

### Prajñānam: Self-Awareness

The 'Prajñānam: Self Awareness', in essence, is an edited version of some of the discourses and select research papers presented during the National Symposium on 'Matter, Mind and Consciousness' held during 28-29 November 2014 at Kaivalyadhama Yoga Institute Lonavla. The meet witnessed a rendezvous of eminent scholars in this field who gifted their valuable contributions to the academic world. The

Philosophico-Literary Research Department of Kaivalyadhama has undertaken the work of transcribing the keynote speech and editing the select research papers presented in the symposium. This book is a humble attempt to broadcast to the world the profound words of the scholars pronounced during the symposium at Kaivalyadhama.



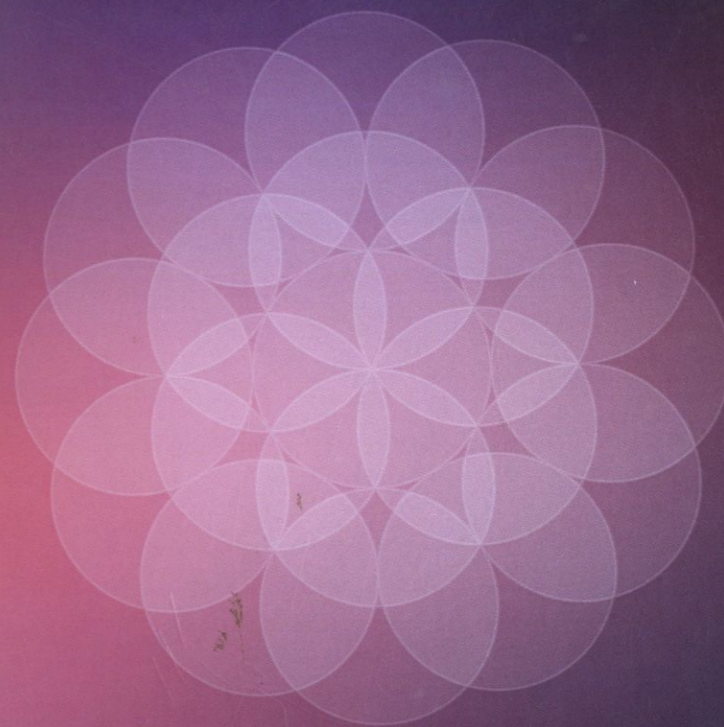
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PRAJÑĀNAM - SELF AWARENESS



# Prajñānam

*Self-awareness*

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K A I V A L Y A D H A M A

## **An Inquiry into the Concepts of Quantum Vacuum in Modern Physics and Akasha in Advaita Vedanta**

*-Prof. Sisir Roy*

*Professor, National Institute of Advanced Studies, Bengaluru*

### **I. Introduction:**

By the end of 19<sup>th</sup> century, Swami Vivekananda asserted that modern physics was inevitably converging towards Advaita Vedanta, a major philosophical and religious movement of Hinduism. Over the following decades, following the revolutionary scientific contributions to the theory of Einstein's relativity and quantum physics many scholars have been inspired to discover striking parallels between world views of Vedanta and modern physics.

In the present paper, our aim is not to discover the findings of modern physics in Vedanta or to show how modern physics can also be claimed as "spiritual". On the contrary, an attempt has been made to critically analyse the claims of convergence between the concept of "Quantum Vacuum" in modern physics and Akasha in Advaita Vedanta. Conceptually, both the terms would refer to the same reality – a ubiquitous physical substratum and its fluctuations, out of which the physical universe come into existence and to which they return. This concept of vacuum occupies minds of many philosophers and scientists for many centuries. Literally, "Vacuum" is simply defined as devoid of any material entity and appears to be empty. However, the birth of Quantum theory and next, as an extension, Quantum field theory (a theory of field, like

electromagnetic field based on the principle of Quantum theory) and modern cosmology give rise to the introduction of a new concept of vacuum or substrate, popularly known as "Quantum vacuum" with fluctuations. Though there exists fluctuations in this kind of vacuum, this vacuum is stable i.e. it does not decay into something else and the equilibrium is being maintained. In the language of modern physics, this kind of equilibrium is known as "dynamic equilibrium". Each kind of fields, like electron field, Higgs Bosonic field with their consequent attributes, like spin, polarization, charge etc are supposed to be hidden in this substrate vacuum, like frozen degrees of freedom or like seeds or imprints in this substratum. This led the author to analyze the parallels between modern physics and Akasha in Advaita Vedanta.

