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On the Last Challenge of Modern Physics

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Abstract:
Synthesis of the current state of research regarding exploration of causality link between energy and mass.

Objective physical reality

Let us first define what "objective physical reality" really means at the fundamental level.

Over the course of the 20th century, a whole bunch of particles have been identified (or "defined"), that have mainly (but not exclusively) been categorized as part of the Standard Model. They can be sorted out into numerous categories: virtual particles, unstable complex particles, unstable elementary particles, stable complex particles, stable elementary particles, and finally, neutrinos.

Let us now examine these categories at the general level.

Virtual Particles

We can include here virtual photons, which are a mathematical metaphor that Feynman proposed in 1949 in the frame of his new Quantum Electrodynamics, to make easier the mathematical representation of the underlying Coulombian interaction which is always in action between charged particles [1]. This real Coulombian interaction, being dynamic, meaning that it is not quantized but continuously and progressively varying with distance, was much more difficult to represent mathematically with the Hamiltonian method, that was used previously, and that accounted for its unquantized nature than by the Lagrangian method proposed by Feynman, that allowed dealing with it as if it was quantized, by making use of instantaneous momentary states, as if frozen in time, and that he proposed to refer to as "virtual photons".

Let us also include here gluons, which also are pseudo-quantized mathematical metaphors, but this time, of the most probably also progressive interaction although still not fully understood between the scatterable components making up nucleons, in the frame of Quantum Chromodynamics.

There are also various quarks (except quark up and quark down), which also are pseudo-quantized virtual particles that were defined in an attempt to balance the equations of Quantum Chromodynamics to allow a precise calculation for the structure of nucleons.

What allows us to clearly distinguish these metaphorical virtual particles from real particles is the fact that it is impossible to prove their physical existence by having them collide directly with particles the physical existence of which we are absolutely certain, like electrons, for example.

In other words, all virtual particles turn out to be, without exception, simple mathematical concepts.

Unstable Complex Particles

Here we find "particles" such as the various configurations of pi and K mesons, as well as hyperons, which are unstable complex particles still more massive than protons and neutrons, and that are all unstable with life expectancy never exceeding a few fractions of a second.

What is remarkable about these unstable complex particles, that are produced only in high energy accelerators, and as fleeting by-products of cosmic radiation, is that, without exception, the final product of their decay is systematically one or other, or a combination of the only known stable particles, that is, electrons, positrons, protons and photons.

Consequently, these unstable and ephemeral complex particles could all be considered simply as hyper-energetic states of this fundamental stable particles set, and that on short notice, all of them eventually revert to these least energy states after having evacuated all of their excess energy. Any further discovery of more unstable ephemeral particles yet more energetic could only confirm this observation.

Finally, neutrons are unstable when isolated, with an average life expectancy of 16.88 minutes. They eventually decay into two totally stable particles, that is, a proton and an electron. *(See a further comment in the Neutrinos section)*

Unstable Elementary Particles

In this category, we find only particles muon and tau. It is well known that both of these always leave behind a single electron as a solitary massive by-product of their decay besides a few gamma photons.

In a certain way, both muon and tau can be considered as hyper-massive states of electrons.

Stable Complex Particles

In this category, we find only protons, which are totally stable, and also neutrons, when they are associated to protons in nuclei. In this case, neutrons are known to become just as stable as protons. *(Although there exists limit cases in some unstable nuclei)*

Stable Elementary Particles

In this category, we find the photon, the electron, the positron (which is the antiparticle of the electron), the up quark and finally, the down quark.

These particles are considered "elementary", because absolutely all non destructive collision experiments that ever were carried out with them, event he most energetic up to but short of destructive scattering, reveal that they behave in all circumstances as point-like particles, that is, that we have formal proof that they are not made up of smaller particles.

They are considered stable, because unless they are physically destroyed (that is, affected by a collision in such a way that they cease to exist under the form that they previously had, either by combining with another particle or by converting into energy), they have an unlimited life span.

Something peculiar can be observed about these stable particles. It is the fact that they all have spin 1/2 (except for the photon), which characterizes all really point-like particles, and that they all have an electrical charge, positive or negative (except for the photon, once again).

The case of the photon is very special, in the sense that even if it behaves at all times as a point particle, its has a spin equal to 1, which is an unmistakable telltale identifying particles made up of two elements, and that it is electrically neutral.

