On the Unifying Nature of Vibration

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Abstract

Light and sound are two very primitive fields of investigation in the arena of natural sciences. Vibration is the basic concept which is fundamentally related to both of these fields. Therefore, vibration or fluctuation has become a cardinal concept in the natural sciences, especially in physics. Mathematically elegant theories have been developed to understand the nature of vibration. Though vibration manifests in various modes and forms, the underlying commonality is markedly significant. The vacuum fluctuations in the early universe giving rise to matter and radiation may be considered to be the primordial form of vibration associated with the origin of the universe. The ancient Indian wisdom conceives of this vibration to be the fundamental entity which not only governs the evolution of the universe but is at the heart of all the natural phenomena. Even primordial vibration is accepted as the cause of the universe. Though not mathematically developed, the characteristics of vibration as theorized by the ancient Indian seers are found to be compatible with the latest conclusions of physics. Above all, Indian wisdom has projected some more insightful and profound interpretations of vibration which shed new light on the nature of consciousness. The paper aims at validating some of the relevant conclusions of ancient Indian wisdom on the basis of the theories of physics with an endeavor to inquire into the unifying nature of vibration. Furthermore, it attempts to demystify the nature of vibration with reference to the cause of the universe and its bearing on the nature of consciousness.

Keywords — *Vibration, Quantum Fluctuation, Sonoluminescence, Density Fluctuation, Quantum Fluctuations, Quantum Foam, Vāk, Jyotiḥ*

I. INTRODUCTION

The nature of light and sound has been intriguing human being since the dawn of civilization. The scientists from the field of natural sciences were engaged in the exploration different of aspects of the Nature. Light and sound have been the two prime fields of investigation where the inquiry started with the attempt to understand the nature of visible light and audible sound. In the days of yore, light was defined in the physical sciences as the electromagnetic wave which is sensitive to human eye and the sound was theorized as a mechanical vibration sensitive to human ears. However, with the passage of time, the scientists applying scientific methods of investigation have arrived at more fundamental features of sound and light which went far beyond the boundaries of audibility and visibility. However, it is remarkable to note that the thinkers and the philosophers of the ancient India have propounded more generalized concepts about the nature of light and sound which are not only in consonance with modern scientific thoughts but transcends the domain of natural sciences to embark upon the novel realms of the science of consciousness.

Analytical study of the texts of ancient Indian wisdom unfolds the following characteristics of sound and light:

- Sound may be of audible and inaudible nature [1].
- Light may be of visible and invisible nature [2].
- Sound and light are wave in nature [3].
- Sound and light are of the nature of particle too [4].
- Vibration is the primordial cause of the universe [5].
- Sound can be the cause of light [6].
- Space-time is characterized by vibration and it is considered that space-time is associated with subtle vibrations [7].
- There is close connection between sound and light [8].
- Sound and light are of the nature of Ultimate Reality or Consciousness [9].

II. SOUND VIS-À-VIS LIGHT

The scientists from natural science in their investigation for the cause of audible sound arrived at the conclusion that audible sound is produced by the vibration of some sound producing devices and it propagates as wave creating disturbance of the particles of material medium. However, the waves propagating through medium of vibrating particles do not produce audible sound for all wavelengths. Of all the elastic waves, only the waves ranging between 20-20000 Hz give audible sound. On the other hand, the visible light is of the nature of electromagnetic

wave and light manifests here too within a certain range of frequency of the wave. There are some differences in the nature of acoustic wave and electromagnetic wave, with respect to the direction of propagation and the direction of vibration of the medium. It is the nonetheless true that both light wave and sound wave are fundamentally of the nature of regular oscillation. The acoustic wave propagates as the oscillation of material particles of the medium and electromagnetic wave is the oscillation of electromagnetic field. Moreover, the acoustic wave which generates sound is longitudinal and advances as the compression and rarefaction of the material medium. The electromagnetic wave, by nature, is a transverse wave and it can propagate through vacuum as well. However, the common features of these two types of waves are enumerated as follows:

1. Both sound and light are wave in nature and are of the nature of vibration. For acoustic waves it is the vibration of the material medium, whereas for transverse electromagnetic waves it is the vibration of electromagnetic and magnetic field.
2. Acoustic waves create motion of the material particles of the medium and light is composed of the particles of zero rest mass called photons.
3. Audible sound manifests only within a certain range of frequencies of the elastic waves and visible light manifests only within a range of frequencies.
4. Both electromagnetic and elastic waves obey the laws of reflection and refraction. They also exhibit interference and diffraction.
5. Light is invisible. The light is perceived when it falls on a body and after reflection/scattering reaches our eye or some light detecting instrument. The visibility and audibility are not necessarily always related to human sense.

