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TRADITIONS

OF

SCIENCE

Cross-cultural Perspectives

Essays in honour of
B.V. Subbarayappa

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Munshiram Manoharlal
Publishers Pvt. Ltd.

Sponsored by Sir John Templeton Foundation, United States of America (USA) with Science and Spirituality Research in India Bangalore (India)

ISBN 81-215-1177-1
First published 2007

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Typeset, printed and published by
Munshiram Manoharlal Publishers Pvt. Ltd.,
Post Box 5715, 54 Rani Jhansi Road, New Delhi 110 055.

Contents

<i>Contributors</i>	ix
<i>Foreword</i> by D.P. Chattopadhyaya	xi
<i>Preface</i>	xiii
<i>Open Word: The Philosopher's Science</i> by J.N. Mohanty	xv
<i>Introduction: A Life in the History of Science – Profile and Publications</i> of Dr B.V. Subbarayappa	xix

SECTION I: HISTORICAL ASPECTS 1

WILLIAM R. SHEA	
1 The Science of Our Origins	1
ROSHDI RASHED	
2 The Invention of Classical Scientific Modernity	11
Y. MAEYAMA	
3 On the Celestial Pole	21
S.M. RAZAULLAH ANSARI	
4 Ibn al-Haytham, the First Proponent of the Scientific Method	35
MICHIO YANO	
5 Pañcāṅga, Ancient and Modern	59
RAYMOND MERCIER	
6 Astronomical Computation for the History of Indian Astronomy	72
V. KIRSANOV	
7 First Russian Translation of Huygens's <i>Kosmotheoros</i>	83
G. VENKATARAMAN	
8 The Spirit of a Giant: On C.V. Raman	93
VINCENZO CAPPELLETTI	
9 Towards a New Perspective in Science	111
STRUAN JACOBS	
10 A Neglected Source of the Metascientific Revolution of the 1960s	115
LIU DUNN	
11 A Brief Introduction to the Studies on History of Science in the People's Republic of China	125

21

Modern Physics and Traditional Insights: An Indian Scientist Reflects

B.V. SREEKANTAN

When Plato established the first academy of the world he said, "Here scholars, researchers, of every stripe come together to fathom the plan of the world and to comprehend under a single edifice the overall scheme of things – poetise phenomena, to reduce the whole visible universe to a small set of abstract concepts and principles." Western philosophy over several millennia and modern science over the past few hundred years indeed have made tremendous progress in the attempts to understand the complex phenomena of the universe. Modern science has unravelled through the power of technology many more aspects of the universe than what Plato had envisaged in his reference to the visible universe. The extension has been in time, space and in the nature of contents. From a philosophical point of view however, the emphasis has remained on the discernment of the nature and relations between matter, mind, space-time and Spirit (God).

In this essay, we will focus on some of the quintessential questions of philosophy and examine to what extent the developments of science in the last four hundred years have provided satisfactory answers to these questions. We will also consider to what extent the various streams of philosophical thoughts extending over several millennia both in the East and West are relevant and meaningful and whether they supplement or complement the scientific explanations or entirely contradict them. The objective is not to put one at a higher pedestal than the other or indicate any priorities of thoughts and ideas, but to let winds of knowledge flow from all directions.

Let us begin with some of the most fundamental questions – the origin of the universe, of life, of consciousness – the universe which we are all part of the one and we all cognize. How and when did the universe originate? How did the various constituents such as matter, radiation, forces, space, time etc., come into being?

First we shall present a very brief overview of certain general typical responses from the side of the Indian quests before moving on to Western science moderated by their philosophical critiques within the respective traditions.

Indian Schools

Not unlike in the West, among the ancient Indian philosophers we have radical materialists, pure spiritualists, and some who require both spirit and matter, albeit in different proportions and combinations or permutations, to complete their grand metaphysical explanation of the cosmos and its origins. It often boils down to discerning what is *primary* – spirit or matter? And what is real? And what is illusory?

A characteristic of Indian philosophy has been not only to *discover* the "truth" but also to "realize" the truth as such in one's own experience. In this sense, it is not merely an intellectual endeavour. It is more significantly a basis for a manual of living. Therefore philosophy has necessarily a close relation to religion – the code of ethics and conduct in daily life. This is embedded in the fact that the various schools in the Indian subcontinent are traditionally referred to as Darsana Sastras. For ease of reading we will refer to these as Schools of Indian Philosophy.

