Exploration

Theoretical Physics between Adjacent Realities

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Abstract

We introduce and develop the idea of adjacent realities - the mesostratum and physiostratum - to establish a new viable foundation for theoretical physics. The interplay between the adjacent realities must be considered and incorporated in any theoretical attempt to clarify and understand the origin and operation of the physical world in which we reside and which we observe and evaluate empirically and theoretically.

Keywords: Quantum state theory, entanglement, adjacent realities, Mesostratum, Physiostratum.

1. Introduction

Quantum mechanics which deals with the notion of quantum state has always posed philosophical and theoretical problems. Theoreticians have contended that quantum states represent potentiality, not reality. Quantum non-local entanglement is a problematic state because quantum theory asserts that it is not a potentiality. Quantum entangled systems are putatively correlated across the cosmos instantaneously. One of two entangled particles, even if separated by billions of light years distance, responds instantly to a change, say spin vector, of the other. These problematic areas and enigmas have been reviewed [1]. We offer a resolution based on adjacent realities, the mesostratum and physiostratum, and conclude that non-local entanglement may occur within the mesostratum reality but not the physiostratum reality.

2. Tutorial Review

All potential quantum mechanically-predicted outcomes of any empirical measurement are regarded as real although we perceive only a specific outcome. This has been linked with the notion that the observer's brain is part of the quantum state and is therefore strongly correlated with the outcome. The quantum mechanical evolution of the relevant wave function is regarded as deterministic, although it is unable to predict the outcome of an experiment - that is, it fails to anticipate the observed result. We cannot anticipate which aspect of the wavefunction predicts our future state of mind - our observation. Although we perceive quantum mechanical randomness, we remain convinced that the universe is deterministic, from our local perspective.

Quantum mechanical rules for computing probabilities fail to explain the system. The main hurdle is the Born rule which states that quantum mechanics gives the probability that a measurement on a quantum system will yield a given result. It states that the probability density of finding the particle at a given point is proportional to the square of the magnitude of the particle's wavefunction at that point.

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The problem of probability in the Born view of quantum mechanics arises because there is an inherent splitting of inferable and observable worlds - unrelated to the Born probabilities. The challenge is to show the existence of probability in the context of completely unitary time evolution of the wavefunction. It was expected that this paradox may be resolved with the Bayesian interpretation of quantum probability.

Bayesian probability evaluates the probable applicability of a given hypothesis. Bayesian probability specifies some prior probability, which is then updated to a posterior probability in the light of new, relevant empirical data. The Bayesian approach is expected to provide a set of procedures for performing quantum mechanical calculations. The Bayesian approach is an extension of propositional logic that enables reasoning with hypotheses, i.e., the propositions whose truth or falsity is uncertain. In the Bayesian approach, a probability is assigned to a hypothesis, whereas a hypothesis is typically tested without being assigned a probability

Bayesian probability is a concept of probability in which, instead of demonstrable empirical frequency or propensity of some phenomenon, probability is interpreted as reasonable expectation representing a state of knowledge or as quantification of an informed belief. The objectivist view holds that probability is a reasonable expectation which represents the state of knowledge, an extension of logic. The subjectivist view holds that probability quantifies implicit personal belief, justified by rationality and empirical coherence.

It has been argued that quantum information theory may help solve the puzzles of quantum mechanics. One such proposal holds that of information theory simply reinterprets immaterialism and instrumentalism. Immaterialism adopts the view that the world consists not of physical objects but of immaterial ones which transcend the material and consist of pure information. Instrumentalism is the view that the task of science is to provide a tool for making predictions but not descriptions of fundamental objects and governing laws. Instrumentalism argues that the quantum state is merely a representation of information, allowing predictions of experimental results, but not a description of a fundamental reality.

The many worlds interpretation is a transcendent interpretation of quantum mechanics which asserts the objective reality of the universal wavefunction and denies the objective reality of wavefunction collapse, i.e., the reality of any empirical observation such as the actual detection of a quantum particle, say a photon, impingement on a photosensitive screen or the human retina. The many worlds idea implies that all possible alternate histories and futures are real, implying simultaneity of an infinite number of parallel worlds.