The dissimilarities of the between the elastic waves and light waves are the following:

1. Light wave is a transverse wave and elastic wave is a longitudinal wave.
2. Light wave can travel in vacuum too. Sound wave does not have any existence without medium.
3. Light wave exhibit polarization, but sound wave, being longitudinal, does not exhibit polarization.

In view of the similarities and dissimilarities the following questions become pertinent:

a. Having so many common features, can it be said that these two waves have a common background?
b. Can light emerge from acoustic vibration and vice versa?
c. Did the acoustic wave exist in the early universe?
d. What should be a general definition for vibration which can embrace both light and acoustic vibration?
e. What do the Indian seers mean by the word vibration which is the cause of the universe as well as both electromagnetic and acoustic wave?

III. CAN LIGHT ORIGINATE FROM SOUND AND VICE VERSA?

Generation of light from sound is not a very common phenomenon. However, the experiments on sonoluminescence, to a great extent validate that acoustic waves can produce light.

A. Sonoluminescence

Sonoluminescence is a phenomenon in which a bubble in liquid is subjected to sound wave causing it to expand slowly and resulting in a rapid collapse of the bubble with the manifestation of light. The phenomenon of sonoluminescence was discovered by H. Frenzel and H. Schultes, in 1934, exposing a photographic plate to acoustic waves generated in a water bath to find that the plate was darkened at the exposure of the acoustic wave. This was treated as the luminescence from the sound field and was termed sonoluminescence. The luminescence was the not produced directly by the acoustic field but resulted from a process called cavitation. Cavitation is a process in which small vapour filled cavities are formed in liquid due to rapid changes of pressure at the places of very low pressure. The compression portion of the acoustic cycle leads to the collapse of these vapour filled cavities called bubble representing an appreciable degree of energy concentration as high as 12 orders in magnitude. The huge concentration of energy happens because the collapse of the cavitation bubble collapse obeys spherical symmetry until the development of the instabilities at the interface. In the single bubble luminescence, the symmetry is conserved up to the dimension of single micron-size giving rise to phenomenon of emission of short bursts of light with clock-like-precision.

Multiple-bubble sonoluminescence is an associated phenomenon in which the local acoustic pressure in the bulk of a liquid exceeds the threshold for cavitation resulting in the development of a zone in which many bubbles are activated. Cavitation being sufficiently intense sonoluminescence takes place. Many bubbles grow and collapse together

throughout the regions of intense acoustic stress in multiple-bubble-sonoluminescence [10].

B. Insights from the specific heat of solids:

Mechanical vibration giving rise to optical mode of vibration can be observed in the study of the specific heat of solids. The history of the development of the theory of specific heat is quite fascinating:

The specific heat for all solids was related to the kinetic theory by Dulong and Petit on the basis of kinetic theory assumptions. The assumptions are as follows:

1. A solid consists of atoms, every one of which is regarded as harmonic oscillator with three degrees of freedom [11].
2. The mean kinetic energy corresponding to each degree of freedom is ½ $\boldsymbol{kT}$, according to the law of equipartition of energy [12]. These assumptions led to derive the result that $\boldsymbol{C_v = 3R}$. But the values of the specific heats of different substances, especially beryllium, carbon, boron and silicon, obtained through laboratory did not always match with the result. In the year 1907, Einstein was the first to explain the inconsistencies of the Dulong Petit's law applying for first time the quantum mechanical laws to the problems of specific heat. He observed that the average energy of an oscillator vibrating with the frequency ν is not $\boldsymbol{kT}$ per degree of vibration but is given by, $\frac{h\nu}{e^x-1}$ where $\boldsymbol{x = \frac{h\nu}{kT}}$. He considered that the solids like Ag are characterized by monoatomic vibrators. Though Einstein's work had given the proper direction to the investigative method, the weakness in his theory was also revealed. He had himself suspected that the assumption of monochromatic vibration did not correspond to the actual fact [13].

