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I give below the abstract of my paper to be presented at the Delhi seminar on March 1,2 and 3.
Best fregards
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Scientific Approaches to Consciousness Studies

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Abstract:

Most biologists have held that mental activities including consciousness are just physico-chemical activities of the brain.The neuroscientists have been able to map out in great detail these physico-chemical and electrical and electronic processes in the various cortices of the brain, in the billions of neurons that connect the cortices to various parts of the brain itself and to other organs of the human body and to the sensors like the eyes,ears , nose, etc., which receive inputs from the outside world.They are trying to establish spatio-temporal correlates in terms of action potentials and neurotransmitter chemicals.If that is all there is to the functioning and definition of consciousness,then consciouness itself must be capable of being explained in terms of the more basic concepts of all sciences namely in terms of concepts like mass,energy,space,time,force, causality and so on.However, experience tells us that while the electical signals and the chemicals belong to one category of knowledge , sensations,feelings,cognition,insight, memory etc., which we associate with consciousness belong to an entirely

different category that cannot be understood in terms of the above concepts only.The real problem of consciousness from the scientific point of view is to bridge this gap.
In the history of physical sciences,there have been many occasions when the scientists were faced with similar barriers.These were surmounted by (1) total modification of the prevalent concepts themselves (2) recognizing the existence of an ultimate substratum that interconnects everything and whose activities are responsible, in the ultimate analysis, for all the happenings in the universe including cration of space,time, matter,force etc and(3) emergence of new forms,effects from the coherent activities of the constituents.
Typical examples of such instances will be presented and the need and relevance of similar transcendent approaches,of-course, well within the framework of science, to the solution of the consciousness problem will be discussed.

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Scientific Approaches to Consciousness Studies*

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Abstract:-

Most biologists have held that mental activities including consciousness are just physico-chemical activities of the brain. The neuroscientists have been able to map out in great detail these physico-chemical and electrical and electronic processes in the various cortices of the brain, in the billions of neurons that connect the cortices to various parts of the brain itself and to other organs of the human body and to the sensors like the eyes, ears, nose etc., which receive inputs from the outside world. They are trying to establish spatio-temporal correlates in terms of action potentials and neurotransmitter chemicals. If that is all there is to the functioning and definition of consciousness, then consciousness itself must be capable of being explained in terms of the more basic concepts of all sciences namely in terms of concepts like mass, energy, space, time, force, causality and so on. However, experience tells us that while the electrical signals and the chemicals belong to one category of knowledge, sensations, feelings, cognition, insight, memory etc., which we associate with consciousness belong to an entirely different category that cannot be understood in terms of the above concepts only. The real problem of consciousness from the scientific point of view is to bridge this gap.

In the history of physical sciences, there have been many occasions when the scientists were faced with similar barriers. These were surmounted by (1) total modification of the prevalent concepts themselves (2) recognizing the existence of an ultimate substratum that interconnects everything and whose activities are responsible, in the ultimate analysis, for all the happenings in the universe including cration of space, time, matter, force etc and (3) emergence of new forms, effects from the coherent activities of the constituents. Typical examples of such instances will be presented and the need and relevance of similar transcendent approaches, of-course, well within the framework of science, to the solution of the consciousness problem are discussed.

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1. Neurosciences and Consciousness:

Most scientists, particularly biologists subscribe to the view that all mental activities including consciousness are just physico-chemical processes in the brain and in its accessories. This view is superbly exemplified by the hypothesis of Francis Crick,[1] which he calls the `astonishing hypothesis' stated as follows:

> "your joys, your sorrows, your memories and your ambitions, your sense of personal identity, your free-will are all in fact no more than the behaviour of vast assembly of nerve cells and their associated molecules".

Following the anatomical studies that led to the identification of various cortices of the brain for particular functions, the neuroscientists in the past several decades have mapped out in great detail the physico-chemical, electrical and electronic processes that occur in the various cortices of the brain in the billions of neurons that connect to the sensors - the eyes, ears, nose, skin etc associated with particular perceptions, cognitions, memories, etc. What is amazing is that though the different sensors respond to different physical inputs like light, sound, heat, pressure etc., the outputs of the sensors are all very similar electrical signals, the specific information being coded in the form of bursts, multiple neuron discharges and time sequence of single and multiple bursts and so on. These signals preferentially get aborted or are modulated further at the various synapses based on inputs from dendrites which connect to neighbouring neurons. The nature of final response depends on the particular cortex to which the neuronal information gets fed. The visual information becomes manifest if the neuronal pulses go to the visual cortex, the sound becomes manifest when the neuronal pulses from the ear go to the auditory cortex and so on. The crucial question that remains unanswered yet is: what is it that correlates all this information and gives meaning to whatever is happening? This according to popular beliefs is really the business of Consciousness. Where is this consciousness located in the brain? And in what form?