The many worlds interpretation is currently considered a mainstream interpretation in physics and philosophy - along with the other decoherence theories - including the historical Copenhagen interpretation and hidden variable theories such as the Bohmian pilot wave theory. Before many worlds became prevalent, objective reality had been viewed as a single unfolding history. Many worlds has been accepted because it reconciles the observation of non deterministic events, such as random radioactive decay, with the fully deterministic equations of quantum physics. In many worlds viewpoint all worlds are but wavefunctions wherein the appearance of wavefunction collapses are explained as quantum mechanical decoherence, putatively resolving all the correlation paradoxes of quantum theory since every possible outcome is self-defined in its own world.

David Bohm proposed the idea that the whole universe is in some way enfolded in everything, and that each thing is enfolded in the whole, everything enfolds or implicates everything. The implicate order prevails as the most fundamental aspect of the universe as currently known to us. It ultimately represents an active and essential aspect of each observable entity. External relationships are then displayed in the unfolded or explicate order in which each thing is observed, measured, defined. The explicate order, which dominates ordinary experience thus appears to stand by itself. But, it cannot be understood apart from its grounding in the primary reality of the implicate order, the mesostratum reality.

The quantum world of the mesostratum reality is apparently devoid of space and times as reckoned in the physiostratum reality. In the mesostratum, instantaneous action or transfer of non-local information does appear to be possible, according to quantum mechanics theory. This is in direct contravention of the Einstein's 'principle of locality' or the 'principle of local action' the idea that distant objects cannot have direct influence on one another, and that an object is directly influenced only by its immediate surroundings, an idea on which physiostratum physics is predicated. Nonlocality suggests that universe is profoundly different from our local understanding of it. But given the mesostratum reality and foundational quantum mechanics theory, separate parts of the universe are potentially connected in an immediate non-local way.

In this paper, we identify attributes of implicate order as implicit features of the mesostratum, the energetic foundation of the physiostratum, which is in turn the observable material reality in which we reside and conduct experiments. It is appropriate to first consider the spacetime background of the physiostratum.

3. Attributes of Spacetime

Space and time have been assigned aspects of empirical reality by geometers who invented the language and algebra of dimensionality. Prior to that, space and time were indifferently perceived as amorphous realities, devoid of metrics. Initially a tabulae rasae, with metrics, space and time became mathematical objects, e.g., geometric manifolds with measurable attributes: shapes, distances, topology, intervals. Euclid and other ancient geometers gave spatial dimensions axiomatic meaning by positing mathematical objects such as lines, triangles, circles, spheres, cubes and other regular and irregular geometric solids. Descartes recognized relations among geometric points and temporal instances, giving them meaning by means of algebraical coordinates and equations. This was followed by the notion of multi-dimensional spaces and synthetical spaces which ostensibly produce quantum particles, quantum waves and force fields that interact energetically. Theoreticians imbued space and time with dimensionality, material attributes and properties.

The notion of four dimensional spacetime was introduced by Hermann Minkowski and elaborated upon by Albert Einstein in his general theory of relativity. Current concepts of spacetime are not restricted to just four dimensions. In an attempt to explain quantum particles and waves, string theory posits a ten-dimensional hyper-spacetime. M-theory, an elaboration of string theory, posits hyper-dimensions which reside unnoticed in Minkowski spacetime.
To make string theory mathematically consistent, the strings must have ten dimensions. This

contradicts the experience that our world has four dimensions: three space dimensions and a time dimension. String theorists explain that the additional six dimensions exist but cannot be detected directly because they are compactified sophisticated mathematical objects. The number of dimensions was later increased to 11 based on various interpretations of the 10-dimensional theory that led to five partial theories combined under M theory, a theory that unifies all consistent versions of string theory.