Debye took the investigation further on the basis of the following assumptions:

1. The vibrations would form a continuous spectrum [14].
2. These vibrations are identical to the acoustic vibration of a continuous solid [15].

Whenever a continuous solid vibrates elastically two kinds of vibrations are observed: The transverse vibration the longitudinal vibrations with the velocities given respectively by [16].

$$\boldsymbol{c_t = \sqrt{\frac{n}{\rho}}}\ ,\ \boldsymbol{c_l = \sqrt{\frac{k+\frac{4n}{3}}{\rho}}}$$

(n = coefficient of rigidity and k = bulk modulus)

Debye derived the value of the specific heat of solid as a function of the absolute temperature given by,

$$\boldsymbol{C_v = 3R.\frac{12\pi^4}{15}\left(\frac{T}{\theta}\right)^3}. \quad (1)$$

θ is a constant for the substance and hence $\boldsymbol{C_v \propto T^3}$.This is popularly known as Debye's $\boldsymbol{T^3}$ law.

The lattice structure of solid is prevalently considered to study the thermal properties of solids particularly at low temperature. In low temperature, quantum effects are predominant. Lattice-points are at rest when the solid is at absolute zero. With the slightest increase of temperature, the equilibrium structure of the lattice is disturbed. They start vibrating about their mean position. The vibration is more or less like the vibration of a large number of coupled springs. The frequency of vibration can have all possible values. This is the classical picture. In quantum mechanics, the vibration of the lattice points is replaced by a large number of quanta. These are like simple harmonic oscillators having all possible frequency of vibration. There are two types of mode of lattice vibration: acoustic mode vibration and optical mode vibration. The Quanta of acoustic mode vibration are called Phonon, whereas for optical vibration, the quanta are known as photons. The phenomenon substantiates that mechanical vibration can give rise to acoustic mode and optical mode simultaneously.

It has been deduced that the one-dimensional lattice energy for a particular mode of vibration is equivalent to that of a simple harmonic oscillator with the same frequency.

It is remarkable that for a linear atomic chain in an actual crystal there exist both longitudinal and transverse waves moving with velocities c_t and c_l respectively. The dispersion relation for a one-dimensional diatomic lattice is given by,

$$\boldsymbol{\omega^2 = \beta\left(\frac{1}{m}+\frac{1}{M}\right) \pm \beta\sqrt{\left(\frac{1}{m}+\frac{1}{M}\right) - \frac{4\,sin^2\,ka}{mM}}}. \quad (2)$$

A one-dimensional diatomic lattice is considered, the dispersion relation yields two values of ω given by ω_+ and ω_- respectively. When $\boldsymbol{K \to 0}$,

$$\boldsymbol{\omega_+ = \sqrt{\left(\frac{2\beta}{m}\right)}} \text{ and } \boldsymbol{\omega_- = \sqrt{\left(\frac{2\beta}{M}\right)}}. \quad (3)$$

Here ω, β and k represent angular frequency, spring constant and wave number respectively.

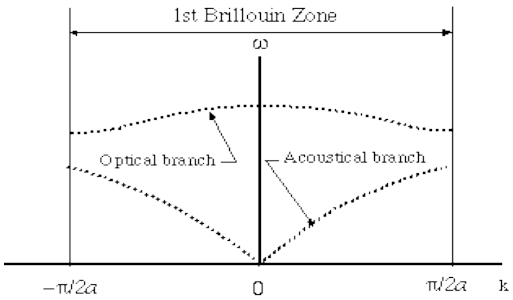

Fig 1

[Acoustic and optic modes for a linear atomic chain]

Therefore, the allowed frequency range is thus split into the acoustic branch and optical branch respectively. The lower branch is acoustic branch and the upper branch is the optical branch. The frequencies for the optical branch are higher and when $\boldsymbol{k \rightarrow 0}$, the frequency for the branch approaches an angular frequency ω_+ which is non-zero. ω_+ comes under the infra-red range and therefore this mode of vibration is said to be optical mode vibration. It can be said that mechanical vibration can give rise to optical mode of vibration. It indirectly accounts for the phenomenon that acoustic vibration may produce optical vibration.

