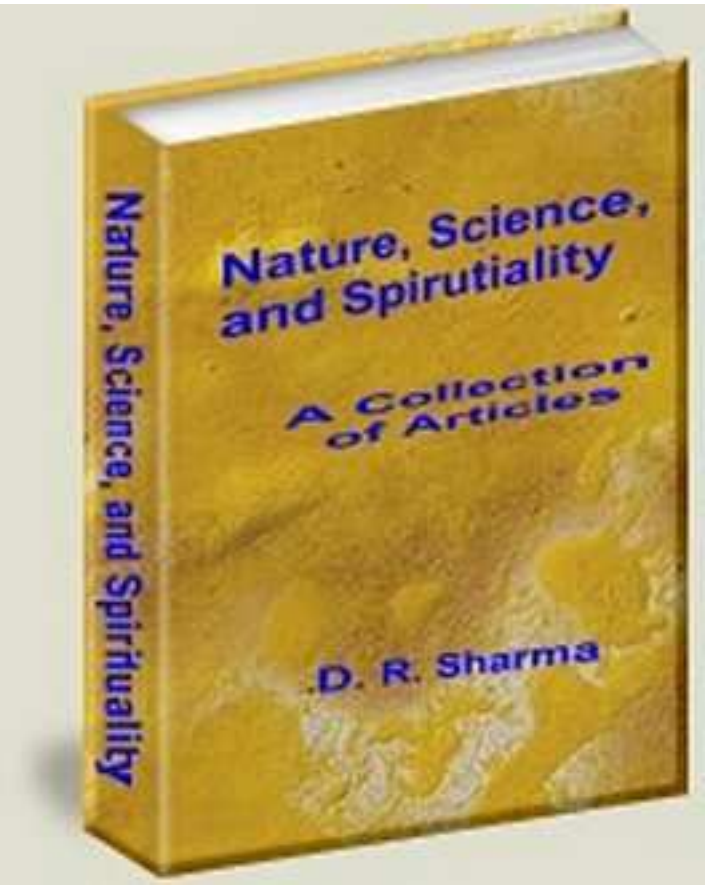

Cosmos Ebooks

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MYSTICISM AND SCIENCE

In the past few decades there has been a growing interest in bringing science and spirituality closer to each other. There are an ever-increasing number of books and articles on science and consciousness. Mysticism is closely related to consciousness as all mystical experiences involve altered states of consciousness. It is commonly understood as the doctrine or belief that an intuitive knowledge of, or communion with the Ultimate Reality is possible through meditation or contemplation. Traditionally, therefore, mysticism and mystics have always been associated with religion. In the modern age though some believe that mystical experiences can be induced by other means, by ingesting psychedelic drugs for example. This brings physiology into the picture leading to the belief that mysticism can be studied scientifically, meaning thereby that there can be scientific explanations of mystical experiences. As a result mysticism has attracted attention from scientists in a wide range of fields including chemistry, neurology, psychology, and even quantum physics.

There is a wealth of information available in the literature on the current state of affairs in the study of mysticism, containing among other things, the views of prominent scientists and psychologists, some of them famous ‘experts’. The premise of this article is to discuss whether mysticism can be explained in a rational way, i.e. if science can successfully explore it. However, in order to get anywhere in that quest one must be sure about what mysticism means. The diversity of opinions expressed by the experts from different fields is a reflection of the difficulties in even precisely defining mysticism let alone understanding it. This leaves one with a feeling of skepticism in accepting in totality the views of any expert, and at the end there are more questions than answers. The main problem in the scientific investigation of mystic visions is the impossibility of verifiability and repeatability. Each vision is unique and even the same person rarely has the same vision twice. Unlike the usual scientific experiments there is no snapshot of the vision, only the description given by the subject. Mystical experiences are believed to be ineffable, so how accurate the descriptions are? In the case of brainwave patterns how can one know with certainty in what meditative state the person was? The neurologist has to depend on the subject’s description. If it were a truly transcendental state, it would transcend language as well.

Mystical experiences, at least those sought out deliberately, consist of visions and the attendant feelings. Some may lead to enlightenment, others remain just experiences. They all result from altered states of consciousness. The rationalists would like to believe that they are all products of the chemical and electromagnetic transformations induced in the brain. Since consciousness operates through the mind and then

physiologically through the brain, this assertion may be true as far as the brain function is concerned. Like everything else, brain function itself is a manifestation of conscious experience. So it cannot reveal anything about consciousness, which is absolute and cannot be defined in terms of anything else. The brainwave patterns are determined by the state of consciousness, not the other way around. The basic premise of the neurological study of mysticism is, therefore, flawed. Furthermore, we run into the classic problem of the observer, observed, and observing system. It is doubtful that with all the electrodes stuck to his scalp any mystic, however adept, can replicate his natural meditative state. This is not to say that these experiments do not serve any purpose. They can be very useful in many other ways but not in the study of mysticism as a path to enlightenment.

In his vision a mystic is still in the realm of sense perception. He is 'seeing' things and is 'feeling' pain, pleasure or whatever as a result of the visual perception. It is not a transcendent vision because he has not transcended anything. It is no different from the dream state. This is true regardless of the method used for getting that mystic vision.

There are different levels of reality. Each successive level transcends but enfolds the lower one. As a commonplace example we can consider a movie or a play. At the lowest level it is a celluloid film consisting of individual frames. Projected on a screen in quick succession they present a continuous picture depicting the underlying story. For the duration of the movie the scenes and the actors appear real even though the viewer knows that everything is made up, just a shadow play. It is a transient conglomeration of people, things, and places to impart a virtual reality to mental images. Still the emotions and feelings evoked are the same as those produced by real events in real life. The movie lasts only for a few hours and the individual actors play their assigned parts and are back to their normal life. The real physical world that we live in, also has its own levels of reality just like the movie, only the time scale is different. We are all actors on the world stage and our roles may last for decades instead of hours. The only difference is that we cannot view the play from outside; we are in it and can have only a partial view. The story and the script are not known in advance. As in the movies the director of this play is someone viewing it from the outside (or the direction is orchestrated by probabilities and wave function collapse). But just as we cannot watch the movie without a screen, there has to be a background for any perception to occur. To write we need a blank paper, to hear anything we need a background of silence. To perceive anything we need a background of emptiness. We perceive the world around us against the background of an infinite void and that is the Ultimate Reality. This is the view from the macrocosm not very different from the one from microcosm. At extremely small scales

everything in the universe is intrinsically a swirling mass of quarks and electrons, which keep appearing (and disappearing) on the background of the quantum void.

There may be different stages or degrees of enlightenment as well. If enlightenment means merging with the Ultimate Reality or union with God, it is a goal beyond reach during one's lifetime. One can see the light but can never grasp it; it is there to lead one on. The soul, when liberated from the body, may reach that goal. But whatever happens after death is merely a conjecture or a philosophical theory based on some intuitive knowledge. It does not matter where it comes from, be it Vedanta or the theology of Abrahamic religions; it is still a theory and not the description of reality. No body has ever come back to say he is dead and relate his experience. However, even though the path is endless one can strive to get as close to the goal as possible. And there may be a few who have reached close enough to be called enlightened. But they are not going to proclaim their achievement to the world, write books, and attract followers. That stage of enlightenment, even though it is not total, means complete disappearance of the ego. The state of non-duality and the presence of ego are mutually exclusive. Also, attaining a certain level of enlightenment does not guarantee a permanent abode there. The person still has his feet on the ground and subject to the same human limitations as others. To reach a height is one thing and to stay there is another; fall is much quicker than ascent. This is what happens to the so-called gurus who end up being perverted creeps.