The M-theory, first conjectured by Edward Witten in 1995, is incomplete, but the underlying structure of its mathematics has been established and agrees with all the string theories and has passed tests of internal mathematical consistency. No experimental support of M theory exists and it is doubtful that it will ever lead to a physical theory describing our real world. M theory has mathematical elegance but may continue to reside in mesostratum as a potentiality.

If we can assign four dimensions to spacetime, we can keep adding more dimensions, if needed, to satisfy and perhaps never quench the thirst theoreticians have for even more multidimensional sub-spaces. Synthetical spacetime manifolds are considered to be able to manifest as physical objects. Various vibrational modes of these manifolds have been taken to be the origins and constituents of quantum particles, fields and forces that pervade the cosmos. Spacetime origami has emerged as a tool to fold-forge a variety of quantum particles.

Roger Penrose decries the multitude of compact extra space dimensions of string and M-theory although they may well lead to an ultimate destination and next level of understanding. In his view, that destination resides in twistor space which he studiously sets apart from the domain of Minkowski spacetime. Twistor space is envisioned as a separate domain which coexists with and complements Minkowski spacetime [2]. We posit the mesostratum to include Penrose's twistor space.

In the section Adjacent Realities and the Particulate Cosmos we adopt the notion that strings exist in the mesostratum and that they vibrate in multiple dimensions, and depending on how they vibrate, might be seen in physiostratum space as matter or energy, specifically that the appearance of particulate matter is the result of the vibration of strings.

4. Spacetime Voxel Substructure

The cubic nucleon model employs a radical approach to visualizing the substructure of nucleons and the function of quarks [3]. Still, the model agrees with the essential properties of previous models - combining their strengths while not introducing paradoxical properties, contradictory ideas, or unrealistic parameters. Established concepts, such as quark containment and nuclear binding forces are used in an unique way in the cubic nucleon model and these strengthen its underlying rationale.

Lee Smolin, in *Three Roads to Quantum Gravity*, explains that according to loop quantum gravity theory, there is an atomic structure to space, describable in terms of the nodal spin networks devised by Roger Penrose (*The Road to Reality*). The most improbable and puzzling aspect of this atomized space is its apparent smooth and continuous nature. The apparent

continuity or smoothness may be because the granularity of space and time are on the scale of Planck length (10^{-33} centimeter) and Planck interval (10^{-43} second). We are currently unable to detect or measure these infinitesimal quantities and therefore must rely on imaginative approaches to deal with Planck-scale spacetime voxels that the cubic nucleon model envisions for nucleons and nucleus architectures.

The cubic nucleon model assumes that spacetime is particulate - that spacetime is a fractal substance consisting of energetic four dimensional spacetime parcels - cubical volumes (voxels) of space that oscillate in time. The voxel - the cubic unit spacetime parcel - is proposed as a fundamental unit cube common to all elementary particles (neutrinos, electrons, positrons) and nucleons (neutrons, protons, quarks). This is useful for developing the cubic nucleon model for nucleon substructures and nuclei architectures [3].

In 1936, Einstein expressed the rather contradictory, counter-intuitive notion that "perhaps we must give up, by principle, the spacetime continuum." The cubic nucleon model adopts the principle of spacetime as a particulate discontinuum. Indeed, this corresponds to relativity theory treatment of spacetime as a deformable substance - like the gravitational deformation of adjacent spacetime by the sun. Einstein posited a deformable spacetime, that is, a substantive material-like spacetime. The calculus of his theory of relativity demanded it.

Dimensional analysis of Einstein's equation, $E = mc^2$ indicates a profound relation between the ratio (E/m) and the space/time ratio [L/T]. The explicit meaning of the equation is that nuclear binding energies and mass defects are related - that matter (mass) and energy are interchangeable and complementary. The implicit meaning of $E = mc^2$ is that energy and mass are essentially properties of space and time, that is, space-displacement [ΔL] and time-interval [ΔT]. Accordingly, we assume that select spacetime parcels (voxels) have energy and mass and contribute energy and mass - when combined as components of sub-atomic particles. This idea is applied in the abstract representations of nucleons and nucleus architectures. The genesis of cubic neutrons and protons is given in the section Adjacent Realities and the Particulate Cosmos.