IV. ACOUSTIC AND ELECTROMAGNETIC WAVES: THE EARLY UNIVERSE SCENARIO

The Inflationary Hot Big bang scenario is the standard model of cosmology which is capable of explaining some critical observations about the universe which began with the big bang at t=0. It suggests that the universe has been dominated by the vacuum energy soon after the big bang for a brief period of time. The universe grew exponentially during this inflationary epoch with a time constant given by,

$$\frac{1}{H} = \sqrt{\frac{3c^2}{8\pi GV}}. \qquad (4)$$

The creation of all cosmic structures is considered to be caused by the quantum fluctuations during the inflation. However, quantum field fluctuations are observed in the realm of quantum vacuum. In his paper in 1960, Nernst made a wonderful observation. He noticed that vacuum is permanently filled with electromagnetic field fluctuations propagating at the speed of light. In other words, quantum vacuum may be defined as the field state where the energy of field fluctuations is minimum. That is the reason this energy cannot be harnessed to build up perpetual motions violating the laws of thermodynamics [17]. The concept of empty space was revised with the understanding that vacuum is not an empty space but teems with quantum field fluctuations. The existence of these field fluctuations, which are irreducible in nature, is a very significant discovery of modern physics. Amazingly the ancient Indian sciences also hold the similar concept. Swami Vivekananda, in the 19th century, pronounced that empty space is filled with subtle vibrations drawing insight from the wisdom of the Vedānta [18].

Quantum fluctuations start as very small and they grow in time along with the exponential expansion of the universe. New quantum fluctuations are formed after the previous generation of fluctuations. It is strongly believed that the universe started with a big bang, which is quantum fluctuation. At this stage all forces are in unified form. This is known as symmetry restored stage. The universe inflates during 10^{-43} sec to 10^{-35} sec. The universe is very hot and is filled with energy. As it is of the size of a point, it is a quantum mechanical system with strong gravity. The classical GTR is also not applicable here. The universe expands as the temperature decreases. As a result, the symmetry breaks one by one. In the beginning the fundamental interactions remain in the unified form. First the gravity gets separated from the other three and then the strong interaction. The electroweak interaction, which is a unified form of electromagnetic and weak forces, separates then. At 10^{-11} seconds, the symmetry between the weak and the electromagnetic interactions starts breaking. The temperature at which this transition takes place is 160 GeV. Thus the weak and the electromagnetic interaction manifests separately. This electromagnetic interaction is mediated through the exchange of photons. The photons are fundamentally the light quanta. One microsecond after the big bang, at around the temperature of 1 GeV, the universe is filled up with hot and dense soup of quark-gluon plasma with photons and electrons. Quark-gluon plasma and the electrons make the universe charge-neutral. Quarks and electrons are the building blocks of everything. Then the early universe is in the state of plasma composed of photons, electrons, protons and neutrons along with dark matter. Photons were coupled with the elementary particles and dark matter. The baryon-photon mixture behaves like baryon-photon fluid. The baryon-photon fluid does not behave like a smooth soup but has been found to be little lumpy. This lumpy nature of such fluid is revealed through the density fluctuation as found imprinted in the cosmic microwave background. Actually, during this time, the gravitational force from the potential wells, which are created by local curvature perturbations or dark matter clumps, cause the compressions of fluid. When the plasma collapses, it meets resistance from the pressure of the photons. Thus, the plasma is reversed in direction resulting in a rarefaction. The cycle of rarefaction and compression gives rise to acoustic oscillations where the baryons act as the sources of inertia. The acoustic oscillations are represented by the peaks and valleys [19]. In an

important work, which computes the time evolution of thermodynamical quantities of the early universe, Guardo *et al* describes the early universe as the quark-gluon plasma along with electroweak matter in thermal equilibrium. Their work aimed at studying the effect of an equation of state which takes into account the existence of the QCD crossover on the evolution of the early universe. To study the energy density fluctuations, they solved numerically the system of coupled equations originally worked out by Christof Schmid *et al* [20].