Mysticism as a spiritual quest may lead to realization or nirvana. If nirvana is the ultimate goal, why does the soul get separated from its source in the first place? Nobody knows or will ever know the answer. But the underlying motive may be the same as for the creation of the universe. The question as to why the universe came into being can also never be answered either scientifically or philosophically. As a famous hymn (*Nasadiya sukta*) from Rigveda says: ".. may be He knows or may be even He does not know". So here also only conjectures are possible. Looking at the nature we find that the desire for self-expression is inherent to every living organism; the life cycle itself represents that. The flower blooms not for others but for itself, a bird in the forest sings not for others but for itself. The urge for self-expression leads to creativity. Perhaps consciousness itself seeks self-expression and that is why the Supreme Consciousness expresses itself in the manifest universe and its life cycle. Getting back to the separation of the soul, it is reasonable to assume that without the soul there would be no consciousness and the creation would be inert and meaningless; the very purpose of self-expression would be defeated.

Can mysticism be rational? It depends on what one understands by mysticism which has different colors, each having different shades. If it is understood as a quest of the Ultimate Reality, it is beyond reasoning and, hence, cannot be rational. On the other hand if it is identified with some sort of vision, as is commonly done, it may be explained in a rational way; this is what neurologists and psychologists are attempting to do. But visions do not represent reality. Here mysticism is not related to spirituality except in a subjective sense.

The mystic vision is not necessarily tied to meditation or ingestion of psychedelics or even to asceticism. People leading ordinary life can have these visions. When Kabir sees ‘the ocean merging into a drop’ or Blake sees ‘the world in a grain of sand’, it is mystic vision. Mysticism is an aspect of the mind and not associated with any external manifestation. It is inaccessible through rational knowledge that is the foundation of science. Reasoning, intelligence, and logic are all fine attributes but they have their limitations. They will not help in understanding and appreciating the serene beauty of a gorgeous sunset, the mesmerizing smell of an exotic flower, or the exhilarating spell of the sweet song of a bird.

ZERO INFINITY AND GOD

Language and culture are inherently related. Sanskrit is perhaps the best example. The word for culture in Sanskrit is *sanskriti*. Vedanta is the foundation of Hinduism and Hindu culture and Sanskrit is its language. So when one talks about Vedanta the use of Sanskrit words becomes inevitable since translation has serious limitations. For example there are two words in Sanskrit - *gyan* and *vidya* and both are translated as knowledge in English although they have different meanings. *Vidya* is something that can be acquired and accumulated. *Gyan* is inherently there in latent form but covered by *avidya*, i.e. lack of *vidya*. It comes suddenly when the covering gets removed just as things become visible when fog lifts; vidya helps to lift that fog. So *vidya* is associated with learning while *gyan* is associated with realization. These two words are further elaborated. There is *para-vidya* pertaining to spiritual subjects; this is distinguished from *apara-vidya* pertaining to material objects in the manifest universe. *Gyan* is undivided whole but it also has an associated word *vigyan*. The prefix vi- in Sanskrit means 'deviation from' or 'something-other-than'. So *vigyan* means realization of something other than consciousness. The universe has only two constituents - consciousness and matter. The goal of philosophy as well as science is to unravel the mysteries related to these two. So *vigyan* is rational knowledge whereas *gyan* is transcendental knowledge.

In science zero and infinity are mathematical concepts. Mathematicians consider zero as a finite number although physicists do not always agree with that view. Infinity of course cannot be regarded as a number. In Vedanta zero and infinity are regarded unknowable and therefore explaining or defining them is out of question. For any unknowable we cannot say what it is; it can be described only in terms of what it is not. That is why to answer the question what is Brahma Vedas only say 'not this not this (*neti neti*)'. This is not quite evident in the case of zero but in the case of infinity it is contained in the word itself. The Sanskrit word, from which zero and its equivalent words in all other languages are derived, is *shunya.* It is far more comprehensive in meaning than zero; it means zero only in the context of numbers. Its general meaning is void or emptiness, a concept that the mind cannot comprehend unless it itself is empty. (It should be noted that the mind that we usually speak of is the lowest level of *chitta*.) The same is true for infinity. Even in mathematics strictly speaking zero and infinity cannot be arrived at – any variable can only tend to either. Asking for the smallest number greater than zero or the largest number less than infinity is meaningless. In Sanskrit there is no single word for infinity. Several words like *anadi* (without beginning) and *ananta* (without end) are used. Upanishads characterize Brahma as 'smaller than the smallest and larger than the largest' (anorniyan mahato mahiyan … /1/). In the usual sense in which the words small and large are commonly used this statement may seem

to be a contradiction in terms. This is because our perception of small and large is tied to the mental construct of space and time. Small and large are a pair of opposites like pleasure and pain, happiness and misery etc. According to Vedanta they are two faces of the same coin. Opposites are an illusion produced by language. The small is contained in the large and the large is contained in the small in latent form just as a huge banyan tree is contained in the tiny seed. Even in mathematics (more precisely in geometry and in set theory) it can be shown that the infinite is contained in the finite. The notion of space-time leads to that of causation – cause preceding effect; as Swami Vivekananada put it, the sum total of space, time, and causation is *maya* that obscures the Reality /2/. In order to realize the meaning of zero and infinity one has to transcend space-time.

We exist in space-time. We as well as everything else in the universe are events in space-time. There are no objects only events. Every event has a lifetime and on cosmological scale most of the events are transient. Anything that has name and form (*naam roop*) is limited in space-time. How do we transcend space-time? Physically we cannot. But we are not the physical body, we just live in it. Human beings are capable of recognizing the fact that besides the gross body there is also a subtle body. It is the subtle body that can go beyond space-time and experience things outside of the phenomenal world. When I think of an object I am already bringing in a separation; the object is something different than myself the subject. If there is no object there is no separation. When every object is viewed as an event and the object vanishes, space-time also vanishes. The vanishing of the subject-object duality essentially means that the person has merged himself with the universe. In this state one has transcended space-time and zero and infinity come together. This is stated in Ishopanishad in a very simple language. “One who sees everything in himself and himself in everything does not have ill will against anyone. *Yastu sarvani bhutani atmanyevanupashyati, sarvabhuteshu chatmanam tato na bijugupsate /3/.*”

In science space and time were regarded absolute entities until Einstein shattered that notion with the Relativity theory. In Vedanta the only absolute entity is Brahman the Ultimate Reality. Space and time both imply separation, i.e. distance relative to positions or events. Anything that is relative cannot be absolute. According to quantum theory the position and time of an individual event are random and unpredictable. This is known as the Heisenberg’s uncertainty principle. Quantum physics also showed that the observer and observed are not separate but form an integrated system along with everything else involved in the process of observation. It has also done away with the concept of elementary particles; now there are no elementary particles. The fundamental unit is supposed to be vibration of a super string; different specific

configurations of these vibrations condense into particles that combine to form atoms, molecules and matter. Vibrations represent energy. Thus the empty space is no longer empty but filled with energy and myriads of virtual particles keep appearing and disappearing constantly. So at the most fundamental level there can be effects without causes and vice versa. In other words there is no distinction between cause and effect and the idea of causation becomes irrelevant. This is exactly what *vivartavad* of Vedanta implies. Matter comes from energy and disappears into energy; what happens is simply a transformation. Thus science is coming close to the viewpoint of Vedanta that the ultimate source of energy is Brahman and the entire universe comes out of this source. According to the generally accepted Big Bang theory in cosmology the universe originated from a single concentrated source – the space-time singularity. Here also zero and infinity come together – zero space-time and infinite energy. But science has no idea (at least not yet) why this point source exploded with a big bang or what was happening before. Vedanta has an explanation (even though philosophical) for how the universe originated from the one energy source Brahma. Physics can explain the conversion of mass into energy but has no clear idea of how mass, let alone consciousness, is created from energy.