Apart from cognition of the external world, the sights, the sounds, the textures, etc, consciousness also has to account for thoughts, memories, flashes of insight etc. There is no identification of specific regions of the brain that consciousness uses to perform these functions as well.

Essentially in all this we are dealing with two kinds of experiences as depicted in Table 1. During the simple act of observing a flower, the happenings in the brain can in practice be recorded with instruments of various kinds. In the other, mind (or consciousness) comes into play and no instrument has been designed so far to record the happenings. Even for the first, instruments alone will not suffice.

TABLE 1

Two kinds of experiences generated in the individual who looks at a rose flower.

.A (Physicalism) What happens in the Brain and Its accessories	B (Mentalism) What happens in the mind
• Formation of `image' of the flower in the retina.	• Distinctive perception and recognition of the flower as a rose.
• Activation of rods and cones in the retina's various layers.	• Evokes sense of beauty - Smell of the rose flower
• Generation of action potentials - electrical pulses.	• The colour of the flower.
• Transmission of pulses through axons in neurons.	• The softness and smoothness of petals on touching the same.
• Happenings in Synapses and Dendrites	• Appreciation of Symmetry, beauty and aroma.
• Releases of Neuro-transmitter chemicals at various locations	• Earlier happy associations flood the mind
• Activation of Cortices	• Emotions triggered.
Basically:- Electrical Signals } in various oscillations chemicals } locations time sequence.	The mind is able to gauge the size, distance, shape and other physical characteristics as well.

In Table 1, on the left hand side (A), there are terms like electrical signals, oscillations, chemicals etc. that have specific connotations which we learn in the process of schooling at various levels, and start attaching certain kind of reality to them. It is to be pointed out that these are actually representations of something things which are more basic and physical. For example, the electrical signal represents the flow of a certain quantity of electrical charge in a certain period of time in a certain location. These parameters are again related to more subtler realities as we shall see later on. Similar is the situation with the neurochemicals which are made of various elements which in turn are made of fundamental particles like protons, neutrons and electrons. For certain purposes one can stop at the level of signals and chemicals. The question is whether we can stop at these gross levels for understanding what consciousness is.

The terms on the right hand side of the Table (B) fall into an entirely different category. There we come across terms like beauty, fragrance, softness, etc. which we learn in the process of everyday living and through interaction with others. They cannot be described in terms of more fundamental entities. They cannot be quantified. They have a certain intensely personal (subjective) character about them. Some of these like joy, happiness etc. are triggered by past associations and memories of events and individuals. More than anything else, we read a certain `meaning' to these. They are not just data as in the first case (A).

The crucial difference between (A) and (B) is that while (A) can happen even when one is unconscious, (B) can never happen when one is unconscious. Even if all the signals and chemicals are released in the brain and its accessories, (B) cannot happen if the person is in a unconscious state or when he is not paying attention - when the intentionality for registering the particular happening is not there. While for seeing a flower or registering its fragrance, (A) is necessary, (A) alone is not sufficient for (B) to happen. On the other hand (B) can happen in a different way - by thinking of the flower and recalling from memory, its fragrance.

Let us consider the reverse situation when the input is not from outside, but from within. If I "will" to get up, then the necessary instructions are sent to the relevant parts of my body and I stand up. What or Who is this I, that wills and how does the will get

translated to all the mechanical actions of the body? Clearly I can "will" only when I am conscious.

In both these examples, the net result is some kind of `action'. In the first case the source is physical and the action is mental and in the other the source is mental and the action is physical. In both cases, the action takes place is a certain space-time framework - the body and its surroundings and in a certain time sequence.

Is it possible at all to relate these two different kinds of experiences of the same event in any meaningful way? Clearly at the gross level they appear to be distinctly different and unconnected entities though the two experiences are the consequences of the same physical event, namely seeing and smelling a flower by the same individual. Can they be reconciled at a deeper fundamental level?

2. Reality and levels of explanation in physical sciences

It has happened in the field of science, particularly in physics, that even the same event requires widely different concepts for explanation depending on the level and purpose for which the explanations are required. Let us examine a few typical examples of such cases.