$$\frac{1}{H}\delta' + 3\,(c_s^2 - w)\delta = \frac{k}{H}\psi - 3(1+w)\alpha \quad (5)$$

$$\frac{1}{H}\psi' + \,(1-3w)\psi = -c_s^2\frac{k}{H}\delta - (1+w)\frac{k}{H}\alpha \quad (6)$$

$$\frac{1}{H}\delta_{ew}' = \frac{k}{H}\psi_{ew} - 4\alpha \quad (7)$$

$$\frac{1}{H}\psi_{ew}' = -\frac{k}{3H}\delta_{ew} - \frac{4k}{3H}\alpha \quad (8)$$

$$\left[\left(\frac{k}{H}\right)^2 + \frac{9}{2}\,(1+w_R)\right]\alpha = -\frac{3}{2}(\,1+3c_{sR}^2)\delta_R \quad (9)$$

$\delta \equiv \frac{\delta\varepsilon}{\varepsilon}$, where $\delta\varepsilon$ represents energy density fluctuation and ε represents background energy density. ψ and α related to fluid velocities and fluctuation of the temporal part respectively.

The numerical solution of these equations gives the time evolution of the energy density function which is depicted in fig. 2.

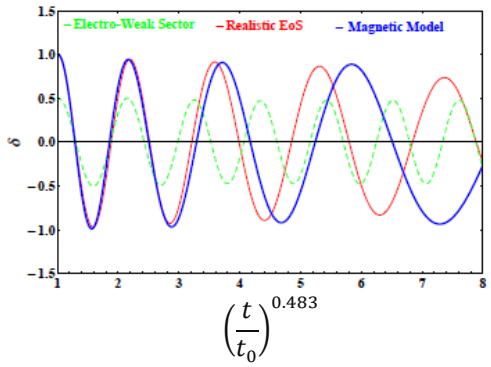

Fig 2

[The time-evolution of the energy density function corresponding to the electro weak part, lattice QCD data and with reference to primordial magnetic field are given by green dashed line, red line and blue line respectively.] [21]

It is evident that the density fluctuations are associated with the thermal fluctuations in the early universe. The model holds that the distributions of matter at the largest scales are connected to the temperature fluctuations as found in the CMB records. The black body spectrum of the CMB radiation reveals that ordinary matter and dark sector should be locked together in thermal equilibrium with the same temperature of the CBR. The thermal gravitational waves through gravitational interaction get coupled with dark matter and dark energy. Thus, the CMB radiates gravitational phonon black body radiation [22**].**

Because of thermal fluctuation, the material particles execute mechanical vibration, which produces both acoustic mode and the optical mode. The acoustic mode of vibration gives rise to phonons and the optical vibration gives transverse photons. In the early universe, the optical mode, i.e., the photons remain embedded in matter and are in thermal equilibrium. Due to high density of the early universe, the quantum effects predominate in spite of high temperature.

The acoustic part plays major role in structure (galaxy) formation. It has been established from observations that in the condensation region there are the formation of more galaxies. This happens because of density fluctuation produced by the acoustic waves. Of course, the wave length of this longitudinal wave is extremely high (~parsec or greater than that). Only when the light and matter get separated, it can be said that universe become visible from the darkness. However, at very high temperature, the wavelengths of the electromagnetic waves, which are photons in quantum sense, are not in the usual visible zone. They are very hard X-rays or Gamma rays. Because of expansion of the universe, they became visible to human eyes. Now it is in the microwave zone.

Both acoustic wave and electromagnetic wave are of the nature of oscillation. The acoustic wave manifests as the oscillation of material medium whereas the electromagnetic waves are of the nature of the oscillation of fields. De Broglie's theory of matter waves suggests that there is a wave associated with every particle of the universe. This wave is the oscillation of probability. May it be a material object or a field, oscillation is common to all. Therefore, it can be inferred that vibration is fundamental to all material objects in the universe. The universe, at its early state, consists of electromagnetic radiation which contains high energy photons. These photons through the process of pair production initiate the process of manifestation of matter. Moreover, acoustic oscillation of the primordial fluid was also found in the early universe. Again, field theory suggests that elementary particles are born out of the quantum vacuum in the terms of vacuum fluctuations as understood in the framework of quantum field theory (QFT). Quantum fluctuation, as we know, is the change of material existence at any point in space and is equated with creation of particle-antiparticle

pairs. Vacuum neither contains matter nor does it contain energy. The fluctuation at the fundamental level within the quantum vacuum gives rise to matter and energy. Therefore, it can be comfortably asserted that fluctuations give rise to forms and structures to the evolving universe. But at lengths smaller than Planck scale, due to the unavailability of a consistent quantum theory of gravity, the real scenario is not very clear. However, Wheeler's concept of quantum foam throws some light on the nature of fluctuations existent in the region of Planck's scale.