In quantum theory void is not void after all; it is full of cosmic energy. Two great minds – Krishnamurti a philosopher and David Bohm an eminent quantum physicist discussed among other things the subject of emptiness and came up with the phrase – 'nothing is everything' /4/; once space-time is transcended void and emptiness take different meanings. As long as one is in the realm of space-time whatever one knows or can ever know is relative. Zero and infinity (*Shunya* and *ananta)* are absolute. As soon as we try to put anything absolute into words it ceases to be absolute because the very purpose of language is to isolate and put labels. Every thought involves the subject-object duality. We cannot be conscious of consciousness in the same way, as we are conscious of an object. Consciousness is not an object; as soon as we think about consciousness it becomes an object and ceases to be consciousness. The aim of any thought process is to know something. We cannot know consciousness. And that is why Upanishads say: how can the knower be known (v*igyataram are ken vijaniyat*). The absolute cannot be known, it can only be realized.

Both relativity theory and quantum theory point to an undivided wholeness of the universe in which there are no autonomous parts – everything is in everything. Starting from the premises of these theories David Bohm introduced the concept of implicate and explicate order /5/. Everything is enfolded into everything else and what one observes is unfolding of the enfolded version at a given instant. Like a hologram the part contains the whole as the whole contains the part. The fractal theory (which is a part of

chaos theory) shows this graphically. For example any piece of a cauliflower is a miniature cauliflower. There are many examples like that in nature. Thus the microcosm is a mirror image of the macrocosm, which is Vedanta's view. Prigogine a pioneer in the field of dynamic system theory (commonly known as mathematics of complexity) says; "The world we see outside and the world we see within are converging" /6/. In the life sciences the idea of wholeness has been there for a long time but it has come into prominence only in the last few decades. Every living organism depends on the process of feedback and thus all parts of the organism are not only interconnected but also interdependent. A living organism is not a thing but a smoothly flowing process and its flow is determined by two things: its pattern of organization and its structure. The pattern determines its identity, while the structure formed by a sequence of changes or modifications, determines the system behavior. So the course of evolution of a living system including human beings is both determined and free. This is what the doctrine of karma implies.

The concept of undivided wholeness is basic to Vedanta. Everything in the universe is Brahma because it is simply a manifestation of that Ultimate Reality. The Upanishads say: He moves and remains still at the same time; He is near as well as far; He is inside as well as outside (tadejati tannejati taddure tadvantike, --- /3/). The first of the four great sentences (mahavakyas) of Vedanta is 'I am Brahma (Aham brahmasmi)'. If I am everywhere at the same time, for me there is no space and there is no time. There is movement because energy is dynamic. However, the concept of movement is now totally different. Space and time are not involved in it. The concept of non-locality in modern physics has come very close to this view.

We have seen that according to philosophy as well as science the primordial form of the universe is energy. What is energy? We really do not know. We cannot see energy, we can feel its presence only through its effects on our senses. Our sensory perceptions are only quantitative not qualitative. That is why there is a threshold for every sense organ. We cannot hear sound unless it is above a certain intensity level; we cannot see anything unless the light falling on it has a certain minimum intensity. And that is true for all sense perceptions. So we do not know anything about the quality of energy. Out there, there is no light and no color, there are only electromagnetic waves. Out there, there is no sound or music only acoustic waves, periodic variations of the air pressure. What we finally sense is the projection by the mind after it processes the signals sent by the sense organs. This is true for everything that we see out there in the universe. Everything is a packet of waves - the dynamic representation of energy. According to quantum physics everything in the universe can be mathematically represented by wave functions. An object is seen at a given place at a given time only as a result of bunching

together of the wave functions. Technically it is called wave function collapse or state vector reduction in mathematical terms. Thus modern science is also coming to the viewpoint, although from a different direction, that the universe as we know it, is built and experienced entirely within our heads. In Vedanta (specifically in *advaiatvad*) this is known as the doctrine of *maya*. What we see is not real; only thing that is real is energy and we cannot see energy. Energy is also consciousness and once realized, it is the highest state of happiness and contentedness. The ultimate source of energy is Brahma. That is why He is known as Reality-Consciousness-Bliss (*Sat-Chit-Anand*). Only Brahma is real everything else is unreal and *jiva* is none other than Brahma (*Brahma satyam jaganmithya*, *jivo brahmaiva naparah /7/*). That is the quintessence of *advaitavad* expressed in a single line of Shankaracharya. The phenomenal world is real so long as the veil of ignorance (*avidya*) is not lifted, just as the dream world is real as long as the dream lasts. Once Brahma is realized everything else becomes unreal.

References

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4. Krishnamurti and Bohm, The Ending of Time, p. 27.
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7. Shankaracharya, Vivek Chudamani, p. 7 (verse 20)

NUMBERS, NATURE, AND PHILOSOPHY

Numbers are something with built-in exactness. When we think of five in whatever context it is precise, there is no ambiguity about it. The preponderance of numbers in our lives is such that we hardly pay much attention to this feature. There is hardly any activity in which numbers do not figure. Numbers come in different sizes but all can be expressed as a collection of ten primary or natural numbers from zero to nine. There is some argument as to whether zero is a finite number but we shall not go into that here. We simply note that it does not have the exactness referred to earlier.

Numbers are also classified in various ways like prime, rational, irrational, and also transcendental. Some of these terms are anthropomorphic and are used as mere definitions. But whatever be their classification numbers are just symbols to be used in expressing some idea. By themselves they mean nothing. There is nothing seven-like in seven; it acquires a meaning only in association with something being counted. Although we deal with numbers all the time in our daily lives, we hardly ever see them as existing in their own rights. However, if we look at them closely, we find that some are special with distinct 'personality'. For example, zero and one; multiply any number by zero and it puts its face on it; as for one it creates all whole numbers by adding itself repeatedly.

Then there are groups of numbers in special combinations – series are sequences that are unique in their own way. One of them is encountered conspicuously in nature, although there is as yet no satisfactory explanation for that. This is a sequence of numbers starting from one*, with each subsequent number obtained by adding up the previous two. This is known as Fibonacci sequence in the literature. The first few numbers are one, one, two, three, five, eight, thirteen, twenty-one, and the sequence continues on indefinitely.

Numbers in Nature

There is well-documented evidence of occurrence of these numbers in nature. Pinecones, pineapples, daisy flowers, sunflowers all exhibit these numbers. If you look closely at a pineapple or a pinecone, at any point on the surface you find the little protrusions are arranged in spirals going in mutually perpendicular directions. The same is true for the arrangement of seeds at the center of the flowers. A curious fact is that the numbers of spirals in each case are always two consecutive numbers of Fibonacci sequence. A pinecone may have spiral count of (3,5), (5,8), or (8,13). A ripe pineapple has a spiral count of (8,13). A coneflower has (13,21) spiral count at its center. The

center of a daisy flower has a spiral count of (21,34). The sun flower has a spiral count of (34,55) or (55,89) depending on its size. Similar patterns are found in many other plants and even vegetables.

The sequence is named after Fibonacci because he found it by studying the reproduction progress of a pair of rabbits in a year assuming that the pair produced a pair of babies each month and the babies at one-month age were able to produce a pair likewise. The number of pair of rabbits follows the sequence. He published the results in a book and the sequence came to be known by his name. The genealogy of honeybees also follows this sequence.