5. Mesostratum Reality and Attributes

We posit the mesostratum in place of ether, which early in the last century was considered a substance that carries light waves. This was disproved and abandoned. It can be demonstrated that light waves, indeed all electromagnetic waves and fields, transpirate in the mesostratum (a hyperspace continuum, not a substance, transcending gravitational physicality by definition). This reality has been obvious since Thomas Young's double slit experiment and the Michelson–Morley interferometer experiment [4].

The main burden of this paper is to demonstrate the reality of the mesostratum. A leap of blind faith is not needed. One need simply observe that just as Platonic perfect forms and mathematical objects exist, Schrödinger wavefunctions, electron orbitals, probability functions, magnetic fields, electromagnetic waves, light waves, and other such continuumthings exist; and the mesostratum exists and is necessary to subsume them. It is apparent that mesostratum continuumthings like informational signals and mathematical objects transpirate outside and

independently of the particulate physiostratum and its granular spacetime.

Continuumthings, like Plato's perfect forms, can only exist in the mesostratum hyperspace. Continuumthings are inherently energetic and influence/govern the dynamic behavior of quantumthing gravitational agglomerations in the physiostratum. Schrödinger's wavefunction, is a continuumthing; it is essentially a mathematical invention that predicts probabilities regarding the quantum state changes of an energetic signal system with respect to time and space. The reality of the wavefunction is unquestioned because it describes the evolution of the quantum system's state. The endpoint event, which is detected which is consciously experienced and observed in the physiostratum - is a wavefunction collapse during which according to John von Neuman, 'a miracle happens!' The miracle is that a specific quantumthing suddenly appears here after being emitted way over there. The mystery is what happens while the quantumthing is in transit in the mesostratum, decoupled from the physiostratum, before being redelivered to the physiostratum. The wavefunction evolution scenario which apparently plays out entirely in the mesostratum is empirically unmeasurable; the collapse alone is manifest, when a quantumthing suddenly lands in a physiostratum gravitational agglomeration of quantumthings and is observed - is detected/measured.

Since the mesostratum waveform evolution scenario is not observed, it may be declared to be a non-reality, reinforcing the notion that the only reality is one that is observed and measured. We might say that neither the mesostratum nor wavefunctions are objectively real and are therefore sufficiently transcendent to be dismissed by reductionists, empiricists, naturalists. The idea of the mesostratum and its presumed attributes are nevertheless useful because they help explain the operation of strings, quantum entanglement, non-locality, and other esoteric phenomena as transcendent extra-physical entities, adjacent to the physiostratum.

String theory was developed to describe the nature of quantum particles. In theory, strings are basic physical entities - different vibrational states of which represent the different elementary particles. A string can be visualized as a mathematical object in mesostratum hyperspace. In some versions of string theory, strings generate two dimensional extended objects called branes (an apocope of *mem*branes). Theorists posit multi-dimensional manifolds, mathematical objects, that require many more than just four dimensions in mesostratum hyperspace (*Shape of Inner Space*, Shing-Tung Yau). In string and M-theory these extra, six or more dimensions, are 'infinitesimal'. String theorist say that these extra dimensions are not observed because they 'curl' up tightly in physiostratum spacetime. We hold that they are unobservable simply because they are continuumthings in the mesostratum and cannot exist in the physiostratum particulate spacetime.

While each exists within its own unique domain, the physiostratum and mesostratum are adjacent. The physiostratum is conceptually a subset of the mesostratum. We are aware of the mesostratum not as an objective reality, but indirectly because of its influence on physiostratum, primarily at the quantum level. The mesostratum's transcendent reality is demonstrated by considering photons in transit. When photons (light waves) traverse the mesostratum, they are decoupled from the physiostratum while in transit from a physiostratum source/emitter to a physiostratum receptor/detector (photo emulsion, CCD array, or human retina). The decoupling is self-evident because the velocity of light is a constant independent of the velocity of the

photon source/emitter. This was famously demonstrated by the Michelson–Morley experiment in 1887. Photons (light waves, electromagnetic radiations) return to the physiostratum objective reality as quanta of energy - absorbed by agglomerate gravitational matter, e.g. detector screens, retinae. We suspect that there is an osmotic interface between the physiostratum and mesostratum. This conceptual interface facilitates the interplay between intangible quantum states and tangible aspects of particulate matter.