V. QUANTUM FOAM: FLUCTUATION BEYOND THE PLANCK SCALE

It is well known that no physical laws, which are valid in the continuum space-time, are valid beyond or around Planck Scale. Planck time is the shortest time in this physical universe which is even shorter than the resonance, the short-lived particles. The value of the Planck time is 10^{-23} sec. Similarly, the value of Planck length is 10^{-33} cm. It is considered as the shortest length in this physical universe. Some scientists are of opinion that space-time are the emergent properties. When the microscopic nature of space-time is studied, it is observed that at smaller length scales the uncertainty principle becomes important. Although classical mechanics considers flatness of the space-time even at small scales, quantum mechanics changes the notion by concluding that everything in this world even the gravitational field is subject to quantum fluctuations consistent with the uncertainty principle. The size of fluctuation of the gravitational field becomes larger in the smaller regions of space. These quantum fluctuations manifest as violent distortions of the surrounding space and time. In this context the concept of quantum foam, upheld by John Wheeler, becomes meaningful [23]. Therefore, the smooth geometry at small scale cannot be found due to the violent quantum fluctuations. Wheeler theorized that, according to the Heisenberg's uncertainty principle, over sufficiently small distances and sufficiently small intervals of time, the "very geometry of space-time fluctuates" [24]. These fluctuations may be sufficiently large to impact the smooth nature of space-time at microscopic scales giving rise to a foamy character of space-time at the very small regions. The reality beyond Planck scale is termed 'Veiled reality' by d'Espagnat [25].

But what was there beyond the singularity? Whether such fluctuations existed before the creation of universe? Whether fluctuation is more fundamental than space-time-matter continuum? All of these are open questions in the field of physics which have not yet been satisfactorily answered. However, some profound insights in this regard may be derived from the ancient the Indian wisdom and may be dovetailed with the latest findings of modern physics to construct a complete scenario.

VI. INSIGHTS FROM ANCIENT INDIAN WISDOM

Several terminologies like *jyotiḥ*, *tejaḥ*, *agni*, *prakāśa* etcetera have been used arbitrarily in Indian wisdom to denote light. It is notable that Pāṇinian *Dhātupāṭha* most often has documented the meaning of the roots like *varc*, *kāc*, *ej*, *bhrej*, *bhrāj*, *haṭh*, *kan*, *bhās*, *kāś*, *dyut*, *ruc*, *jval*, *bhrāś*, *rāj*, *tviṣ*, and many more, conceiving the notion of light, as *dīpti*. Although, the modern Indian languages of Sanskrit origin most often use the word *āloka* to denote *light*, the same without being compounded with a preceding word, was not in common use in ancient scriptures. However, the primitive as well as contemporary term *jyotiḥ*/*jyoti* seems closest to the notion of physical *light*.

Sound–both audible and inaudible have often been denoted by the words *vāk* and *śabda* since the vedic era. It requires mention that the words *vāk* and *śabda* are interchangeably used in the sense of mechanical sound and all sorts of vibration. *Nāda* and *spoṭa* are other two philosophical terminologies which were used to denote sound/vibration.

Both *jyotiḥ* and *vāk* are often identified with Brahman–the Supreme Reality in ancient Indian scriptures. For example,

1. The *Vāk-sūkta* of the *Ṛgveda* expresses the nature of vibration in mystic language, where vibration is identified with Consciousness–the *Brahman* [26].
2. *Īśopaniṣad* conceives of the Absolute both as primordial vibration as well as the cessation of vibration [27]. When the vibration associated with the *Ākāśa* (space-time continuum) appears to cease becoming potential, the *Ākāśa*, then appears without vibration. The vibration exists in potential form within it. The motionless and vibrationless *Ākāśa*, being one with the potential vibration, is termed *Kha*, which may be referred to as *Śūnya* (void) of the Buddhist tradition [28].
3. That motionless and vibrationless *Ākāśa* is said to be interwoven with the *Akṣara*–the Absolute/Consciousness [29].
4. An ancient vedic text identifies the *Ākāśa* with *Vāk* (vibration), *Āditya* (Sun) and *Indra*. *Vāk* and *Agni* (fire) are further identified with each other [30]. Sun and fire, being the source of light are thus identified with vibration and space-time continuum.
5. It is found that lightning, which is a manifestation of light is considered identical with the Absolute Consciousness. Vibration is also considered as indicative of the Consciousness Absolute [31].