On this issue, Louis de Broglie brought us however a most promising explaining hypothesis to explain these special characteristics of the photon. Having analyzed at length the characteristics of photons in light of the verified aspects of the various pertaining theories, he drew the conclusion that the only way for a photon to satisfy at the same time Bose-Einstein's statistic and Planck's law, and to perfectly explain the photoelectric effect while obeying Maxwell's equations and conforming to the symmetry property of complementary corpuscles in Dirac's theory, would be for the photon to be made up not of one corpuscle, but of two corpuscles, or half-photons, that would be complementary, like the electron is complementary to the positron ([2], p.277) but that would be so intimately interacting as to explain their point-like behavior.

This conclusion, coupled with the fact that in conformity with Maxwell's theory, he considered that the magnetic aspect of particles can only be dipolar, if we hypothesize that particles are full-fledged electromagnetic entities, and would not be singularities in an underlying wave phenomenon, seems to mandate associating charges (possibly unsigned ?) to each half-photon, and consequently to the photon itself, which would still account for its known electrical neutrality.

What is remarkable about stable elementary particles, is that without exception, we can verify their objective physical existence by mutual collisions with any other particles of the same group.

Presently, it could even be considered that at the fundamental level, physical objective reality can only be made up of the whole collection of discrete electromagnetic particles, whose existence could be physically proven through scattering, in constant electromagnetic interaction, and of the whole collection of the least action trajectories that their electromagnetic interaction forces them to constantly follow in a very precise manner.

Neutrinos

Neutrinos are a very peculiar case in physics. We know since the early 1920's that part of the energy of a decaying neutron seems to completely vanish when it decays into a proton and an electron, meaning that the sum of the energies of the electron and the proton that result from the decay, is almost always (but not always[1]) less than the total energy of the neutron before decay.

Fermi proposed the hypothesis that this unaccounted for energy must be carried away by some sort of new particle that we were as yet unable to physically detect, and that he proposed to name "neutrino". Let us mention that at that time, the variability of the loss at the level of each individual neutron decay had not yet drawn attention. Afterwards, the limit cases for which no energy was lost did not suffice to induce a re-questioning of the concept of the neutrino as a particle.

Let us mention here that particles muon and tau also seem to lose their excess mass in a similar manner, leaving behind an isolated electron as the only massive detectable end product of their decay, besides gamma photons, the process also involving the apparent “disappearing” of an amount of energy.

Even after 80 years of research and experimentation, we still have not been able to physically detect neutrinos by colliding them with other particles in a directly verifiable manner.

But given that the loss is zero in some cases of free neutron decay, unless it can be explained why no neutrino is emitted in these cases, this may be the telltale that the neutrino concept as a particle may not be the right solution to this problem, which would mean that no satisfactory explanation may yet have been found to this variable loss of energy.

The Stable Matter of the Universe

Let us come back now to the set of stable scatterable elementary particles. It must be understood that all of the stable matter in the Universe, that is, all possible stable atoms making up all bodies in the universe are made up exclusively of these stable elementary particles, which, by themselves, are all that is required to describe the only objective physical reality that exists at the fundamental level.

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[1] A seldom documented fact about decaying neutrons (dubbed β-decay) is that in reality, the amount of energy that track is lost of as they decay varies from one case to the other from zero in some cases to an absolute maximum.

This loss is directly dependent on the velocity with which the electron escapes at the moment of actual decay. In some limit cases, the electron escapes with a velocity sufficient for no loss to be measurable while at the other extreme the loss is maximized when the electron escapes with very low velocity.

Quarks up and down are associated in groups of 3 to form the nucleons (protons and neutrons), that is, 2 up quarks plus 1 down quark to make up a proton, and 2 down quarks plus 1 up quark to make up a neutron. The various elements of the periodic table and all of their isotopes are made up of all the possible combinations of these nucleons, and electrons settle on the various possible electronic layers to define the measurable volume of the various atoms.

When a photon is absorbed by an electron in an atom, this excess energy forces it to leave its rest orbital to move further away from the nucleus until it reaches another orbital that exactly matches the increased energy that it just absorbed, or even, to completely escape from the atom if the added energy allows it.