Even though the sequence became well publicized only in early thirteenth century, it had been known earlier albeit without a name. In Sanskrit poetry syllables are classified as short or long. A line of a poem contains a combination of these. In the metrical construction a problem arose as to in how many ways the short and long syllables could be arranged, assuming that every line takes the same time to recite. Studying this problem in relation to the number of time units, in 1150 AD Aachaarya Hemachandra in India found that the number of ways in which short and long syllables could be arranged for sequentially increasing time units followed this very sequence. This was more than seventy years before Fibonacci published his book Liber Abaci[1].

Numbers and Philosophy

Although spirals with adjacent numbers of the sequence occur in nature so abundantly the reason for this is not clear. There are two aspects to this problem. One is the presence of interlocked spirals, the other is their numbers. The current belief is that during the growth of the plants, flowers, and fruits this arrangement gives the optimum space utilization for a given surface. We can also think of the spirals as interconnecting links for all the elements as well as connecting each one to the single source – the root, symbolically representing the fact that everything in the universe is connected to everything else.

One way of looking at the numbers in the sequence is to consider the start of the life cycle itself. One seed germinates into one plant with two leaves to begin with. In some plants the next two stages are three and five leaves. Thus the building blocks for the sequence are in place. Now we carry this idea to philosophy considering, specifically Vedanta and its theory of the origin of the universe. To begin with there is only one

[1] Acarya Hemcandra and the (so-called) Fibonacci Numbers, Int. J. of Mathematical Education, Vol. 20 (1986), pp. 20 – 30.

Ultimate Reality – the Universal consciousness. The other aspect of consciousness is energy and now we have two unities. In Vedanta and Sankhyathese are called Purusha and Prakriti . Next there are three universal qualities (trigunas) and five intrinsic natures of matter (panchatattva ; there is no exact English equivalent of the word tattva unless we coin a word 'thatness'). Consciousness and energy together with trigunas and panchatattva create everything in the universe. So the origin of the universe itself is based on the numbers one, one, two, three, and five, the building blocks of the Fibonacci sequence.

*Strictly speaking the starting numbers should be zero and one because their addition gives the second one in the sequence. Conventionally though zero is not included in the sequence. The only meaningful operation with zero is addition, which itself sets it apart from finite numbers.

So far we discussed numbers in nature and their possible philosophical significance. Now let us consider some other unusual aspects of numbers.

Zero and Infinity

Unlike other real numbers zero and infinity do not have any quantitative attribute. Strictly speaking they are not numbers although mathematicians do consider zero as a finite number. The statement that I have five dollars makes perfect sense but 'I have zero dollars' does not. If asked to I can show the five dollars but cannot show the zero. So zero is just a concept like infinity. The concept of a thing is not the thing itself but only an attempt to describe what it is.

Zero and infinity figure prominently in philosophy, especially in Eastern philosophies. They are considered two sides of the same coin, as are all pairs of opposites. They are interlinked like the two ends of an infinite spiral and also contained in each other. We cannot go into the details of these philosophical arguments here and simply mention that the Ultimate Reality is described as 'smaller than the smallest and larger than the largest' (Vedanta) and 'nothing is everything' (Tao).

Irrational and Transcendental Numbers

Numbers that cannot be expressed as a ratio of two integers are called irrational. I suppose they are called irrational because of the belief that the only rational way of

expressing a number is in terms of two other whole numbers. Their decimal expansions do not terminate nor become periodic. The most well known irrational number is the square root of two. These numbers are, by definition, indeterminate, although geometrically one can get the value of square root of two by measuring the hypotenuse of a right-angle triangle with height and base equal to one. However, as we shall see later, it brings in another problem – the error of measurement.

As one can guess from the name itself, the definition of transcendental numbers is a little complicated. (These are numbers that are not roots of integer polynomials so they are not algebraic numbers of any degree.) All transcendental numbers are irrational. Frankly I do not know what they transcend other than an easy definition! Anyway, two are most common. One is associated with circle and is denoted by the Greek letter Pi; the other is denoted by e for exponential and is associated with logarithm. Another such number is the so-called golden ratio denoted by the Greek letter Phi, which is apparently favored by nature and can be traced even in human anatomy. Architectures using this ratio are aesthetically more pleasing. It also related to Fibonacci sequence discussed in part 1 of this article.

Approximations and Errors

Since the values of irrational and transcendental numbers cannot be determined precisely, one has to resort to approximation. Any approximation has some inherent error. This means that the use of these numbers will not yield a unique result. The circumference or the area of a circle cannot be determined precisely because it involves multiplication by Pi. The exponential growth of any variable quantity cannot be calculated exactly because of the use of e. The same is true for using the golden ratio. If we use geometrical methods of determining the values of the square root of two or the circumference of a circle, the approximation error translates into measurement error that can never be completely eliminated.

This takes us back to what was mentioned about zero. No matter what we do we can never get to zero. The same holds for infinity. This bears an analogy to the spiritual goal of reaching the Ultimate Reality. If this goal is nirvana, it cannot be attained while living. One can only strive to get as close as possible and the closest possible approach is called enlightenment.

COSMIC SINGULARITY AND GOD - A VEDANTA PERSPECTIVE

The goal of both science and philosophy is to explore and understand the Reality behind all existence. From the very dawn of civilization man has tried to know the nature and the universe it is embedded in. Philosophers and scientists alike have probed into the secrets of nature and the origin of the universe has been the focal point of their investigations. Philosophers have their conjectures and scientists have their theories but no one has been able to grasp the reality. According to the generally accepted theory in cosmology it is now believed that the universe grew impulsively from a concentrated point source of infinite energy called space-time singularity. In spite of the general acceptance the theory has many problems, one of them being the very nature of the singularity. Singularity is a mathematical concept that brings together two other mathematical concepts – zero and infinity. Although mathematics regards these as the two extremes of the number system, they have nothing in common with numbers. By very definition numbers are quantitative. They have meaning only in relation to some objects. By themselves they mean nothing; five has nothing five-like, it is only a symbol. Zero and infinity have no quantitative aspect to them, they can be referred to only qualitatively. Each is an indivisible whole. They do not depend on other objects for their meaning. In other words they are absolute not relative. Any number multiplied by zero or infinity loses its identity, it merges into the multiplier. Any number divided by zero yields infinity, but divided by infinity yields zero. This process of division is like flipping a coin having zero and infinity as the two sides. The same idea is expressed in Vedanta from a different perspective.

In Vedanta zero and infinity are regarded unknowable and therefore explaining and defining them is out of question. Strictly speaking, even in mathematics zero and infinity cannot be arrived at; a variable can only tend to either. Looking for the smallest number greater than zero or the largest number smaller than infinity is futile. For any unknowable we cannot say what it is; it can be described only in terms of what it is not. That is why in answer to the question what is God (Brahman or Brahm) the Vedas say ‘not this, not this (*neti neti*)’. The Sanskrit word, from which zero and all its equivalents in other languages are derived, is *shunya*. It is far more comprehensive in meaning than zero; it means zero only in the context of numbers. Its general meaning is void or emptiness, a concept that the mind cannot grasp unless it is itself empty (the initial premise of yoga philosophy). The same is true for infinity. In Sanskrit there is no single word for infinity. Several words like *anadi* (without beginning), *ananta* (without end) etc. are used. Upanishads characterize Brahman as ‘smaller than the smallest and larger

than the largest' [1]. In the usual sense in which the words small and large are used, this statement may seem to be a contradiction in terms. This is because our concept of small and large is tied to the perception of space and time. Small and large are a pair of opposites, which according to Vedanta are two faces of the same coin. Opposites are illusion produced by language. Small is contained in the large and large is contained in the small in a latent form. As Kabir, one of the greatest Indian mystics has said: "The drop merges in the ocean. Where do you search for the drop? The ocean merges in the drop, where do you search for the ocean? The end of the search is the realization that each is in the other" [2] (translation is mine). The concept of space-time leads to that of causation – cause preceding effect. The sum total of space-time and causation is *maya* that obscures the Reality [3]. Being absolute, zero and infinity are two aspects of the one Ultimate Reality. In order to realize them one has to transcend space-time.