It is to be mentioned that Duquette (1) in his doctoral dissertation made a rigorous analysis and comparative analysis between the concepts of quantum vacuum and Akasha in Advaita Vedanta. I emphasize that his analysis needs critical evaluation to understand the convergence. In the beginning, I discuss the historical developments of the concept of vacuum in section **II**. In section **III** the present understanding of vacuum within the paradigm of quantum theory and quantum field theory will be discussed. Then the concept of quantum vacuum and the creation of the universe will be discussed in section IV. This will shed new light on problematic aspects of Duquette's comparison which led us to reconstruct the dialogue in a more consistent way in section **V**.

## II. Historical development of Vacuum concept: From ether hypothesis to geometrization concept

Greeks called a vacuum by the adjective 'kenos', i.e., the "empty". The word originates from the Latin adjective *vacuus* for "vacant" or "void". Thus, vacuum is space, devoid of matter. According to Aristotle, *Nature abhors a vacuum*. Early Greek speculations about vacuum in the works of Aristotole, Leucippus, Democritus and Epicurus mainly concerned with the questions of ontological nature – something immutable on which the world drama is played or actively participate in this universe? Since then, the concept of vacuum attracted the attention of large community of philosophers and scientists to study vacuum both as theoretical and experimental object. Newton identified vacuum more or less like **absolute space** like a passive container in which bodies move with respect to each other. In various theories of nineteenth century physics, vacuum is considered to be just as **ether** as an all pervading and subtle substance which may be involved in transmission of light or electromagnetic fields. In the beginning of 20<sup>th</sup> century, the **experiment like Michelson-Morley (circa 1885)(2)** was done to detect the existence of ether and the result was **negative**. Based on this experimental result, Einstein formulated his special theory of relativity in 1905 without considering the existence of ether where light moves with a constant and maximum speed in vacuum (devoid of any matter or ether) but not like absolute space conceived by Newton. So vacuum loses its substantiality and identified with space-time continuum devoid of any matter. However, the formulation of general theory of relativity by Einstein in 1911(3) introduced the geometric

interpretation of vacuum. Here, the gravitational field has been described in terms of the curvature of non-Euclidean geometry (Riemannian geometry)(3) and vacuum got its ontological status closely connected to the gravitational field. This geometrization of vacuum by Einstein leads to "*According to the general theory relativity, space without "eather" is unthinkable; in such space, there would be no propagation of light, but also no possibility of existence for standards of space and time, nor therefore any space-time intervals in the physical sense*".

In this picture, fields are considered as the internal characteristics of space-time which constitutes the physical vacuum. The birth of quantum theory by Bohr and Einstein and the discovery of uncertainty relation by Heisenberg (4) shed new light on vacuum model. According to quantum formalism, the **energy of the zeroeth state of a simple harmonic oscillator is shown to be non-zero**. This zeroth state of the oscillator is known as the **ground state**. This has been explained by considering the uncertainty relation where the existence of fluctuation of zero-point energy in vacuum or empty space gives rise to this value of the energy of the ground state. Now **we have a model of physical vacuum or a substratum where there exists fluctuation of zero-point energy**. The developments of quantum theory and its applications to various fields like electromagnetic field etc. lead the physicist to construct the model of vacuum called "Quantum Vacuum". Before going into the details of the structure of "Quantum Vacuum" let us classify the various models of vacuum in historical perspective based on Duquette(1) analysis:

1. *from Antiquity to Renaissance: a period of philosophical speculations about vacuum, concerned mainly with ontological arguments;*
2. *From Renaissance to 17th century: empirical evidence for the physical existence of vacuum and its integration in Galilean/Newtonian mechanics and Newton's Gravitation theory;*
3. *From 17th century to 1900s: reflections on vacuum as an "etheric" medium and rejection of ether theories with Einstein's Special Theory of Relativity (1905);*
4. *From 20th century onwards: formulation of General Theory of Relativity and Quantum physics (including Quantum Field Theory (QFT), in which the vacuum is endowed with some substantiality.*
5. *Modern Cosmology and Dark energy: concept of vacuum.*

### **III. Physical Vacuum and Quantum Field Theory:**

The applications of quantum theory to classical electromagnetic fields led to the discovery of Quantum Field Theory (QFT) in late 1920(5). There exist several characteristics of fields (even for classical field as described by Maxwell equations) which led to introduce the field ontology instead of particle ontology. Field is an entity, continuous over whole space-time and has infinite degrees of freedom. It affirms the holistic nature of reality. First consistent framework of QFT was produced in 1940-50 by three physicists Schwinger, Feynman and Tomonaga (5) who shared Nobel Prize for this discovery. This theory is recognized as most successful fundamental theory of physics whose results have been verified in the laboratory experiments with very high degree of accuracy.

Since the inception of Quantum theory, the debate started among the pioneering personalities like, Schrödinger, de Broglie, Heisenberg, Einstein, Bohr, Born etc., regarding wave or particle ontology. In quantum theory, a microscopic entity like electron, proton or photon behaves like a wave or particle and it is not possible to perform any single experiment to detect both the aspects simultaneously with infinite precessions. Schrödinger and de Broglie used to have more realistic interpretation of the wave function. In contrast, Born is said to be the advocate of particle ontology. But, Schrodinger(6) is considered to be radical advocate of field ontology:

*"A realistic interpretation of the wave function usually implies a field ontology rather than a particle ontology. The field is distinct from the discrete, individual and impenetrable particle by its continuity, extension and the superimposability of its different portions. This is however true only of "classical" field ontologies (like Schrödinger's) and not of quantum field ontologies in which the field displays some form of discreteness (Cao(7))".*

It is difficult to think of any kind of particle or wave ontology within the framework of non-relativistic quantum theory. Very recently, new experiment has been performed where the authors (8) claim to detect both the particle and wave aspects in the same experiment. However, it needs to be analyzed carefully before making any definite conclusion regarding the ontological status of quantum theory.

In regard to ontology of a physical theory, Cao (9), a philosopher of science defined it

*“as an irreducible conceptual element in the logical construction of reality [that] is concerned with a real existence, that is, with an autonomous existence without reference to anything external”.*

Within the framework of Cao (9), the quantum field is considered to be the best candidate for being the basic ontology of QFT. In this framework, particles do not have eternal and independent existence but are epiphenomena of substantial quantum field. However, quantum field ontology is different from classical field ontology. Within the framework of QFT, the wavelike or field like and corpuscular aspects of radiation are considered as different manifestations of the same fundamental entity i.e. the quantum field.

These attributes are like charge, spin, polarizations, colour etc. We call it as **Quantum vacuum**. Considering the field ontology within the framework of QFT, it helps us to conceive the nature of vacuum in a radically new manner. In Einstein’s special theory of relativity, vacuum is considered as a state of nothingness with zero energy, zero charge, zero momentum etc. According to quantum theory, the vacuum has non-zero energy because of the existence of zero point fluctuations. However, within the framework of Quantum Field Theory, vacuum is a state though devoid of matter or radiation, yet full of fluctuations along with the imprints of attributes of various fields like electron field, photon field or Higgs Boson.