Photons are produced when over-energized electrons in atoms, lose that excess energy under the form of a photon as they fall back towards the nucleus until they ultimately reach the orbital closest to the nucleus that they can possibly reach, that is, the rest orbital, or "least action" orbital for that electron in that atom. Photons can also be produced when nucleons in nuclei lose excess energy in a similar manner.

The Nature of Stable Elementary Particles

Given that all unstable particles turn out to be, when all has been considered, only extremely short lived hyper-energetic states of stable particles, from this point on, we will restrict our discussion to only this stable subset, assuming of course, that all laws that apply to stable particles, also apply to unstable particles.

It was Maxwell who first understood that light had to be an electromagnetic phenomenon, when he concluded that the light that reaches us from the stars was caused by the interaction of an electric aspect of the energy involved acting orthogonally to a magnetic aspect of the same energy, and that the plane determined by the orthogonal relation of these two aspects was moving in the vacuum of space at the speed of light in a direction orthogonal to that plane.

Maxwell perceived light as a wave whose surface, or wave-front, propagated in spherical expansion at the speed of light from the point of origin. But from analysing Wien's experimental results on the black body however, Planck demonstrated mathematically that this "wave" could not be a continuous phenomenon at the fundamental level as Maxwell had concluded, but a discontinuous phenomenon, and that Maxwell's wave could successfully be treated as continuous at the macroscopic level only because of the crowd effect of the innumerable quanta involved at the microscopic level.

Einstein confirmed this hypothesis in 1905, with his photoelectric experiment. Further confirmations were subsequently provided by Compton and Raman.

Doubt was not allowed anymore. Electromagnetic waves such as Maxwell conceived of simply did not exist, because in reality, at the microscopic level, they are made up in an experimentally verifiable manner of innumerable discrete electromagnetic events, that were called photons, each of which being able to be produced only by de-excitation of an electron reaching an orbital closer to the nucleus of an atoms somewhere in the universe or by de-excitation of a quark up or down or of a complete nucleon doing the same inside the nucleus of an atom..

A little later, de Broglie hypothesized that electrons also had to be electromagnetic in nature and consequently also had to have a frequency, which was then experimentally confirmed by Davisson and Germer.

Proof that Photons and Electrons are Made up of the Same Substance

A further step was then taken, which left no doubt whatsoever as to the close relationship between photons and electrons, when Frédéric Joliot and Irène Curie demonstrated experimentally in 1933 that any photon of energy 1.022 MeV or more can de-couple into a pair electron/positron when it is caused to graze the nucleus of an atom [3].

On the other hand, we already knew that there existed a direct link between the energy that an electron accumulates as it accelerates between the electrodes of a Coolidge tube, and that which photons are made of, because after an electron has left the cathode, and has accelerated through the vacuum of the tube, a photon is emitted in the x-ray frequency range at the very moment when the electron brutally slows down as it is momentarily captured by an atom of the anode. We know though experimental verification that the energy of that photon is exactly equal to the quantity of motion (kinetic energy) that the electron was animated with at the moment of its capture, just prior to its slowing down.

Consequently, we have since the 1930's the formal experimental proof that it is possible to convert the quantities of motion (kinetic energy) that accumulate through acceleration of electrons to photon state, and to reconvert photons of energy 1.022 MeV or more to pairs of electron/positron.

In short, we knew from then on that massive particles (electron and positron) were of the same electromagnetic nature as photons and that photons are made up of pure kinetic energy.

Coming briefly back to the issue of neutrinos, theoretical considerations stemming from de Broglie's conclusions regarding the internal structure of photons, and by extension, to that of electrons, lead to think that the energy associated to neutrinos, when muons or tau de-energize or when neutrons decay, could simply be energy that would de-quantify into space as simple free kinetic energy through a process inverse of that observed when energy induced by electron acceleration in vacuum quantify as photons in Coolidge tubes as these electrons are captured by atoms on the anode.

Electromagnetic Mechanics of Fundamental Particles

In the set of stable scatterable elementary particles, the only two other proven stable scatterable elementary massive and charged particles, that is quark up and quark down, have not yet been associated by such a direct link to the sequence of conversion of kinetic energy into electromagnetic energy followed by conversion of electromagnetic energy into massive particles[2] that

[2] Formal proof that kinetic energy induced by acceleration can convert to photons state (converting to electromagnetic state) by a process of bremmsstrahlung, and formal proof that photons of energy 1.022 MeV or more can convert to massive particles electron and positron (conversion from electromagnetic energy state to massive state) when such photons graze the nucleus of atoms.

we just clarified because no attempt was ever made to ascertain such a possible link ever since their existence has been experimentally ascertained in 1968 at the SLAC linear accelerator.