The singularity brings zero and infinity together. The cosmic singularity combines zero space-time and infinite energy. In Vedanta the primordial state of existence of the Reality is an infinite emptiness (*shunyata*). When the mind is completely empty and one transcends space-time in deep meditation, one is able to realize this state. However, this emptiness is not nothingness or non-existence. It is pervaded by energy and consciousness. We have arrived at the same concept coming from quantum physics; the quantum void is not empty. There are myriads of virtual particles appearing and disappearing constantly and there is an all-pervading cosmic energy. This state is the substratum of all existence and is called the 'ground' by mystics as well as physicists [4]. The dictionary meaning of singularity is 'the state of being unique or only one of its kind'. In that sense we can view the Ultimate Reality also as a singularity. In cosmology a 'naked singularity' cannot be observed or probed because it is enveloped by the event horizon. From Vedanta's point of view we cannot see the Reality because it is veiled by *maya*. The laws of physics break down at the singularity; the rational knowledge cannot penetrate through the veil of *maya*. Even though space-time goes to zero at the singularity, the concept is still wrapped up in space-time; it is defined as a point singularity. We cannot transcend space-time through the rational mind.

We exist in space-time. We as well as everything else in the universe are simply events in space-time. Every event has a lifetime and on cosmological time scale most of the events are transient. Anything that has name and form has a beginning and an end in space-time. How do we transcend space-time? Physically we cannot. But what one calls 'I' is not the physical body, 'I' just lives in it. Besides the gross physical body there is also a subtle body. It is the subtle body that can go beyond space-time and experience things outside the phenomenal world. When I think of an object I am already bringing in a separation, the object is something different from myself, the subject.

Space-time implies separation – distance between two points or two events. When every object is viewed as an event and the object vanishes, space-time also vanishes. The vanishing of the subject-object duality essentially means that the person has merged with the universe. In this state one has transcended space-time and zero and infinity have come together. The Upanishads describe this as the state in which a person sees everything in himself and himself in everything [5].

As we have seen, zero and infinity are indivisible. The concept of undivided wholeness is basic to Vedanta and it expresses the omnipresence of God. Again the Upanishads say: 'He moves and remains still at the same time; He is near as well as far; He is inside as well as outside' [5]. Everything in the universe is God because it is simply a manifestation of that Ultimate Reality. The first of the four great sentences (*mahavakyas*) of Vedanta is 'I am Brahm (*Aham Brahmasmi*)'. If I am everywhere at the same time, for me there is no space and there is no time. Still there is movement because Brahm is consciousness, which is dynamic. However, now the concept of movement is totally different; space and time are not involved in it. The concept of non-locality in modern physics has come very close to this viewpoint.

In the end we have to think about the distinction between the reality and the knowledge of reality. The uncertainty principle has ramifications far beyond the realm of physics. Any theory, scientific or philosophical, presents only a model of the reality based on the interpretation of the facts known about the reality. A model by very definition is simply a representation of the actual thing, not the thing itself. Just as in mathematics a variable can only tend to zero or infinity, the model is forever trying to get closer to the real. One can never be certain about the degree of correspondence between the knowledge and the reality. The knowledge is a bunch of ideas about reality; the ideas cannot be the reality. The situation is far more complex when it comes to knowing the Ultimate Reality. According to Vedanta God is pure consciousness, which is in every living being. So everything that we perceive or know is through Him; He is the ultimate knower. The subject-object duality precludes the possibility of being conscious of our own consciousness in the same way, as we are conscious of an object. How can the knower be known – is a famous exclamation in Vedanta [6]. Knowledge has two aspects, rational and intuitive; one comes from logic, reasoning, and intelligence, the other from insight and realization. Rational knowledge can never help one uncover the ultimate truth.

References

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3. The Complete Works of Swami Vivekananda, Vol. 2, p.135.
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5. Ishopanishad, 5,6.
6. Brihadaranyak Upanishad, 2-4.14.

Does Evil Exist?

Before answering the question of existence of anything we have to be clear about what we mean by existence. The existence of a thing, whether physical or abstract, depends on our perception. Our perception in turn depends on our minds conditioned by factors such as social, cultural, and religious backgrounds. We tend to see things not as they are, but as we are. Good and evil like all other pairs of opposites exist only in relation to each other. There is no absolute good or evil; what is considered good by one may be regarded evil by another. We see this happening all the time.

There is also a misconception about the opposites in general. The absence of one is taken as the presence of its opposite. The absence of good does not necessarily mean the presence of evil or vice versa. There is always a midpoint where there is neither good nor evil and that may be the ideal state to be in. This is true for all pairs of opposites. The pairs are like the two sides of a coin; they do not exist independently. It is very hard to make a coin stand vertically but it is not impossible.

All our perceptions are within the constraints of space and time, and in most cases, are limited to the world that we live in. We define good and evil according to how events in space-time affect us. To that extent the perception of good and evil is subjective. In a general sense the destruction of life and property is regarded as evil. However, when the end justifies the means, as for example in wars, it is no longer evil. Here the perception of good and evil depends on winning and losing although the hard facts of destruction remain the same.

Then there are natural disasters like earthquakes, hurricanes, and floods etc. that cause as much destruction. Here we bring in God and call them God's act. But why would God wreck havoc on people whom He created in His own image? Or could it be that man has created God in his own image and we need to refine our concept?

Even if we believe in a personal God, the argument that God created everything does not prove that He is responsible for everything that happens in the creation. If we apply the same logic to people, parents would be responsible for every act of the children (and grandchildren as well). Even granting that God is omniscient, there are limitations to what He can do. For example, even He cannot reverse the flow of time and undo things that have been done without dissolving the creation itself. What happens within the creation depends on myriads of things going on within it. Our earth is only a tiny fraction of the creation and no one can be sure that man is the only sentient being in the

universe to decide about the nature of the creation and the creator. And as we well know, even here there is no unified view.

Good and evil are intrinsic to the creation itself and how they develop and manifest depends on the creation. Here, of course, we get into the origin of the universe itself. Even according to modern science the primordial source of matter (and the entire universe) is energy concentrated at a single point. In a metaphysical sense energy is consciousness that is the substratum of the universe. It is this universal consciousness that is eternal and the Ultimate Reality. It cannot be described in words because the very purpose of a language is to isolate and put elements of the whole into parts. The Ultimate Reality is both infinite and infinitesimal; hence it cannot be put into parts and labeled. It has no form and no attributes.

It is impossible for a common man to think of someone or something that has no form. Every thought is accompanied by a corresponding image; it is the intrinsic nature of the mind. So we created a symbol - an image of the Ultimate Reality depending on the conditioning of the mind and gave it a name – God. To make things easier for the common man the image was cast in the form of a benevolent king, which was the highest place of honor and authority known to man. But the symbol is not the reality and one has to be aware of this fact while thinking of God.

Everything in the universe has only a relative existence; it exists because of something else. Causation is a corollary of space-time. Does cold or heat exist? The answer is no. What exists is the temperature difference between the body temperature and outside temperature that we feel. The temperatures result from the thermal agitation of the molecules. Cold is not the absence of heat because there is no such feeling when the temperatures are equal. Does light or darkness exist? Again the answer is no. Light results from some physical processes that convert matter into energy producing electromagnetic waves. It does not exist by itself. Darkness is not the absence of light but the absence of only the visible part of the electromagnetic spectrum. Finally, evil is not the absence of good, let alone the absence of God. Absence of God and His omnipresence are mutually exclusive.