Among Indian philosophies there are two broad categories those that owe either partial or full allegiance to "the Vedas" (*astika* or the so-called orthodox) and those that are independent of any Vedas (so-called *nastika* or heterodox). (Incidentally, the question of the authority of the Vedas has nothing to do with belief or disbelief in God, or even for the *astikas* the source of the Vedas are or can be *apauruseyatva* or non-personal, i.e., timelessly without personal author, in God or beings.) Those that subscribe in part or full to the former position are Vaisesika of Kanada, Nyaya of Gautama, Samkhya of Kapila, Yoga of Patanjali, Mimamsa of Jaimini, and Vedanta of Badarayana. The Carvaka of Brihaspati, Jainism of Mahavira, and Buddhism of the Buddha do not concede the authority of the Vedas, and therefore are said to belong to the other half of the tradition. Among the former the differences arise essentially in the interpretation of the Vedic utterances and also on the extent of their dependence on post-Vedic texts. We shall not go into the historical or developmental details of these various schools, but consider only the main insights from the point of view of comparing and contrasting them with the insights from western philosophies and of modern science.

Prominent materialistic philosophers of ancient India date back to 7th century BC. Among them are the Carvakas-Lokayatas of Brihaspati – (7th to 6th centuries BC) who restricted themselves to the world of common experience; the Samkhyas (Kapila, 6th century BC), Nyaya (Gautama, 3rd century BC), and Vaisesikas (Kanada, 3rd century BC) held views which are somewhat similar to those of modern materialists. They believed in the atomic nature of matter, the cause and effect links for all phenomena, the manifestations of the external world attributable to physical actions rather than linking them up with ideas, magic, prayer, etc. They did not believe in supernatural powers. They believed in the conservation of matter and emergence as a transformation of matter without destruction. The development of the world was attributed to spontaneity without any outside interference.

The Carvaka philosophy is perhaps the earliest, atheistic material philosophy dating back to a period earlier than 600 BC. It totally denounces the authority of the Veda. Perception (*pratyaksha*) is the only means of knowledge that is accepted. What is not perceived, does not exist. Inference is totally rejected.

Matter is the only reality. The basic constituent elements of the world are earth, water, fire and air. Even space or *akasa* is not there because it is not directly perceived. It is only inferred. Intelligence is a modification of the four elements. There is no soul since it is not directly experienced, but inferred. Consciousness arises from a mixture of these. The Lokayata, the other name for Carvaka, does not deny a spiritual principle, but maintains that it is a property of the physical aggregate of the body and disappears when the body disintegrates. Consciousness or Soul is not external to the body. The Carvakas have no belief in the supernatural, nor transcendental being, nor a God that controls. According to them, there is no life after death, no deeper reality. Pleasure in the individual's life should be the sole aim (Hedonism). Pain is an inevitable feature of life, and so should be endured. The over all philosophy is "make the best of the bad bargain and enjoy yourself".

Though there are some differences between Nyaya and Vaisesika system of philosophy founded by Gautama and Kanada respectively in the 3rd century BC, for our purpose here we can treat them together. In Nyaya-Vaisesika system, diversity and not unity is at the root of the universe. Experience reveals nine entities which make up the universe. These are called *dravyas*. Not all the 'dravyas' are material. The four materials are earth, water, fire and air all of which are actually composed of "atoms" which are indivisible and have specific properties.

Akasa which is the other constituent of the universe is partless and infinite and does not produce anything like the combinations of the *dravyas* do. Space and Time are conceived as objective realities. They are infinite and partless like *Akasa*. In this scheme *akasa* stands for what fills the space as some ethereal substance which supports *Sabda* or Sound.

There are infinite number of souls. Each soul, the object of the notion, "I", is omni-present and eternal. Though present everywhere feelings, thoughts, volitions of a soul are confined to the physical organism with which it is associated at any given time. Soul by itself is unconscious but consciousness is produced by the reaction of the individual soul and organic nature. The soul is present even after the body is lost. The original Nyaya and Vaisesika philosophies are not theistic though there have been later attempts to fit them into a theistic mould.