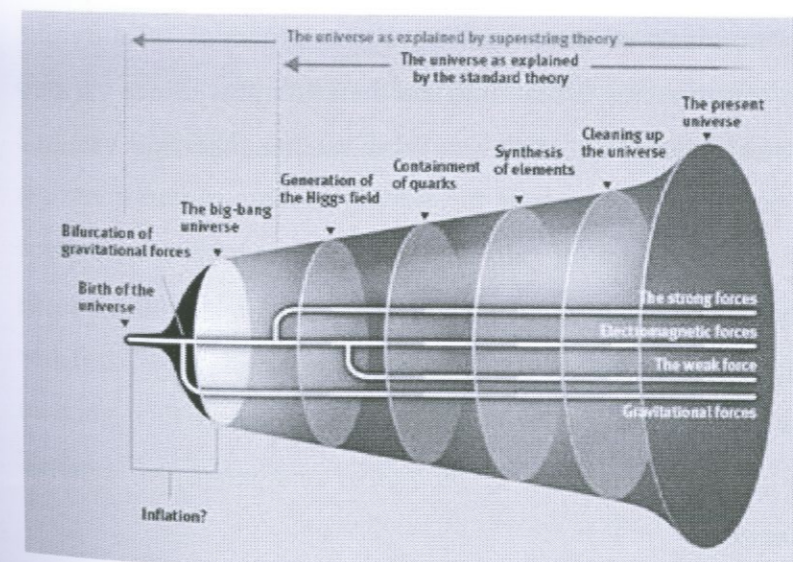
Duquette critically examined the convergence of ontological issues of QFT and Advaita Vedanta such as the concept “akasa”, “Brahmana” and

“avyakta”. Before going into the details of parallelism, let us briefly discuss some aspects of modern cosmology and vacuum fluctuations.

#### **IV: Modern Cosmology and Quantum Fluctuations:**

In modern cosmology, the universe is emerged from the quantum fluctuations in the substratum. There exists concept of “true” and “false” vacuum in modern cosmology. According to several scientists, the evolution of the universe started from a true vacuum with perfect symmetry and cooled into our present vacuum state (called false vacuum) which may melt down again. The release of energy due to breaking of symmetry may explain the origin of Big bang. This can be depicted in the following figure:

#### **Cosmological evolution of Vacuum:**



**Vacuum has transformed many times during Universe expansion!**

(Reprinted from Roman Pasechnik: The Physical Vacuum: Where Particle Physics Meets Cosmology, Lund University)

The above picture clearly indicates that there is evolution of false vacuum.

It raises the immediate question: *Is vacuum self tuning?*

The density in various false vacuum corresponding to different interactions are different:

$\rho_{vac} =$

$\sim 1 \text{ GeV}^4$ , strong interactions

$\sim 10^8 \text{ GeV}^4$ , electroweak interactions

$\sim 10^{76} \text{ GeV}^4$ , gravitational interactions

This is due to our lack of understanding about dynamics of different known vacuum substructures in real time and their interplay. Since various interactions are associated with different false vacuum, the true vacuum may be considered as *self-referential*.

*Extremely complicated structure of the Physical Vacuum exhibit intrinsic self-tuning properties for its parameters with very degree of precision which gives rise to the Structure Formation in our Universe, and ultimately to the appearance of biological and intelligent systems (Anthropic Principle).*

Genz (10) suggests,

*"May be quantum mechanical fluctuations initiated not only the stuff our world was made of, prior to inflation but also space-time itself. Maybe the true vacuum, the true nothing, of philosophy and religion should be seen as a state wholly innocent of laws, space, and time. This state can be thought of as nothing but a collection of possibilities of what might be".*

**V. Parallels between Quantum vacuum and Akasha of Adaitva**

**Vedanta:**

Drawing parallels between claims of different disciplines like modern physics, especially the concept of quantum vacuum and Adaitva Vedanta may create various problems: lack of contextuality, problem of translation, language fallacy, oversimplification, ideological bias etc. Any such comparative study should take care of the methodological difficulties.