6. Nature of Mesostratum Signals

It is easy to conclude that all mesostratum signals consist of electromagnetic language. But we must assume that they are unlike radio and internet Wi-Fi modem signals which are coherent and channeled and may be immediately recorded, audited, and displayed without conscious processing - any processing is purely algorithmic and based on machine architecture and programming, Similarly, one may imagine a parallel between information conveyed by photon signals impinging the retina and optic and cerebral neural network vision processes. The mesostratum presumably has *wireless* signal origination, exchange, and transmission capabilities. The mesostratum signals and dynamic fields which transmit information and energy are not necessarily restricted to electromagnetic waves and fields. It is inadvisable to exclude the possibility of other kinds of signals - signals far stranger than the familiar electromagnetic waves that figure so prominently in terrestrial technologies.

It is uncertain if mesostratum signals have been empirically observed and measured. Application of diverse informatics methodologies may ultimately demonstrate that mesostratum signals and fields are empirically retrievable, resolvable, albeit essentially transcendent. Arguably, the most effective instrument for retrieving and processing these transcendent signals is the human mind - specifically of individuals with the will and unique capability of applying, perhaps meditatively, their transcendent minds - individuals like Srinivasa Ramanujan, Leonard Euler, John von Neuman who, either by force of will or effortlessly, can access and explore the mesostratum and deduce physiostratum-relevant mathematical objects and theory.

7. Adjacent Realities and the Particulate Cosmos

The Bohm's implicate order assumes the *wholeness* of the observing instruments implicitly combined with the exotic quantum entities and phenomena which are observed. We will argue that implicate wholeness cannot be understood unless it is recognized as the intertwining of two adjacent realities: the mesostratum and physiostratum. We suggest that any further progress in quantum theory depends on the understanding and development of the adjacent realities concept and of new mathematics that describes their interrelation - assisted by intuitive insights regarding fundamental phenomena apart from empirical findings.

The wave function and associated spin, charge, and momentum specify the state of subatomic entities during transit within the mesostratum continuum while their mass and particulate nature specify their specific locations within physiostratum massive agglomerations, as for example on

detector screens. Wave functions, strings, branes, and similar mathematical objects are mesostratum 'continuumthings' while quantum 'particles' are physiostratum 'discontinuumthings' - material empirically-knowable aspects of discrete entities, for example, neutrons, protons, deuterons. The adjacent realities, mesostratum and physiostratum, interact and form the objective reality which is observed and measured in the physiostratum material discontinuum which is coupled to and originates in the mesostratum energetic continuum [3].

Figure 1 illustrates a conceptual spontaneous ZPF (zero point field) generation of a particle-antiparticle pair by a mesostratum string interacting with a slice of the physiostratum spacetime voxel fabric. The emergent pair typically consists of an electron and its anti-particle, a positron. Figure 1 shows a string loop intersecting spacetime and the appearance of an electron-positron pair. As the string loop interacts with the physiostratum spacetime parcels, spacetime voxels are converted into particles - as an electron in one voxel and as a positron in another voxel. Figure 1 depicts the particle pair being encapsulated in a primordial neutron - without annihilating and vanishing from the physiostratum.