The equivalence of matter and energy is now a physical fact. The conversion of matter into energy has been amply demonstrated but science has not come up with a definitive explanation of the reverse process. Ancient philosophies had already suggested the basic mechanism of this process. The consciousness/energy interacts with three basic qualities and five basic intrinsic elemental properties (respectively called *triguna* and *panchatattva* in Vedanta) to produce matter in all diverse forms. This is somewhat

similar to the idea of string vibrations combining to form elementary particles in the string theory. In a simplistic way the three basic qualities may be seen as good, moderate, and evil. Everything in the universe animate or inanimate has these qualities in varying proportions. Thus good and evil coexist in everything including nature itself.

As mentioned earlier a constructive tendency is usually termed good while a destructive tendency is termed evil. In a general sense, though, everything in the universe (including the universe itself) goes through the cycle of construction and destruction or birth and death. One implies the inevitability of the other. Are birth and death intrinsically good or evil? Our concept of good or evil is built upon how some act or event affects us. Earthquakes, hurricanes, wild fires are all destructive and termed evil forces of nature. But nature also sustains all life on earth. In the universe outside our planet catastrophic events occur all the time. Stars explode and collide and planets might be vanishing but they do not affect us. Still these are part of nature and, hence, everything in the universe has both good and evil. In spite of all the advances in science and technology man cannot control or regulate nature. But man does have control over how he behaves toward nature and other human beings. If man makes an honest effort to maximize good and minimize the effects of evil, the world will be a much better place to live.

SYMBOLS AND REALITY

Introduction

Symbols have always been an integral part of man's life. We have symbols in every walk of life; some are obvious, others not even though in every day use. In this modern world every organization public or private attempts to have a unique and distinctive identity by creating a symbol in the form of a logo or emblem. By very definition a symbol represents something that may be physical or even nonphysical such as an idea or a concept. It is not the 'thing in itself', the substance or reality behind it. As long as the distinction between the symbol and the substance is clearly understood the use of symbol serves its purpose. The problem comes when it is confused with the substance. This occurs most frequently when a symbol represents something nonphysical; we find it happening in almost every human activity. For example, when we are reading a book or a newspaper we are hardly aware of the fact that the letters and words are only symbols that convey ideas through the medium of a particular language. In fact each letter forming the words on the pages is a symbol for a particular sound. The letter in itself means nothing. The same is true for numbers; there is nothing seven-like in number seven. It is just a symbol written in a certain way in a given language. Languages are man made and, in general, everything that is man made is a symbol for some idea.

When the symbol takes the identity of the real thing it results in a degeneration of the original idea and its very purpose is lost. The form becomes the substance and the principle becomes a dogma. The individual loses the ability of rational thinking which in turn stunts personal growth.

It is also important to remember that the symbol itself may not be physical. Statues are physical but institutions as symbols are not. For example schools, colleges, and universities are symbols for education as a concept. A government is a symbol for the concept of running the affairs of the country according to some well-defined principles. A religion is a symbol for the spiritual development of groups of people. Each one of the institutions may have its own distinctive symbols to depict things within it. Symbols can also be in the form of actions such as rituals prescribed within a religion. Everything symbolic has a concept behind it and it is for the individual looking at the symbol to keep that in focus.

Every symbol starts as an image in the mind of the creator while thinking about the concept he wants to illustrate. An inherent characteristic of the human (perhaps any) mind is that a thought is always accompanied by an image. The image is then given a physical form and becomes a specific object. In some cases it is taken to be real as in

the case of a photograph. Looking at the photograph of a person one often identifies it as the real person knowing fully well that it is only a piece of paper depicting the person's image at a given time and place. A similar situation occurs in the case of image worship in religions. An image is simply a symbol for the god or goddess it represents; it is not the god or goddess. Unless the worshipper is aware of this the worship becomes a mechanical function devoid of any significance.

Symbols and Self-development

Now what significance does this relationship between symbol and reality have in the context of self-development? We shall consider a few examples here to answer this question. First we consider personal relationships of which marriage is the most intimate. Even the word marriage is a symbol representing a special relationship between two people of opposite sex, a union of two souls. It is the beginning of a lifelong relationship that has to be developed with mutual faith and respect. Looking at the number of marriages that end in divorce it would seem that very few couples understand the real concept of marriage. They may profess to be in love without realizing the true meaning of love. Love is the most noble of human emotions and true love is not based on mere physical attraction.

In the old days of matchmaking and arranged marriages there was no mention of love as such; love was supposed to start and grow from the union. Instead there was devotion and moral strength gained from a complete understanding of mutual responsibility. There were no undue expectations, just a determination to dedicate one's life to another for the betterment of both. In particular the bride's virtues had endurance far greater than that of physical attraction. With time the lust and passion would dwindle but they would have something more substantial to keep the bond in place. We cannot go back to those old practices now but it would help if people remember and try to inculcate those values.

Next we consider the modern system of education. It is commonly believed (and wrongly so I think) that education is meant to impart to a person sufficient knowledge in a given field. But knowledge is only a part of the process. The real purpose of education is to give the person the capability of independent thinking and generating new ideas. Knowledge is an accumulation of facts which can only serve as the basis for developing ideas. Without the capacity for thinking independently there cannot be advancement. The present system of education has become so rigid and stereotyped that it is not conducive to intellectual growth. The result is that students go to schools not to get education but to get a degree. The degree, which is just a symbol, has

become the real thing instead of education. The society is partly responsible for this state of affairs by putting more emphasis on the degree for evaluating candidates for jobs. The motivation for higher education has also changed. The prospects of better and higher paying jobs increase for the holder of a higher degree. Students go for higher education not for the sake of learning more but for earning more. There are, of course, exceptions but they are very few.

The problem, which starts from elementary schools, is that the education has become fact-based instead of being idea-based. Right from the beginning the emphasis is what and how with little attention to why. Children are taught how to do something without providing the reasoning behind the process of doing. At high school and college levels it becomes more serious. Students are taught about a phenomenon and they know facts pertaining to it, but they usually lack the insight into the fundamental processes that go to make up that phenomenon. A superficial knowledge symbolically replaces the real understanding.

Religion and Science

We now move to a more abstract discussion of the relationship between symbol and reality and consider religion and science. In recent years there has been much discussion on the convergence (or a tendency towards) of science and religion, especially in view of new developments in quantum physics. The goal of science is to understand nature in all its manifestations. The goal of religion is to understand and (if possible) get in contact with the Ultimate Reality underlying nature and the universe. Physics deals with phenomena occurring in the universe which are always in space-time. Quantum physics pertains to the subatomic world lying at the lower end of the space-time scale, while the relativistic physics deals with the upper end of that scale. So the domain of physics is limited to space-time and the universe. Physics cannot go beyond. On the other hand the Reality that religion tries to reach is beyond space-time and, hence, outside the domain of science. Therefore, strictly speaking, there cannot be a convergence of science and religion. At the same time it is important to keep in mind that lack of convergence does not imply disagreement or conflict.

It also does not mean that there are no similarities between the findings of science and religion. The quantum void, the absence of cause-effect relationship, nonlocality and phase entanglement, the behavior of electrons in selecting orbits etc., all these quantum phenomena resonate with religious/spiritual experiences. But the reason for these

similarities may lie in the fact that the underlying Reality of both the manifest and unmanifest existence is the same.