One can wonder why of course, considering that understanding this last missing causality link could possibly have given us access decades ago already to a source of potentially unlimited energy ([13], chapter **The Corona Drive**), immensely superior to even nuclear fusion energy which involves only binding energy between nucleons!

With this last link, we would have mastered at long last the complete sequence of fundamental electromagnetic mechanics of elementary particles.

So, the following question of course comes to mind:

Why has no one attempted to clarify this last remaining causality link since the confirmation of the physical existence of quarks up and down in 1968?

The Obstacles to the Exploration of Objective Physical Reality

The Copenhagen School of Thought and Causality

To understand why this possible link has not yet been explored, we must go back to the end of the 1920's, right after Quantum Mechanics was formulated, combining Schrödinger's equation and Heisenberg's uncertainty based statistical method.

The interpretation that was then made of this method was pivotal in the general giving up of any further causal research that ensued, because the equations of Quantum Mechanics do not allow simultaneously calculating the precise localisation in space and the relative velocity of a particle. With this method, either one or the other can be computed, but never both at the same time, which makes it impossible to define with QM any physical trajectory for a particle, contrary to classical mechanics, which allows calculating any least action trajectory to a degree of approximation quite sufficient to be useful.

By combining this method to the paradoxical notion of wave-particle (two contradictory notions, as we have seen, since an electromagnetic wave would mandatorily spread in spherical expansion from its point of origin, while an electromagnetic particle mandatorily remains localized at all times on a trajectory), which complicated the picture still more, Heisenberg drew the conclusion that even if an electron can be considered to exist as a localized particle when it is individually detected, that is when it stops moving, it can move only as a diffuse wave packet at any other time, the extent of which can theoretically reach infinity and the sum of the energies associated to each wavelet of the packet making up the total energy of the electron.

This conclusion was in total contradiction with simple common sense, which intuitively reveals that in reality, if a precise quantity of energy is emitted as a localized event, it is totally contrary to common sense that if it is detected elsewhere later it would not have followed at all times some least action trajectory, otherwise how could it have sufficiently preserved its integrity to be identified as being the same event?

But Heisenberg, immediately approved by Bohr, now proposed as a fundamental dogma to justify the inability of the wave-function and of the statistical method of Quantum Mechanics to compute least action trajectories of particles, that a discrete quantum of energy, that is, the electron, ceases to be discrete between its point of origin and its point of detection, as if the underlying physical reality that Quantum Mechanics was meant to describe, whatever it happened to be, changed as if by magic to conform to a statistical method invented by man!

In other words, Heisenberg and Bohr simply decreed that least action trajectories of particles could not exist, for the simple reason that a calculation method whose function was the determination of the stationary states of electrons in atoms was incapable of calculating.

The acceptance of such a premise established Quantum Mechanics as the very foundation of reality in the minds of supporters of this idea, and branded as suspect any attempt to explore further a physical reality that would challenge an assumed “ultimately fundamental nature” of Quantum Mechanics beyond which nothing could be further understood.

Many prominent physicists protested forcefully, the most notorious of which being Einstein, de Broglie, Planck, and Schrödinger, sensing here a potential hindrance to further research to comprehend the underlying physical reality more deeply, but nothing could revert the trend. The 1927 Solvay congress confirmed the apparently final triumph of Heisenberg's interpretation, and the history of physics up to now seems to confirm that the worries of the causalists were well founded, since no research whatsoever has been carried out since regarding the nature of the physical reality that underlies Quantum Mechanics and all other theories based on that interpretation.

The debate raged on until the mid 1950's to end abruptly when the most famous defender of causality, Albert Einstein, passed away in 1955, with the complete victory of the Copenhagen-Göttingen interpretation (Cities where resided Bohr and Heisenberg, and that gave its name to that school of thought). The subsequent persistent efforts of de Broglie, Bohm, Vigier, and others, to bring their peers to reason were just as vain as those of Einstein.