I am going to make a comparison one the one hand, the concept of Akasha as addressed in Indian Philosophy particularly in Sankara's Vedanta and on the other hand the concept of Quantum vacuum as interpreted in modern physics. In modern physics, some parallels have been drawn between Akasha and the luminiferous ether of classical physics. Probably, Swami Vivekananda established such a correlation. He was familiar with ether as physical concept during his stay in the west and meeting with Lord Kelvin, von Helmholtz, William Thomson and Nikola Tesla.

Duquette made an extensive analysis regarding the parallels between the two concepts within various schools of Indian philosophy and wrote

*"We have seen that Upanisadic literature endows the word Akasha with various meanings. In some passages, Akasha is stated to be one of the five elements (mahabhutas), connected with hearing and sound. Elsewhere, it acquires a metaphysical meaning while being closely equated to the eternal **Brahman** and the innermost **Atman**."*

The analysis presented in the last section, clearly indicates that universe is created out of the fluctuations of quantum vacuum. This quantum vacuum is all pervading, self-tuning and self referential. Moreover, this vacuum **has some kind of memory as it contains some imprints or seeds of various fields and their characteristics**. On the other hand, according to Indian philosophy the spatial and material universe is created of five elements: four of matter (fire, earth, air and water) and one of pure space or ether (the Akasha). The ether has two phases, subtle and gross. So to discuss parallels between Akasha and quantum vacuum, we need to understand the gross and subtle aspect of vacuum within quantum paradigm.

In Yoga Vasistha Ramayana Vasistha used three words as "cidakasa", "cittakasa" and "bhutakasa" in the context of the concept "akasa" and creation. If one takes literally meaning of akasa as "space", "cidakasa" means "consciousness – space, 'cittakasa" means mind-space and "bhutakasa" means the element space.(11). Swami Venkatesananda suggested better translation of the word "akasa" as "dimension". For example, "the same infinite consciousness is

known as cidakasa, cittakasa and bhutakasa viewed from the spiritual, mental (conceptual) and physical dimension respectively."

With respect to creation, Vasistha discussed using a metaphor. He talked about a holy man named "akasaja" (born out of space). In conversation of "Death" with "Yama", Yama said: "O death, this holy man Akasaja was truly born of space and has no karma at all. He is as pure as space. Hence he has incurred no karma which can help you grasp him or devour him." Here, the concept of self-creation is introduced without having any memory.

Quantum vacuum has been studied considering quantum field theory. Quantum fields are having infinite degrees of freedom and continuous over all space-time. We call it as global existence. Here, quantum fields are defined over a space-time manifold endowed with Minkowskian structure. This is physical space-time where the special theory of relativity holds good. It means there is constrain on the speed of propagation where speed of light is considered to be constant and maximum. The metric of space-time is Minkowskian in nature. We should call it as gross aspect of vacuum or ether. But to make a comparison, one needs to understand the subtle aspect of the vacuum so as to compare with subtle aspect of ether. Duquette did not discuss these aspects and hence the comparison remains incomplete.

Recently, the present author along with mathematician Ralph Abraham studied these aspects using rigorous mathematical structures which shed new light on the issue of subtle and gross aspect. Our results have already

been published in a book form (12). The main ideas are elaborated as follows:

The word Akasha is generally translated in English as ether. However, the concept of ether as a medium for the propagation of light is not the appropriate one in Indian philosophy. The concept of Akasha has the distinguishing quality of sound in contrast to ether as that of light. In fact, to understand the concept of Akasha, one needs to understand the concept of "tattva". The Sanskrit word tattva consists of two syllables: tat and tva. "Tat" means that and "tva" means ness and hence the word tattva signifies "thatness". On further analysis it signifies the essence which creates the feeling of existence. There is another Sanskrit word "bhuta" which is used synonymously with tattva. There are five elements or five different states known as pancha tattva or pancha mahabhuta associated with distinct vibratory motions which appear during the evolutionary process of manifestation from Parabrahman. The first evolutionary state is the Akasha tattva. It has the distinguishing quality of sound. If we want to use a word similar to ether for Akasha it is better to use an adjective with ether. The five tattva can be classified as

- Akasha tattva as sonoriferous ether
- tejas tattva as luminiferous ether
- vayu tattva as the tangiferous ether
- apas tattva as the gustiferous ether
- prithvi tattva as the odoriferous ether.