Now what has all this to do with symbols? All phenomena in physics are described by mathematical equations. At the quantum level in particular direct visualization of the results is not possible and everything is described in terms of probability and wave functions. Mathematical equations and wave functions are just symbols. All events in the universe result from the collapse of wave functions. Thus in effect here we are dealing not with the real universe or nature but only with its symbolic representation. In spiritual experiences the person is in contact with the Reality itself and at this stage there is no symbol involved.

MANTRA
YOGA- SIGNIFICANCE OF MANTRAS

The word yoga brings to mind, especially in the West, a system of exercises beneficial for physical and mental health. The exercises are only a small, albeit an important part of it. Yoga is actually a philosophy – one of the six main schools of philosophy propounded in India in the post-Vedic period. It deals with the mysteries of life and universe, so it has a mystic aura about it. At the same time it is based on the experiences of countless individuals over several millennia and deals with facts of life. Thus it is also a science but goes beyond the realm of rational knowledge of modern science. It deals with life at successively higher levels. Some of the facts come within the range of human experience, others (of higher life) lie outside and, as such, are beyond being proved are disproved on the basis of rational knowledge. However, every aspect of yoga is based on sound principles that are in accord with the ideas of modern science.

We also come across a number of qualifiers for the word yoga, such as raja-yoga, *gyaan*-yoga, *bhakti*-yoga, mantra-yoga etc. Yoga is, of course, the same, the goal being the liberation of the soul and its union with the Supreme Reality.

One simple but far-reaching idea of the philosophy is the recognition that there can be many different paths to the goal. The prefixes in front of yoga denote just that – different paths to the same goal. An individual is free to choose a path depending on

one's nature and disposition. The basic premises underlying each of these paths agree astonishing well with the recent discoveries in science even though they were conceived thousands of years ago. In the present article we discuss mantra-yoga.

Mantra yoga may be simply defined as the science of unfolding of the consciousness with the help of mantras; it attempts to modify matter and consciousness through the agency of sound. A mantra represents a specific combination of sounds for producing some specific results. Here it is important to note that the basic structure of a mantra involves sounds and not words. Sound is the fundamental element of articulation and is eternal; words are part of a language and man-made using alphabets as symbols for sounds. The sound elements used in mantras are those of Sanskrit alphabet. Again the primary element is the sound, the letter is merely a symbol. Each letter, pronounced properly, becomes a vehicle for conveying a basic elemental power. It is for this reason that a letter in Sanskrit alphabet is called *akshar* meaning eternal. In the words comprising the mantras each letter contributes to the overall effect desired by the mantra. Since the effectiveness of a mantra is inherently tied to the sound, a proper pronunciation becomes extremely important. This is why in the Vedas so much emphasis has been laid on correct pronunciation.

It is not our intention to suggest that Sanskrit has a special place in the divine scheme of things. It just so happens that people of this particular culture developed the concept and philosophy of mantras. It is quite conceivable that similar systems might have been developed in some other parts of the world or the universe that we are not aware of.

Now sound is simply a vibration or set of vibrations representing a form of energy. It is a basic premise of Hindu philosophy that the entire universe is a manifestation of the primal energy emanating from one source – the Supreme Reality. It was only in the last century that science discovered the equivalence of matter and energy. The concept of energy is related to that of motion. There are only three basic categories of motion – rhythmic, non-rhythmic, and inertial. A deeper insight into the concept would reveal that the rhythmic motion is simply a balanced state of the other two types and is what we call vibrations or waves. Thus the phenomenal word that we view is nothing but vibrations picked up by our senses. Although the conversion of matter into energy is now well understood, the reverse process of matter coming out of energy is still a challenge to modern physics. In general the structure of anything material can be reduced to an aggregate of elementary particles ranging from electrons to quarks. But what are the elementary particles built of? Or are they particles at all? A recent viewpoint suggests that these particles are simply specific configurations of vibrations of virtual strings (the theory is known as Superstring Theory). Thus we get back to the old idea of energy

transforming into matter. The whole phenomenal word is simply a vast aggregate of vibrations of various kinds and degrees. The interaction of these vibrations produces all the phenomena in the physical world existing at different planes. This is a startling concept but nothing compared to the next philosophical concept that all these infinitely complex vibrations of innumerable kinds are simply different components of a single vibration that is also the ultimate source of consciousness. This primary vibration from which all the vibrations in the manifested world are derived, is the primordial energy which is the universal consciousness. We thus see the relationship between matter and consciousness, which are dual expressions of the same Reality. Carrying it a step further every consciousness is a part of that Reality which leads us to one of the basic concepts of Vedanta – every individual (i.e. subjective) consciousness is an infinitesimal part of that universal consciousness. The science of yoga involves unfolding of the individual consciousness to become one with the universal.

It follows from the primary relationship between vibration and consciousness that a vibration is associated with every manifestation of consciousness whether or not we are able to perceive it. Associated with every aspect of consciousness there is a unique vibration. At the lowest level this association manifests itself in visual or aural perception. Each vibration of light of a given frequency produces a particular color perception in the consciousness; each vibration of a given frequency in the audio range produces the perception of a particular note. Similarly each sensation of taste, smell or touch can be traced to a corresponding vibration even though science has yet to reach that stage of advancement. There may be other yet unknown kinds of vibrations and interactions that are transmitted through space and are not subject to the limitations imposed by science. The so-called extra sensory perception is an example. Another aspect of vibration well known in physics is resonance. Using the same concept in the context of yoga it is not unreasonable to assume that a matched type of vibration can activate a particular state of consciousness. This forms the basis of mantra yoga. Also the relationship works both ways, i.e. a particular state of consciousness can activate the corresponding kind of vibration.

A mantra is a special combination of vibrations set up through the sound of the component words, which are meant to produce a desired state of consciousness. A mantra can be long or short; it can be addressed to a particular deity or may relate to the abstract concept of God. It can be chanted only once or repetitively. The shortest but the most often chanted and also the most potent mantra is *Om*. *Om* is an appellation of the Supreme Reality (called *Brahman* in Vedanta) and, hence, its potency. In fact, the chanting of every other mantra is preceded and followed by *Om*. In taking up the practice of yoga there are initial hurdles that must be cleared. Some

are physical; others are mental at different planes. The physical ones are managed with exercises that most of us are familiar with; two different techniques are used for clearing the mental ones. One is the constant repetition of a mantra and the other is meditation which involves fixing attention on something without any thought. A mantra can be chanted aloud or repeated silently. The particular way of chanting depends on the stage at which the yoga practitioner is.

Yoga deals with the inner side of life. A person not familiar with it may think it absurd that a mere monosyllable, as *Om* can be such a potent instrument for the uplifting of a person. But a proper understanding of the relationship between vibration and consciousness will show that there is no inherent impossibility in a word having the power to unfold one's consciousness to any desired degree.

Natural Disasters and God

Hurricanes, earthquakes, famines, and other natural disasters seem to have become common occurrences in recent years. People often call them God's acts and get reconciled with the misery and devastation they cause. Sometimes they are said to represent evil forces of nature. But is it possible to characterize nature as evil or good?

Good and evil, like all other pairs of opposites, are relative terms; neither has any absolute meaning. The concept is also subjective; what is regarded evil by some may be termed good by others. We see this happening all the time. In the case of nature, though, there is no demarcation between 'some' and 'others'. The constructive and beneficial aspects of nature are considered good and the destructive aspects evil.

The problem is with our concept of nature. For most people nature is what directly affects the planet earth. They are, of course, aware of the existence of the universe but anything happening out there does not figure in determining the constructive and destructive aspects of nature. Catastrophic events occur all the time in the universe. Stars explode, collide, or disappear into black holes. Planets freeze and life (if existed) vanishes.
We have no idea if there are other inhabited planets in some other galaxy or even in our own.