Supposing I take a piece of stone and drop it from a certain height. It falls to the ground. Why? The standard school boy's answer is that the gravitational force between the stone and the earth is responsible for this. The stone is a solid and therefore does not change its shape while falling down, while it may break into smaller pieces when it hits the ground. This same phenomenon is explained by a chemist in a more elaborate way. He will say that the stone is a compound made of several elements like silicon, oxygen and other impurities and the molecules of these elements are made of atoms held together by electromagnetic forces. So when the stone falls it is an assembly of atoms falling down held together by these forces. An atomic cum nuclear scientist goes one step further and will say that all these atoms are made of protons, neutrons and electrons bound together by nuclear forces and so what is happening when the stone is falling is that a bunch of protons, electrons and neutrons are all falling down together held by nuclear and electromagnetic forces. A fundamental particle physicist will go even further and say that the protons and neutrons are made of quarks

held together by gluonic forces and it is the assembly of quarks, gluons and electrons that is falling.

What this shows is that though the gross phenomenon is just the falling of a stone, the realities are different at different levels of explanation. The reality goes on changing as we delve deeper and deeper into the structure of matter and nature of forces. Different levels of reality meet different purposes. An engineer designing a steel bridge does not have to go beyond the molecular structure of iron, while a pharmaceutical chemist designing a drug has to go to deeper levels. A nuclear engineer has to go to the nuclear levels for designing reactors and providing protection against radioactive emissions.

What we have considered so far is about the finer and finer constituents of matter. While we have made a reference to the various forces, we have not considered some of the intricacies involved. As the stone is falling, it is entering new regions of space. The electromagnetic, the nuclear and gluonic forces are not rigid bodies like rods that are permanently attached and move down with the particles they connect. According to present concepts of forces, their action is through the creation and absorption of virtual pairs of particles and antiparticles. So strictly speaking, it is not only the bunch of quarks and electrons falling down, it is also the continuous creation and annihilation of virtual pairs of particles in the space between the falling particles. This highlights yet another intricate action that is going on which is very relevant to the act of the stone falling as one piece, but which is not apparent, at the gross levels. We normally treat the space as `empty' of `everything' . Actually this is not the case. Space is the repository of the ultimate constituents of all matter and forces, but existing in such a form that either by spontaneous fluctuation (which is one of the properties of this vacuum) or by the deposition of positive energy they can be made manifest. For example, in the case of a hydrogen atom, the electromagnetic force between the proton and electron is due to the continuous creation and annihilation of electrons and positrons created as virtual particle pairs by the mediating photons emitted by the charged particles. In the case of quark-quark forces the gluons are exchanged. Though the virtual pairs cannot be recorded by any instruments directly because of the extremely short time for their existence and the very short distance intervals in which they manifest, the effects of their production have been recorded (Lambshift, Casmir force

etc.). What all this is telling us is that what meets the eye is very different from th plethora of many subtle phenomena taking place at deeper levels which are not o unseen, but unseeable.

In the above paragraphs, we have talked about force as due to exchange of virtual particles. This is a very different concept from the original ideas of force fields that were introduced in connection with gravitational, electric, magnetic and electromagnetic phenomena. The fields were introduced as mathematical concepts without defining what the physical contents of the field are. It was assumed that these are some vague properties of `ether' which itself was supposed to be non-material something, not identifiable. For several centuries the ether concept held sway, but was finally replaced by the four dimensional space-time continuum by Einstein, as part of his special theory of relativity.

While quantum mechanics highlighted the properties of empty space in terms of its ultimate constituents (fundamental particles or fields representing them), the special and general theories of relativity brought out some other interesting aspects of space - connecting geometrical properties of space with matter and energy. The old common sense idea of time as absolute and same everywhere got a new twist in the special theory. Rate of flow of time became dependent on the velocity of the frame of reference and dilatated as the velocity of motion became higher. Space intervals contracted in the direction of motion. For certain purposes space and time could not be treated as separate characteristics, but had to be fused into a single concept of space-time continuum. The human experience of space is very different from the experience of time. Clearly they belong to different categories of experience. But according to the special theory they had to be merged. The special theory had more surprises in store. It combined energy and mass through the famous relation $E=mc^2$. Here again the concept of mass and the concept of energy, both anthropogenic in origin were certainly very different concepts and were introduced in different contexts. The most surprising of all was the equivalence of mass and curvature of space, established in the general theory of relativity. According to this, matter which is the most concrete of all our perceptions is just a geometrical property of space, in a sense tupsyturvyng the old idea that empty space is there laid out for matter to occupy.

