There must be others at various stages of evolution. Mankind is somewhat a latecomer [3]. But we still have approximately four billion years time available to us.

In my opinion, our habitable Universe with its individual sharp definition does not have an exclusively unique status either. It is one of a huge assembly of habitable universes in four-dimensional space which comprises what I call Uni-Universe [3]. Each individual universe has its own sharp definition. Each individual universe has a beginning and an end.

As one can see, the General Copernican Principle (Pointer P4) provides a real value for foundational direction.

Conclusion

Predictive pointers help us to arrive with minimum effort at fundamental result, such as:

- Our Universe is not governed by quantum laws, at least not exclusively. There are other factors, such as consciousness.
- Fundamental forces are not unifiable at any energy level.
- String theory is pseudoscience – what a waste of talent and effort. Vibrating energy strings is a misconception. The principal mode of existence of elementary particles is spin. That includes spin-0 particles with two opposite one-half spins. Humans can easily visualize such spinning in 3D space.
- Multiverse theories are misconceptions.

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