6. *Praṇava* or *Oṁkāra* includes the domain of all the frequencies which may be produced by the vibration of our speech instruments. Therefore, *Oṁkāra* is the indicative of vibration. *Oṁkāra* is regarded the sound-symbol of the *Brahman* (Absolute Consciousness). It is also noteworthy that *Oṁkāra* in a few texts has been identified with *Āditya*, the luminous Sun, which is the source of light [32].
7. Bhaṭṛhari holds the opinion that the eternal *Brahman* (Absolute Consciousness) is identified with the primordial vibration [33].

The ancient Indian wisdom holds that vibration is not only the basic property of both sound and light, but is interwoven with the entire cosmos. Furthermore, vibration has been identified with the Absolute Consciousness, which the Indian wisdom upholds as the Ultimate Reality. Perhaps beyond the Planck's scale, where the laws of Physics are not sufficient to explain, the space-time continuum displays some sort of wild fluctuations. The primordial vibration quietens down and remains in potential form within the *Ākāśā*. Whenever the vibration becomes potential within *Ākāśa*, the *Ākāśa* is called the *Kha* or *Śūnya* (void). This *Kha* or *Śūnya* is the Absolute Reality. When the vibration becomes active, the potential *Ākāśa* actualizes as the universe.

VII. SCIENTIFIC VIEW RELATING CONSCIOUSNESS WITH VIBRATION

In the recent past, oscillation is referred to describe the rhythms of the brain which is considered as the seat of consciousness. Berger observed that brain gives electrical responses and prominent electrical activity is found in the occipital region of the skull. He related this activity with continuous oscillation. The electroencephalogram reveals these continuous oscillations of different amplitudes [34]. Electrical Waves of different amplitudes correspond to different psychosomatic (conscious) states of an individual. However, Neuronal oscillations, though quite complex, have also its relationship with consciousness.

Recent work on Dirac's Large number hypothesis by Roy *et al* has shed new insights into some sort of linkage between oscillation and consciousness. The workers have found out a large number in life sciences which is of the order of Dirac's Large number (10^{40}). This large number is the ratio of the smallest time scale of 40 Hz of oscillation in neuronal system to the smallest time scale called Planck time. The number thus obtained is similar to the Dirac's large number. The study suggests some sort of connection of material world with 40 Hz gamma oscillation of neurons [35].

VIII. CONCLUSION

Ancient Indian wisdom holds that vibration is the fundamental principle which is inherent nature of the primordial mass that evolves as the universe and its constituents. Therefore, manifestation of vibration, in gross or subtle form, is very natural in all worldly objects and phenomena. The same primeval vibration fills the world as light, sounds as music, opens the skies, sends out subtle ripples floating in space and impels the wind. It strikes the chord of consciousness engendering the sweet music of the soul. The entire existence surges upon the crest of vibration. The cosmic dance in eternal rhythm is the expression of the primordial vibration. Vibration is ecstasy and it is the Reality.

Study of physics also reveals that vibration/fluctuation is associated in almost all systems of the physical universe. Audible sound and visible light are very tangible examples of acoustic wave and electromagnetic wave respectively which are fundamentally of the nature of vibration. Furthermore, vibration of probability reigns the quantum world. Quantum fluctuations appear to be the seed of all manifestations. All these cosmic expressions are imprinted in the oscillation of geometry. Ancient Indian wisdom terms the primordial vibration Brahman which is otherwise called the absolute.

REFERENCES

[1] Cf. Bhaṭṛhari, Vākyapadīya, Brahmakāṇḍa.

[2] Cf. Kaṭhopaniṣad 2/2/9.

[3] The root √*ej*, found twice in the Pāṇinian *Dhātupāṭha*, give the meanings *to glow* (*ejṛ dīptau*, PāDhā 179) and *to vibrate* (*ejṛ kampane*, PāDhā 234; *kapi calane* 374) respectively. This suggests that light is of the nature of vibration/wave. The root √*kaṇ* is read twice, one of which means *to make sound* (*kaṇa śabde*, PāDhā 449), and the other means *to go* (*kaṇa gatau*, PāDhā 794). This again hints that sound also is nature of vibration/wave.