As is well known the special theory of relativity was proposed by Einstein to account for the experimentally observed fact that the velocity of light was independent of the motion of the observer. Several unusual consequences that followed from the theory have been subsequently very well established experimentally. The bending of light around a massive object like the Sun predicted by the general theory of relativity was later verified by the observation at the time of a solar eclipse. The explosion of the atom bomb was clear vindication of the equivalence of mass and energy.

It may be appropriate at this stage to state the revolutionary ideas that brought about a major change in the way of our thinking in science and also in philosophy, in the words of the masters themselves who brought about these revolutions.

Einstein: "Matter which we perceive is merely nothing but a great concentration of energy in very small regions, We may therefore regard matter as being constituted of space in which the field is intense. Field is the only reality".

Dirac: "All matter is created out of some imperceptible substratum. "Nothing", unimaginable and undetectable. But it is a peculiar form of nothingness out of which all matter is created".

What these developments in the field of physics demonstrate is that many of the fundamental concepts like space, time, matter, radiation, energy taken over from commonsense everyday ideas to science in its early days, have had to be radically transformed and even transcended (see Sreekantan[2]) to be able to explain many new phenomena discovered especially in the 20th century. These realizations of the fundamental connectivity of what appeared to be widely unconnected aspects of nature - electricity, magnetism, light, matter, gravitation - came about gradually and in different contexts, and with the application of more and more powerful tools for the exploration of nature - probing on the one hand extremely small intervals of space with high energy particles and with the ability to record happenings in extremely short intervals of time with sophisticated detector and electronic systems, and on the other, accessing the farthest reaches of the expanding universe and identifying entirely new kinds of

celestial objects that revealed new features of the Universe. This new knowledge and the new physics is pointing towards a most important secret of nature as it were - that all this variety is a manifestation just of one substratum, a four dimensional space-time continuum according to theory of relativity and a quantum vacuum (Dirac vacuum) according to quantum mechanics, and theory of elementary particles and their interactions. How this substratum arose and how it was endowed with all the intrinsic properties necessary for these manifestations, science will, perhaps, never find answers. However, what science has been able to do is to specify the properties necessary from the point of being able to explain phenomena in the traditional scientific methodology of breaking down gross phenomena to finer and finer levels by the reductionistic method reinforced by experimental observations and theoretical constructions incorporating mathematical equations and their solutions and guided by conformity to laws and to constants of nature. Howèver, several surprising features that unfolded in this endeavour are (i) occasional breakdown of laws was as, or more important on occasions to the emergence of new features (ii) these deviations were of a controlled nature (Heisenberg's principle of uncertainty) (iii) group behaviour was in some as yet inexplicable way depended on some individual parameters (spin dependent statistics) (iii) entirely new features emerged in assemblies (superconductivity, super fluidity, laser action etc) - (iv) `Resonance' plays an extremely significant role in the explanation of many phenomena.

On the unification of space and time and the connection to gravity, Yu Vladimirov etal[3] write:

"Thus the curvature of space-time has a physical meaning. We have long got used to the fact that many things in this world are different aspects of the same entity. This was the case with mass and energy with inertial mass (resistence to force) and gravitational mass (gravitational charge) and now we see that the same is true of gravitational fields and geometrical properties of space time. Curvature is a geometrical entity whose components vary from point to point in any given system of co-ordinates. Thus curvature is a field in the mathematical sense of the word, and at the same time a manifestation of a physical gravitational field. The credit for this discovery goes to Einstein".

Further they continue

"..... is there any difference between physics and geometry? The only reason we regard geometry as an independent physical reality is because we were educated in the spirit of Euclidean axioms. Think how absurd this view point is: indeed our universe is whole and unique and its properties can all be learned only from experience. The geometry of the real world should be regarded as one of the experimental physical sciences and its assertions and predictions must always be verified through experience or practice. The axioms of geometry are, in fact, no more than a refined form of human experiences. To the question whether it is possible to construct a theory in which all the quantities have a geometrical interpretation the answer is "yes, the most elegant solution lies in the framework of higher dimension."

[Historically, it is interesting to note that William Clifford (1845-1879) had noted: (i) physical properties of matter and properties of curved spaces are related (ii) heat, light, electricity may be related to changes in the curvature of space (iii) the Electro-magnetic field may be related to geometry of space.]