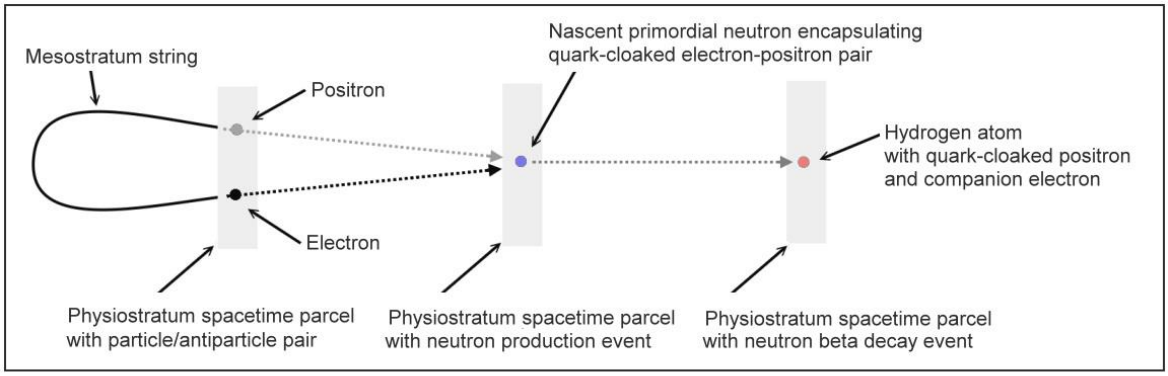

Figure 1 - Conceptual depiction of mesotratum-generated atomic particle emergence in physiostratum spacetime.

We surmise that the nascent cosmos was densely populated with spontaneously-generated primordial neutrons - a proportion of which beta decayed into protons by the process depicted in Figure 2. It is patent that a significant proportion of the new protons immediately fused with adjacent neutrons forming dense populations of quark plaque-triplet-bonded deuterium modules which comprise all atomic nuclei in addition to isolated protons which captured an emitted electron to form protium atoms [3].

Primordial neutrons appear, envelope, and halt the recombination and mutual annihilation of electron and positron pairs. Neutrons transform and encapsulate the eight voxel components of nascent generation 1 electrons and positrons. Annihilation is apparently prevented by the neutron encapsulation process. The neutron functional design is apparently such that it serves as the basis for establishing a physiostratum filled material entities: protons, protium atoms, and ultimately a vast range of deuteron-based atomic nuclei, dark matter, stars, galaxies - which contribute to the cosmic particulate flux [5].

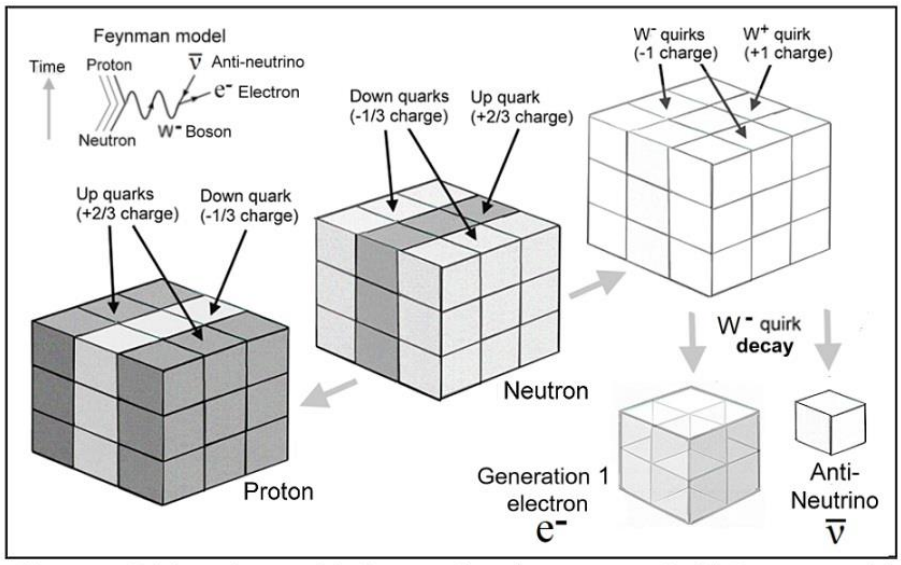

Figure 2 - Cubic nucleon model of neutron beta decay compared with Feynman model.