[4] The Sanskrit word *kaṇā*, which means particle, is derived from the root √*kaṇ*. The root √*kaṇ* connotes movement. Sound and light are vibration in nature. Therefore, particle nature is existent in both sound and light.

[5] Cf. Bhaṭṛhari, Vākyapadīya, Brahmakāṇḍa 1.

[6] Cf. Ṛgveda 1/164/29; Yāska, Nirukta 2/1/9/1.

[7] Cf. Jaiminīyopaniṣadbrāhmaṇa 7/1.

[8] Cf. Nighaṇṭu 1/5, 1/11; Ṛgveda 1/164/29; Yāska, Nirukta 2/1/9/1; Bṛhadāraṇyakopaniṣad 3/1/3; 4/3/5; Chāndogyopaniṣad 6/6/4; Jaiminīyopaniṣadbrāhmaṇa 9/1; Bhaṭṛhari, Vākyapadīya, Brahmakāṇḍa 12, 18.

[9] Cf. Infra., Insights from Ancient Indian Wisdom.

[10] Cf. Lawrence A. Crum, *"Sonoluminescence"*, Physics Today, 47, 9, 22 (1994); https://doi.org/10.1063/1.881402.

[11] Cf. M.N. Saha and B.N. Srivastava, A Treatise on Heat, Allahabad: The Indian Press (Publications) Pvt. Ltd., 1991 (14th rpt.) (1st ed. 1931), pp. 584-585.

[12] Cf. Ibid., p. 587.

[13] Cf. Ibid., pp 586-587.

[14] Cf. Ibid., p. 588.

[15] Cf. Loc.cit.

[16] Cf. Loc.cit.

[17] *Cf.* Edward L. Wright, "*Acoustic waves in the early universe*", *Journal of Physics: Conference Series* 118 012007.

[18] Swami Vivekananda, *Raja Yoga*, Kolkata: Advaita Ashrama, 2016 (48th rpt.), p. 40.

[19] *Cf.* Christopher J. Miller *et al*., "*Acoustic Oscillations in the Early Universe and Today*", arXiv:astro-ph/0105423v1 23 May 2001.

[20] Christoph Schmid *et al*., "*Amplification of cosmological inhomogeneities from the QCD transition*", Phys.Rev., D59:043517, 1999.

[21] G.L Guardo, *et al*., "*Energy density fluctuations in Early Universe*", arXiv:1401.7613vl [hep-ph] 29 Jan 2014.

[22] Li Ti-Pe and Wu Mei, "*Thermal Gravitational Radiation and Condensed Universe*", arXiv:1612.04199v1 [physics.gen-ph] 7 Dec 2016.

[23] S. Roy, *"Plank Scale Physics, Pregeometry and the notion*", arXiv:gr-qc/0311012v1 4 Nov 2003.

[24] Wheeler, John Archibald; Ford, Kenneth Wilson, *Geons, black holes, and quantum foam: a life in physics*. New York: W. W. Norton & Company, 2010 (rpt.) (1st ed. 1998), p. 328.

[25] B. d'Espagnat, *Veiled Reality, An Analysis of Present-Day Quantum Mechanical Concepts*, Reading (Mass): Addision –Wesley, 1995.

[26] Ṛgveda 10/125.

[27] Īśopaniṣad 5.

[28] om khaṁ brahma–end of the Īśopaniṣad, Mādhyandina recension.

[29] Cf. Bṛhadāraṇyakopaniṣad 3/8/7-8.

[30] Cf. Jaiminīyopaniṣadbrāhmaṇa 7/1, 8/1, 9/1.

[31] Cf. Bṛhadāraṇyakopaniṣad 5/7-8.

[32] Cf. Chāndogyopaniṣad 1/5/1.

[33] Bhatṛhari, Vākyapadīya, Brahmakāṇḍa 1.

[34] Cf. György Buzsáki, Rhythms of the Brain, New York: Oxford University Press, 2006, p. 6.

[35] Cf. S. Roy, "*Dirac's Large Number Hypothesis: Is it related to 40 Hz Gamma Oscillation or Consciousness?",* NeuroQuantology, Spetember 2015, Volume 13. Issue 3, pp. 253-258.

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