3. Origin of the universe--creation of space, time and matter:

The Big Bang Theory of Creation of the Universe is one possible and at the moment the most popular theory of creation of the Universe. It spells out the intricate connections between widely different physical parameters in the light of all the developments in physics and astronomy in the 20th century.

The Big Bang Scenario and the first moments of the physical evolution of the universe is beautifully narrated by John Boslough[4] as follows:

"Into a void, so absolute as to mock any human concept of emptiness, appeared a single point of raw potential. At the very instant of its creation, this point bearing all matter, all dimension, all energy, all time burst out spewing forth its contents.

At the instant of its origin, all matter and all forces were indistinguishable from each other. As the universe expanded and cooled, matter and forces split again. Still in the billionth of a second in its history, the universe continued to fragment. Soon all the constituents of matter - what we now call quarks and leptons, assumed separate identities, falling into separate classes that have been joined again. The single force

propelling the cataclysm also became fragmented and the different particles became associated forever with the new forces that were being created. Three of the fragmented forces are still at work inside the atom. The most powerful of these is the strong force that binds the constituents of the nucleus together - the quarks that make up the protons and the neutrons. One thousand times weaker is the electromagnetic force that keeps the electrons, a type of leptons, orbiting around the nucleus. This force makes atoms appear solid and also is responsible for radio and light waves. Another hundred times less powerful is the weak force that causes radioactive decay."

While the above describes the act of creation of matter and force in the first moments of the universe, Boslough[4] has a more graphic description of the whole creation of the universe including space, time, matter, space, galaxies, earth, life and people as follows:

" at first there was nothing - no time, no space, not even emptiness only a void beyond voids, a place that was no place, without colour, without shape or substance, without passing a single moment or a prospect of eternity"

From this pure nothingness sprang a speck of chaos, a seed seething with such raw energy that the thought capable of contemplating it has not yet been formed.

Within this speck of vibrating energy still many times finer than an atom were the dimensions of time and space although these concepts were then meaningless. There was no now, then and will be ; no here, no there. The infinitesimal cosmos began to expand. As it grew it cooled and its energy dissipated. Almost at once one of the forces ranging within it separated from the rest. Some pairs of particles capable of existing only in such extreme conditions flashed in and out of existence, colliding with each other in a shower of annihilation.

Suddenly the infant cosmos erupted from subatomic proportions to the size of a cantaloupe. Within a second, it was as big as solar system a crucible of matter and energy denser than a star. Pure energized light blazed throughout the young universe. As it grew and cooled, flying particles began coalescing into larger structures of hydrogen atoms, which eventually swirled into immense clouds of billowing gas.

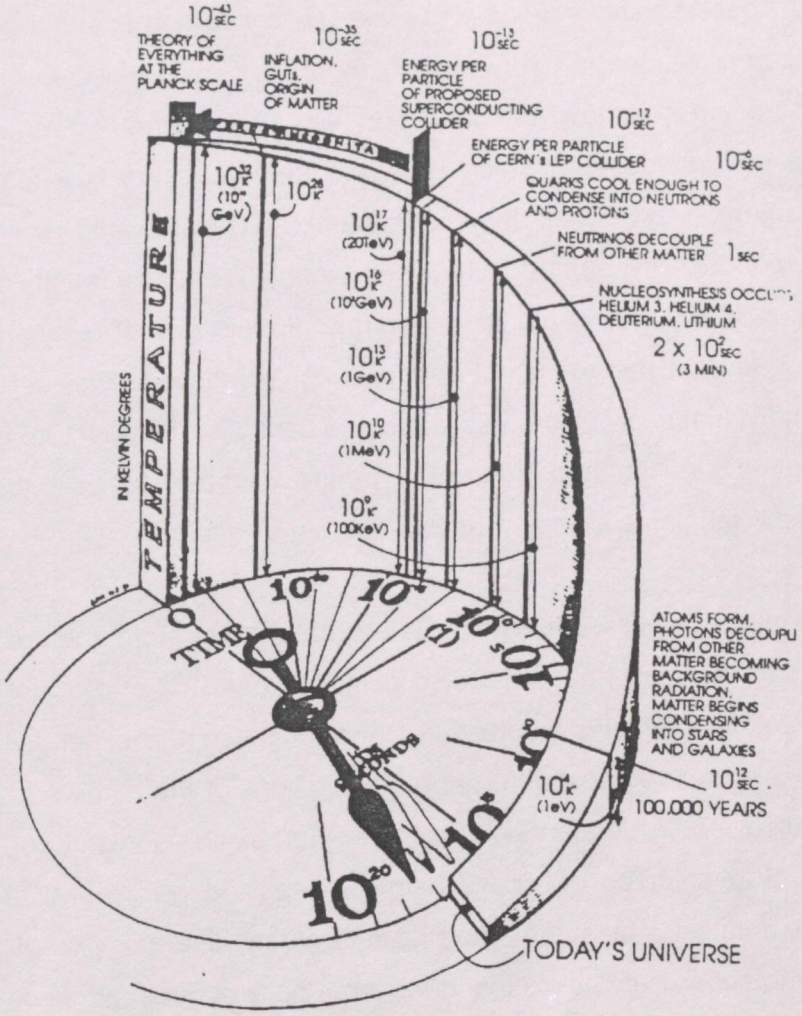
Epochs passed. The universe expanded. Its blazing light faded into darkness. A million years, then a billion years came and went. All at once millions of stars began emerging from the swirling clouds of hydrogen gas. Galaxies appeared, then more stars, other worlds perhaps, Earth, Life and People".