Until the end of his life, de Broglie fought this drift: "The energy and quantity of motion of a particle are quantities that are linked to the concept of a localized object that moves in space along a trajectory" ([2], p.13).

For the past 50 years, in all colleges and universities, physicists have been unknowingly trained from the start to think along the lines of the Copenhagen school of thought philosophy without necessarily being made aware of the implications, and if they personally do not question their own philosophical orientation with respect to reality, they naturally tend to not even become aware of the problem ([4]).

The Theories Put Forward by the Promoters of the School of Thought of Copenhagen

Besides the already mentioned Quantum Electrodynamics (QED) proposed by Feynman in 1949, the only important theory that was put forward by the promoters of the Copenhagen school of thought was Quantum Chromodynamics (QCD) towards the end of the 1970's, which was meant to describe the internal structure of protons and neutrons, and which, adopting the trend set by Feynman's Quantum Electrodynamics, makes use of virtual particles to represent the progressive interactions between the scatterable quarks up and down making up nucleons.

It must be made clear here, that even after 40 years of existence, no one has been able to formulate the equations of that theory with sufficient precision to correctly describe a nucleon ([5]), which was its stated justification when it was proposed. But this has not prevented its being flaunted in physics courses as the only possible theory that can describe nucleons.

These two theories, QED and QCD, played a major role in the underestimation, over the course of the past half century, of the importance of the progressive Coulombian interaction at the fundamental level, because they generalized the perception that pseudo-quantized virtual entities could physically represent the as of yet still only partly understood Coulombian potential, which acts progressively between real charged particles during collision and deflection events involving those particles.

Also, the general acceptance in fundamental physics of the static Lagrangian method instead of the dynamic Hamiltonian method, at Feynman's suggestion, was the direct cause of the complete loss of interest for the fact that collisions and deflection events between particles are precise temporal sequences of events. These collisions and deflection events, not being physically instantaneous, there are serious reasons to question Feynman's opinion when he declared in 1949, and I quote:

"In many problems, for example, the close collisions of particles, we are not interested in the precise temporal sequence of events. It is of no interest to be able to say how the situation would look at each instant of time during a collision and how it progresses from instant to instant." ([1], p.771).

Needless to say that I deeply disagree with Feynman, because this research philosophy by interdiction based on principle, has induced the respectful following generations of physicists, to carefully refrain from exploring the last remaining unexplored frontier in fundamental physics for the past 50 years.

Irrational Drift

By constantly mentally juggling with this mix of virtual and real particles, the fine conceptual line that must be drawn between the two types has become blurred in the mind of an ever increasing number of physicists, particularly among the staunchest supporters of the Copenhagen school of thought. To such an extent that many now believe in the physical existence of many of these metaphorical virtual particles, like the top quark, for example, despite the obvious impossibility to cause such a mathematical concept to collide with a real particle, like the electron or the positron.

The situation has become particularly worrisome since these irrational notions have been taught to generation after generation of physics students, most of the time without them being sufficiently being informed of the issue to clearly bear judgement.

So little consideration has come to be recognized to causalists' opinions at the international level that despite his immense stature as one of the last remaining major architects of modern physics, de Broglie's last book was not even translated to English ([2]). All traces of the ideas of the causalist alternative have now completely disappeared world-wide from physics teaching programs.

The contempt towards these major physicists of the past has become such in the physics community that I recently read on a Usenet physics forum, the intervention of a physicist, pupil of Wheeler, asserting quite seriously to apparently agreeing parties that de Broglie probably received his Nobel Prize for political reasons! One can wonder, can't we, about the reasons why such an important player as Louis de Broglie, one of the finest theoreticians on electromagnetisms of the 20^{th} century, is the object of such a level of contempt on the part of some contemporary physicists!

For the past 50 years, all physicists who even hinted that they tended to lean towards causalist ideas have been considered by their peers as "men who could not follow the trend of the ideas of their time" as already mentioned by de Broglie in 1955, in the Preface of his book "Nouvelles perspectives en microphysique", speaking of the opinion that the supporters of the school of Copenhagen then had of Einstein.

No article proposing an avenue of research towards the physical reality underlying Quantum Mechanics has been accepted for formal publication in specialized journals since the beginning of the 1960's.