Evolution gives rise to light from sound and then to forms. The generation of light from sound has been discovered in twentieth century physics and the phenomenon is known as sonoluminescence.

On the gross level, the physical characteristics of these five tattvas or five mahabhutas can be described as:

- The characteristics of akasa are motion in all directions which are not agglomerated and also not obstructed.
- Tejas corresponds to fire, i.e., going upward, burning, lighting, shining, destruction, power.
- The characteristics of vayu or fire are the movability and friction.
- Ap corresponds to water which characterize smoothness, softness, heaviness, coolness, purification, etc.
- Prithvi or the earth corresponds to form, stability, rigidity, support, etc.

According to **Samkhya philosophy** atoms of the five mahabhutas combine together to form different substances. According to the different schools of Indian philosophy, matter can exist in three forms as tanmatras (i.e. sub-atomic stage), as anus, or the atoms of the mahabhutas. The tanmatras signify the potency of having the characteristics of akasa, fire, air earth, etc. A divergence of views exists regarding the genesis of the tanmatras. Actually, they possess something more than the quantum of



mass and energy, they possess the physical characteristics like penetrability, capability of radiation of heat, viscosity and cohesion. In addition to these capabilities, they also possess the potentials of energies represented by sound, touch, colour, taste, and smell, but are devoid of any particular form. In this way, both animate and inanimate bodies and all forms are created out of the various combinations of these five elements or pancha mahabhutas.

Akasha is all pervading, just like the luminiferous ether described in physics. The vibrations of the elements which constitute sound associated with akasa are different from the vibrations which produce sound and require a physical medium. These elements or tanmatras are very subtle but have the potentiality of creating the sound in the physical world under certain conditions. These subtle tattvas exist in the universe on four planes as follows:

- Physiological, corresponding to prana
- Mental, corresponding to manas
- Psychic corresponding to vijnana
- Spiritual corresponding to ananda

Again some of the secondary qualities of these tattva can be summarised as:

- Space: This is considered to be a quality of the akasa tattva. The vibration here may give rise to the statistical nature of space.

- Locomotion: A quality of vayu tattva, motion in all directions.
- Expansion: A quality of tejas tattva.
- Contraction: A quality of ap-tattva. The direction of this ether is considered to be the reverse direction of the ether associated to tejas tattva or agni tattva.
- Coherence resistance: A quality of the prithvi tattva. This is opposite to akasa tattva. Akasa tattva can give rise to locomotion where as prithvi tattva resists it,

It is worth mentioning that Laszlo (13) proposed an integral theory of everything and the importance of the akasic field in several of his recent monograph.

Let us now discuss the main point of our mathematical model to build up the structure of quantum vacuum starting from more fundamental notion called pre-geometric notion. So that we are able to combine two concepts like subtle and gross structure of specie-time in comparison to subtle and gross ether.

Recent developments in quantum physics (quantum gravity and string theory) have raised questions about the basic concepts of space-time and causality at the smallest (Planck) scale. The length and time at Planck scale are the smallest length and smallest time increments below which no measurement is possible. The concepts of space, time, and causality lose their meaning below this scale. Spacetime behaves discretely at the Planck scale.

The Requardt and Roy(RR) model(14) was created around the year 2000. Requardt had been working on quantum gravity for many years and had

published several papers on the discrete structure of space-time at the Planck scale. He introduced the idea of pregeometry in the following sense:

“Discrete spatial point's transition from a structure of disorder to one of order at the Planck scale in a process somewhat like phase transition in magnetic material, in which the orientations of the magnetic elements change. This kind of phase transition may happen in the case of pregeometric points”.