This Big Bang theory is based on three critical experimental observations and a lot of information gathered from collision studies at high energy particle accelerators. The three crucial observations are (i) expansion of the universe, (ii) discovery of the universal 3^0k Microwave radiation and (iii) percentage ratio of Helium to Hydrogen in the universe as a whole. The creation scenario as a function of time from 10^{-43} sec to 20 billion years in the life time of the universe is shown in the figure taken from Boslough's book.

4. Consciousness and quantum vacuum:

While the advances in theoretical elementary particle and nuclear physics and theoretical astrophysics and cosmology have helped us in formulating this Big Bang scenario - the creation of space, time, radiation, elementary particles, elements, compounds, stars, galaxies etc., what is missing is any hint even, of how and when inanimate matter became animate matter and how and when consciousness emerged. What is established beyond any shadow of doubt by biologists is that the constituents of animate matter at all levels from amoeba to man are made of the same elements as encountered in inanimate matter. No particular new element has been found unique to living matter though the organic molecules are very long chain molecules. Though it is more difficult to be categorical about the absence of any new forces unique to organisms, the biologists continue to work on the hypothesis that the same four physical forces operative in inanimate matter are the only ones in animate matter too.

It has to be pointed out in this context that the experience in the delineation and discovery of forces in the physical domain has depended on theoretical formulations and predictions followed by experimental effort costing enormous sums of money and involving construction of new facilities for carrying out these searches. In very recent years there is considerable excitement over the possibility of yet another new force in addition to the four known forces, attributable to the detection of the "dark energy" in



Thermal History of the Universe. Using even the biggest accelerators, physicists are unable to explore the terra incognita at the dawn of time.

From: John Boslough Masters of Time (92) Pheonix

the universe that is behind the faster expansion of the universe established by astronomical observations. Unfortunately, despite suggestions by Shelldrake and others about the possibility of new kinds of forces in the animate systems no systematic efforts have been made in this direction, may be because of the prejudice against the old concept of vitalism and vital forces. Since we do not know all the properties of quantum vacuum which is the reservoir of all forces, in principle it is not difficult to accommodate new forces. We have seen that the four known forces gravitational, electromagnetic, nuclear and weak forces serve entirely different purposes. Yet another

approach that is being advocated to explain consciousness is the systems approach which incorporates ideas of chaos, coherence. non-equilibrium nonlinear processes which has become popular in connection with phenomena that require group effort. In this class are phenomena which show the 'emergence' of new features which are not there in any manifest way in their constituents. Typical examples in the field of physical are superconductivity, superfluidity, laser action. These are mostly due to long distance phase couplings due to quantum coherence. In this kind of scenario consciousness is considered to arise due to the coherence firings of individual well separated neurons, the firing of individual neurons themselves being controlled by quantum coherence effects in the microtubules[6] of the neurons. In the ultimate analysis these again become processes in the universal substratum - quantum vacuum.

Finally, what this 'oneness' - the universal substratum, the space-time continuum, the quantum vacuum, has done is to point towards a way of resolving the trichotomy between the three entities involved in Consciousness, the experienced, the experience and the experiencer as just different manifestations of the same base level unity. What is interesting and perhaps significant is that similar insights of oneness (Urstoff, Brahman, Sunyata, Tao etc) have been emphasized in several ancient philosophies (see Sreekantan[6,7]), ofcourse following an entirely different line of approach - turning objectivity to subjectivity by exploring the inner halls of our experience.

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