We propose that mesostratum continuum entities generate the particulate content of the physiostratum piecemeal, quantum by quantum. A measure of this is the Planck quantum of action [6]. A continuous, non-discrete, non-quantized flow and expenditure of energy from the mesostratum to the physiostratum would be a profligate and unsustainable expenditure of an infinite amount of energy.

8. Discussion

The transition of a *virtual particle* from the mesostratum to become a *physical particle* in the physiostratum involves a complex and poorly understood process. Particles apparently originate in the mesostratum reality which we define as an intrinsically mathematical continuum. The particles appear in the physiostratum reality which we define as a physical discontinuum. The mesostratum in this sense may well house an infinitude of potential worlds (the many-worlds concept), but what appears in the physiostratum spacetime evidently evolves according to strict and specific rules such as those that produce primordial neutrons and subsequent protons, deuterons, and atomic nuclei, in the manner described previously [3].

Theories of quantum states and representations of the origin and nature of particles in physiostratum space and time are vague and probabilistic because they focus virtually exclusively on the mesostratum continuum. Spacetime voxels, cubic lattice nucleon structures, and associated hidden or obscure variables between the physiostratum and mesostratum should be included in quantum mechanics theories and computations [4].

It is logically inconsistent that the terms universe and cosmos are used interchangeably in the scientific and popular literature. The cosmos is properly called the observable portion of the universe. The material or particulate content of our world, the cosmos, is not apparent unless subatomic and atomic particles agglomerate massively as brains, rocks, planets, stars, etc. The cosmos is thus becomes a knowable, tangible, measurable, observable aspect of the universe.

Conversely, the universe, as represented by the mesostratum reality, is virtually unknowable, unobservable. Since elemental quantum particles that emerge and populate the cosmos apparently originate from the energetic mesostratum, it is important to develop understanding of the processes that transpirate between the adjacent realities of the mesostratum and physiostratum.

The mystique of neutrons arises because neutrons appear, envelope, and halt the recombination and mutual annihilation of electron and positron pairs. Neutrons transform and encapsulate the eight voxel components of nascent generation 1 electrons and positrons. Annihilation is apparently prevented by a process that reduces electron and positron voxel module electric charges by 'sub-quantum' multiples of 1/3. The neutron functional design is apparently such that it serves as the basis for establishing a physiostratum filled material entities: protons, protium atoms, and ultimately a vast range of deuteron-based atomic nuclei, dark matter, stars, galaxies - which contribute to the cosmic particulate/dynamic flux - as represented by Figure 6.

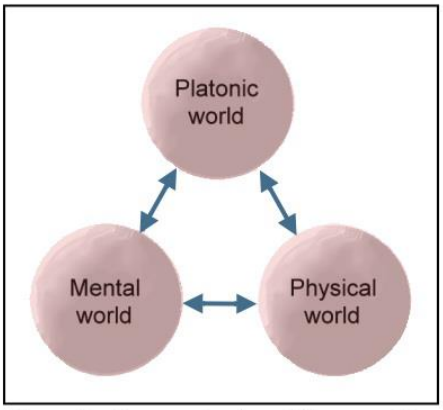

Figure 3 - Communication of three worlds.

John Archibald Wheeler proclaimed that "No phenomenon is a real phenomenon until it is an *observed phenomenon*." Wheeler added, "We are participators in bringing into being not only the near and here but the far away and long ago." He was alluding to our involvement in a grand cosmic scenario which we experience and contemplate here and now. This notion is depicted in Figure 3 which represents Roger Penrose's (*The Road to Reality*) concept of the interrelation among three worlds as conceptualized in the Copenhagen interpretation notion that the observer's brain is part of the quantum state and is therefore strongly correlated with the observed measurements. The human mind (mental world) transcends the its neural network and resides partly in the mesostratum reality (Platonic world) as well as in the physiostratum reality (physical world). This is consistent with our argument that the best available instrument for retrieving and processing transcendent signals and information from the mesostratum is the human mind [7].

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