On the other hand Roy had been working on probabilistic geometry as proposed by Menger to understand the small-scale structure of space-time. He wrote Requardt about this approach and the thought emerged that both approaches could be combined. This became the RR model.

The RR model is a two-level system, comprising two dynamical cellular networks. The model describes how macroscopic space-time or its underlying mesoscopic substratum emerges from a more fundamental concept, a fluctuating cellular network around the Planck scale. Geometry emerges from a purely relational picture a la Leibniz. The discrete structure at the Planck scale consists of elementary nodes which interact or exchange information with each other via bonds that play the role of irreducible elementary interactions. Essentially, the RR model emerges. Then at the next level, Abraham and Roy (AR) (15) discussed the emergence of Quantum vacuum based on RR model. The validity of the postulates of geometry has been questioned around or below Planck scale during the development of modern physics in the late twentieth century. It is worth mentioning that Riemann in 1854 discussed similar issues in

connection with the validity of metrical relations in indefinitely small regions. Here, we have started with a working hypothesis that a type of cellular network exists at the ultimate level of the universe from which the usual or physical space-time emerges. So we are able to make a model of conventional model of quantum vacuum endowed with structure of physical space-time (Minkowskian in nature) starting from a network model extending spatially over the universe. We call it as subtle aspect of gross physical space-time or quantum vacuum.

According to Advaita Vedanta, there exists an all-pervasive “plenum” called Akasha from which the entire universe has originated. According to this tradition, the first element Bhutas is created which seems to be the primordial source of other physical elements. Recently, Panda (16) remarks that this concept resembles in many ways with quantum vacuum as described in Quantum Field Theory. However, most of the authors did not realise that the vacuum within the framework of Quantum Field Theory has specific structure of space-time which is nothing but the features of gross or physical space-time. So unless one constructs a substratum beyond this gross level it – call it as subtle one, it is very difficult to make a useful comparison. As I mentioned above that in our recent book we have succeeded to construct such a subtle level from which one gets physical space-time or quantum vacuum and hence the comparison appears to be meaningful one. It is worth mentioning that our subtle vacuum has dynamic possibilities with fluctuations which give rise to the physical vacuum or gross one. According to Yoga Vasistha “akasa” is pur space without any “karmic seeds”. On the other hand in Buddhist

philosophy “seeds” or “bijas” are there in “Alayavijnana” in Yogacara Buddhism. This will be discussed separately.

In Modern physics, quantum vacuum even in its physical or gross form (as in our model of networks -- AR model) has kind of memory. This is more like concept of “alayavijnana” rather than “subtler one – akasa”. Our model of subtle vacuum (AR model) from which the physical vacuum or gross vacuum originated has more structural similarity with “akasa”.

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## **Mind, Matter and Consciousness: The Yoga Perspective**

*Dr.Penna Madhusudan*

*Dean, Faculty of Indian Philosophy and Culture*

*K.Kalidas Sanskrit University, Ramtek*

Our world experience comprises of three major factors viz., mind, matter and Consciousness. The inert matter influences our consciousness through mind. This is life in short, as per the Yoga philosophy. But, this is not acceptable to some other thinkers who explain that the mind itself is consciousness. Such ideology is presented in the Yoga bhashya gloss on the Yoga sutra of Patanjali, itself. Such being the state of things, one doubts whether mind itself is consciousness or is different from it? What is the difference between mind and matter? In this matter, it is attempted here to present the perspective of the Yoga philosophy regarding the mind, matter and consciousness trio.

As we all know the yoga system has its philosophical foundations on the Samkhya system only. But, it should be borne in mind that the Yoga system does not just reproduce all the tenets of the Samkhya system. It rather compliments and strengthens the Samkhya system. Samkhya is the theoretical part of dualistic philosophy and the Yoga is the practical part of it. The contribution of the Yoga system in channelizing the Samkhya stream is very significant. This we shall see in detail now.

**Matter:** On the lines of the Samkhya system, the Yoga system also holds the view that the world is a modification of three primordial forces called