The Samkhya philosophy founded by Kapila (6th – 5th century BC) is based on the concepts of *Purusa* (Spirit) and *Prakriti* (Nature). *Purusa* is of the essence of pure consciousness without quality or character and is formless. The world of objects is a transformation of Nature or *Prakriti*. *Prakriti* has three qualities or *gunas*, namely, *sattva* (virtue), *rajas* (passion) and *tamas* (darkness). Combinations in different proportions of these decide the variety of objects in nature, including the human. *Prakriti* is the ground condition for all creation in the universe. The three *gunas* may also be equated with essence (*sattva*), energy (*rajas*) and mass (*tamas*). According to Samkhya, *mahat* which is *sattva* – prominent, evolves first from *Prakriti* from which the world, mental and physical is manifest. In Samkhya there is one *Purusa* for each soul. Patanjali's Yoga system is grafted on the Samkhya metaphysics. *Purusa* is the transcendental principle underlying all being and knowing. *Purusa* cannot be perceived. It may be realized by personal development and practice of certain disciplines.

Intellectually the presence of *Purusa* can be inferred from the manifest purposiveness of the universe. Thoughts and images of the world are physical, but more subtle unlike gross physical objects; images of objects are non-conscious unless they are felt, are experienced, made conscious by *Purusa*. *Purusa* is the light which illumines the mind. Patanjali emphasised the importance of controlling the breath (*pranayama*) for cleansing the body and achieving control of mind, and practising meditation. There is no concept of God as Creator which is a subtle form of matter.

The Vedanta philosophy is based not only on the Upanisads, the last part of the Vedas, but also on the non-Vedic texts like the *Brahma Sutras* of Vyasa and the *Bhagavad Gita* which is part of the epic *Mahabharata*. According to Vedanta, the ultimate and only reality is Brahman. Reality is described as "that which persists and remains the same in the past, present and future, both manifest and unmanifest; substratum and structure. Reality is like an Ocean and Creation like Waves."

One school of thought holds that the universe has been pretty much as we find it from times stretching back to infinity in the past and it will continue in the same strain for all eternity (with some interruptions and lapses, or internal shifts, perhaps). Some have modified this view by introducing the notion of a cyclic universe which gives the impression of a beginning and an end and accommodates continuity and changes seen over fairly long periods of time.

Non-Indian Schools

In the most widely held schools of science today, an infinite past is not favoured because of the many observed astronomical and biological features which all seem to fit better into a model of creation and evolution at a specified time than in any other model. Expanding nature of the universe with the rate of expansion increasing with distance of separation, the discovery of a universal microwave radiation and the measured relative abundance of hydrogen and helium in the universe, all strongly support the Big Bang theory of creation according to which the universe that we are all part of came into existence about twenty thousand million years (20 billion years) ago as a result of a gigantic explosion. The first entity to be created was the space-time continuum which we commonly perceive as three dimensional space and one dimensional forward moving time. It is this space that is continuously expanding. When this space was created it was endowed with certain very special and specific properties that have been inferred from the experiments carried out with the highest energy accelerators. These experiments together with a variety of cosmic ray and nuclear physics experiments in the past, have given us an incisive knowledge of the microworld of elementary particles and the forces of interactions which determine the course of evolution of matter and life – in short, all the activities of the observed physical universe.

A synthesis of astronomical and high energy experimental results have made it possible to figure out the precise time sequence of the creation of the various elementary particles, nuclei, atoms, molecules, stars, clusters of stars, galaxies, etc. While it does appear to be a success story, there are aspects which have opened up many new questions that have no answers yet. What it is that exploded? And why? How did the space-time continuum acquire the very

specific properties and how did the laws of nature and the values of natural constants that are so critical for the consistency of the theory get embedded? What the Big Bang theory has done is to push all the mystery arbitrarily close to the first instant of creation. Given the initial conditions (whose origin is a mystery) the subsequent happenings in the inanimate part of the universe can be explained on the basis of this framework.