Nature is the whole universe which consists of events both constructive and destructive. Construction and destruction are intrinsic to any creation. The universe itself has gone through creation and will eventually go through destruction. The destruction of one thing results in the creation of another.

Our concept of nature is closely related to the concept of God. We anthropomorphize God and make Him responsible for the creation and everything that happens in it. Thus we consider the natural disasters His acts. At the same time these events are considered evil. So is God responsible for evil in nature and on earth? Religions may say that God created man in his own image but the fact is that man has created God in his own image. Every religion attributes to God omnipresence, omnipotence, and omniscience, which are inconsistent with the concept of God as a person. God has no form and no attributes. He is simply the Ultimate Reality, the universal consciousness that permeates everything and at the same time transcends everything.

Natural disasters are, therefore, neither acts of God nor they represent evil forces of nature. They are inherent to creation itself. More information on this topic can be found in the booklet “Where Is God” and other articles at www.cosmosebooks.com.

IS SKY REALLY BLUE?

Color is one of the intrinsic properties of something material. We perceive its color because some light reflected from it reaches our eyes. The smallest unit of matter with specific properties is a molecule. All matter in the universe represents conglomeration of different types of molecules in diverse configurations. How light gets affected by material in its path depends on the size of the material. There are four basic processes that light goes through when it falls on an object. These are reflection, refraction, diffraction, and scattering. Of these only scattering is of any consequence when tiny particles like molecules are involved.

On a bright clear day the sky appears blue. This happens because the earth has a gaseous atmosphere in which oxygen and nitrogen are the dominant components. When the light from the sun hits the nitrogen and oxygen molecules it is scattered in all directions. By light we normally mean the visible part of electromagnetic radiation. The light from the sun contains the seven primary colors from violet to red. The color depends on the frequency or the wavelength of the radiation. The wavelength increases from violet to red, while the frequency decreases. For particles comparable to the wavelength of light the scattering depends on the wavelength. The shorter the wavelength, the larger is the amount of scattering.

The human eye senses color mainly through three primary colors – red, green, and blue. In television signals these three colors are used for producing the color pictures. The blue component of the scattered light is almost ten times stronger than the red. Even though the violet and indigo are scattered more than blue the eye senses mainly blue. Therefore when we look at the sky away from the sun the sky appears blue. This is, of course, true only on a clear day. If there are extraneous particles in the atmosphere as in conditions of haze, they scatter light differently and the sky does not appear blue. Also this is true only for observations on or near the earth. In space there is no atmosphere and no scattering particles. There is no light coming to the observer except directly from the sun and the sky appears black or dark.

In the literature we often come across the question: why is the sky blue? The use of the verb ‘is’ here is erroneous. The sky is neither blue nor black nor any color. As stated before, color is an intrinsic property of material objects and sky is not one. So we have another basic question: what is sky? The etymology for the word in dictionaries does not

really provide any clues. The reference to Indo-European languages is also vague. So we turn to Sanskrit, where the word for sky is *aakaashah*. It consists of two parts '*aa'* and '*kaashah'*. As a prefix '*aa'* has several meanings, one of them is 'as far as'. The word '*kaashah'* means visible. Thus *akaashah* means 'as far as visible'. Taking the Sanskrit meaning sky means the empty space all around as far as one can see. Therefore the sky is nonmaterial and it cannot have any properties associated with matter.

We see everything in the universe against the background of the sky, which is total emptiness. We do not see sky – we cannot see emptiness. What we see are the molecules of the atmospheric gases although not directly and in the normal sense of seeing objects. Everything is embedded in this emptiness. In fact, for any human perception it is necessary to have the background of a corresponding emptiness. To see the pictures on television we must have black or gray screen. To hear a sound we need the background of silence and so on.

The sky has no shape and no size. From the earth it appears as a hemispherical dome because the earth is spherical. It extends as far as we can see, which is the limit of the universe. But what lies beyond? Nothing. And what happens when all the matter in the universe vanishes? Space-time also vanishes and nothing remains. The emptiness represented by the sky then merges with the all-pervading emptiness described by ancient philosophies and experienced in deep meditation. At the microscopic level it may be likened to the quantum void, which is empty but holds the potential for all matter to appear. In Vedanta and Buddhism the word *shunyata* is used for this emptiness. It pervades all, contains all, and transcends all.

RAINBOWS

Rainbows are one of the magnificent colorful displays in nature. They have stroked the imagination of man through the ages. They have given rise to fanciful tales, poems, and dreams. Yet their origin is so simple and common. It takes only a little rain and sunshine to make rainbows. Of course these have to occur in a proper setting. The sunlight bathing countless water drops in the rain gets diverted by them towards the observer getting separated into rays of different spectral colors in the process. On a smaller scale rainbows are formed also by running fountains and water spray from a garden hose.

Although attempts at a scientific explanation of the rainbow formation date back to Kepler a complete description of the process was given by Rene Descartes only in the seventeenth century (1637). It is easier to visualize the process considering first a single raindrop. Small raindrops are little spheres. When a ray from the Sun falls on a droplet part of it gets reflected from the surface and the rest enters the drop. Inside the drop it gets bent from its original direction. When this ray hits the surface of the drop on the opposite side a part is again reflected while the rest exits the drop. The reflected part again hits the surface from inside and the same process of reflection and exit occurs. The ray that exits the drop reaches the observer's eye and forms the rainbow.

The ray reaching the observer has been bent backwards by a certain angle. So in order to see the rainbow the observer must have the rain in front of him and Sun on his back. If one goes through the mathematics of calculating the angle of deviation of the ray reaching the observer, it turns out that the angle between the ray and the direction back to the Sun from the drop has a maximum at about 42 degrees. Since the drop is spherical and the rays from the sun fall at every point of the facing surface, the rays appear to come from a circle. Thus the rainbow forms a circle with an angular radius of 42 degrees and the center at the point in the direction opposite to the Sun (antisolar point). Part of the circle is below ground so the rainbow is seen from the ground only as an arc.

This is only a part of the process. Besides reflection and refraction (i.e. bending) inside the drop the rays go through another process called dispersion. White light from the Sun is composed of rays of different colors ranging from red to violet, which bend in water differently. So the ray splits into rays of different colors and exits the drop as separate rays. The 42-degree angle mentioned above is for the red ray; for the violet the angle is 40 degrees and other colors from orange to indigo lie in between. Thus the arc has an angular spread of two degrees.

The rainbow formed by this process involving a single reflection inside the drop gives rise to the primary rainbow. The ray that is reflected twice produces a secondary rainbow that is less bright and with the colors reversed having red on the inner and violet on the outer side. In this case the angle for the red ray is 51 degrees. There is a dark band between the two rainbows as few rays come to the observer from that region.

The purity of the rainbow colors depends on the size of the rain drops. Drops with large diameter produce bright rainbow with well-defined colors, small drops give diffuse rainbows. Other factors like drop deformation also affect the appearance. There is lot more to know about rainbow formation than this short description. But a few interesting facts are worth mentioning.

a. Since the rainbow is a virtual image, the distance to it is largely indeterminate. It depends on the distance of the raindrops from the observer, so for each observer it is at a different distance.

b. No two people – even standing side by side see the same rainbow. Each sees his own rainbow. This is because of the critical dependence of the rainbow on the mutual configuration of the Sun, rain drops, and observer. Two people can not be at the same point in space at the same time.

c. Rainbows cannot be seen when the Sun is high up in the sky. For the ground based observer the largest visible rainbow is a semicircle close to sunset. As the Sun's elevation increases more and more of the circle goes below the opposite horizon. As a rule rainbows are not seen between nine and three.