Hyper Specialization and Compartmentalization of Disciplines

Another very insidious problem also is at play that blurs the issue still more. It is the tendency to hyper specialize and compartmentalize the various disciplines at the university level, that has been on the increase ever since the 1940's.

To such an extent in fact, that no single physicist, in our day and age, has an expert knowledge of every aspects of his own field. All modern reference works have been written by great experts of each sub-speciality, who often only have the most general notions of major other sub-specialities of their own field.

Over time, as sub-specialities kept being separated, reorganized and eliminated, important papers eventually ceased completely to be referred to in reference works written subsequently, and have thus completely disappeared from the collective consciousness in the physics community, even though they are still available in the humongous mountain of past writings.

A few exemples:

1. The important conclusions of Abraham and Kaufmann relative to the distinction that must be made between longitudinal and transverse inertia, key to the calculating the correct angle of deflexion of the trajectories of photons by gravitational attraction in the frame of classical mechanics ([6]), ([7]), ([11]). No contemporary physicist seems to have heard about the total insensitivity of moving quantities of motion (kinetic energy) to transverse interaction that was discovered by these major physicists.

2. The awareness that the level of saturation of the hydrogen basin in the only successful explosive fusion experiments that were carried out, by the neutrons produced by the fission detonator during the initial phase of fusion, no doubt had a major role to play in the triggering of the fu-

sion process ([8]). In that precise case, one can understand that the interdiction imposed for decades for reasons of military security, to write explicitly about nuclear fusion in reference manuals could have caused the loss of this information. The book "The Atomic Nucleus" ([9]) is a perfect example in this regard, not even mentioning the terms "fusion" or "hydrogen" in the Index at the end of the volume, and of course, not even discussing hydrogen fusion in any way, shape or form, contrary to Nahmias's book ([8]) which was published in a different country in the same decade.

> Could this apparent loss be partly responsible for the difficulties met by physicists teams, most probably taught about nuclear physics with such reference manuals, who have been attempting without success for the past 50 years to produce controlled thermonuclear fusion by simply increasing the temperature of the mix, but without adding free neutrons to the mix?

3. De Broglie's important conclusion regarding the possible internal structure of photons, which, in conjunction with Abraham and Kaufmann's discovery regarding the insensitivity of kinetic energy to any force applied transversally, seems to be the very key to building the last missing causality link between the quantities of motion that accumulate through electromagnetic acceleration of particles and the energy that quarks up and down are made up of ([10]).

In our day and age, to acquire a level of general knowledge in physics that would compare to that mastered by the physicists of the beginning of the 20th century, an individual would have to read tens of very specialized books, each using a mathematical language adapted to that sub-speciality, which is not really possible within the constraints imposed by a normal academic education.

This state of hyper specialization of each physicist has caused recent experimental observations, the likes of which threw physics circles into frenzied effervescence at the beginning of the 20th century, and sent every physicist of the time into an unbridled race to discovery, to be taken on today with the deepest of apathy, each physicist being under the impression that some "experts" in this new field are taking charge somewhere else, and that they will eventually be informed of the answer, none of them feeling particularly competent to deal with the issue.

The hurdle here is that the too high a degree of specialization of each physicist forces the setting up of pluridisciplinary teams, teams that seem not to always succeed in sufficiently inter-relating their respective bits of expert knowledge to conclude in a satisfactory manner.

We have had a very telling example of this problem over the course of the past 10 years in the case of the acceleration deemed "anomalous" ([12]) of far spacecrafts Pioneer 10 and 11, for which the equations of General Relativity have been unable to calculate the observed hyperbolic trajectories, and of their seldom documented axial slowing down ([12], p.23), also deemed “anomalous” for which no current theory provides an explanation.

Descartes wrote very judiciously: "Often, there is not as much perfection in the works made up of many pieces, and done by the hands of many masters, than in those on which only one has worked. Consequently, we can see that buildings planned and completed by a single architect, are more beautiful and well ordained than those on which many have tried to patch up, by using old walls that had been constructed for other purposes."

Conclusion

I am convinced that reason will eventually prevail again in fundamental physics, because it is the only means at our disposal to finish exploring the only physical reality that exists, the full comprehension of which is required for the survival of our species, and of which Quantum Mechanics, through the interpretation of the Copenhagen school of thought, offers only the palest of reflection and no perspective of real progress.

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