What about the origin of life and the animate part of the universe? At the moment there is no scientific evidence for existence of life outside the planet earth though it is suspected to exist elsewhere too. While the physical and chemical evolutions have been figured out in considerable detail in the framework of well-established laws of physics and chemistry, it has not been possible to extend the same framework into the biological evolution which has many distinct features of its own. Further, it has not been possible to define at what stage and in what precise physico-chemical manner, the inanimate becomes animate. A very much advanced question is at what stage the mind or consciousness with all its powerful features becomes manifest in organic evolution?

Partial answers to such questions have been forthcoming thanks to developments over the last few decades. These have led to what is known as systemic approach which relies on the self-organising capabilities of complex systems. A novel feature of these systems is the emergence of new properties that could not be envisaged or predicted on the basis of a mere sum total of the properties of the constituents of the system. A classic example is the case of the three elements: carbon, hydrogen and oxygen combining into innumerable compounds with widely different characteristics like alcohols, fatty acids, sugars etc. One cannot from a study of the properties of carbon, hydrogen and oxygen as elements predict all the properties of their compounds. It is surmised that some similar phenomenon – emergence – may be characteristic of biological systems. There is another, feature noticed in some physical systems, like lasers, holograms, superconductors, etc., which may be happening in biosystems as well. This is the phenomenon known as “downward causation” in which higher level laws control those at lower level the group influencing and controlling the behaviour of individuals. In the case of biosystems yet another control is exercised by the millions of bits of information that is inherited in the genes. The study of complex chemical systems in which the chemical reactions are taking place far away from equilibrium conditions with free access to energy and in which there could be feedback from output to input is a fertile field of current research. This may possibly throw considerable light on biological systems.

These approaches bring us to the question of our understanding of the laws of nature at various levels in various systems that operate on the constituents and give rise to all the variety in nature. Einstein has said:

Scientific research is based on the assumption that all events including actions of mankind are determined by laws of nature. Therefore a research scientist will hardly be inclined to believe that events could be influenced by prayer, that is by a wish addressed to a supernatural being. However, we have to admit that our knowledge of these laws is only an incomplete piece of work, so that ultimately the belief in the

existence of fundamental all embracing laws rests on a sort of faith. All the same, this faith has largely been justified by the success of science. On the other hand, however, every one who is seriously engaged in pursuit of science becomes convinced that the laws of nature manifest the existence of a spirit vastly superior to that of men and one in the face of which, we, with our modest powers feel humble. The pursuit of science leads therefore to a religious feeling of a special kind which differs from religiosity of more naive people.

This vastly superior spirit Einstein identifies with his Concept of God.

Like the philosopher Spinoza, Einstein denied the existence of a personal God who rewards and punishes. It is exceedingly educative and thought provoking to become familiar with Einstein's concept of God:

I am not an atheist and I don't think I can call myself a pantheist. We are in the position of a child entering a huge library filled with books in many languages in which they are written. The child knows that someone must have written those books. It does not know how. It does not understand the languages in which they are written. The child dimly suspects a mysterious order in the arrangement of the books, but does not know what it is. That seems to me the attitude of even the most intelligent human being towards God. We see the universe marvellously arranged and obeying certain laws, but only dimly understand these laws. Our limited mind grasps the mysterious force that moves constellations. I am fascinated by Spinoza's Pantheism, but I admire even more his contribution to modern thought because he is the first philosopher to deal with Soul and Body as one and not two separate things.

The ideas of oneness of the soul and the body that attracted Einstein, is contrary to the idea of René Descartes, one of the pioneers of modern science who proposed that mind (Soul, Consciousness) is some kind of thinking substance, not describable in terms of matter that composes the body. This philosophy known as Cartesianism was proposed four hundred years ago, at a time when very little was known about the structure of matter and much less about the structure of brain and the physico-chemical processes in the brain and in its accessories and the correlations between mental process and brain activities. Therefore it is relevant to ask the question whether all the reductionistic developments that have taken place in neurosciences that have enabled very detailed and minute mapping of the physico-chemical processes in the complex neural networks associated with the brain, have led to any clearer understanding of the mind-body identity or distinction. As one progressively went into the discernment of the structure of matter at deeper and deeper levels – molecules, atoms, nuclei, elementary particles, quarks and gluons and photons – it became clear that these entities could no longer be thought of as subtle versions of the types of objects we are familiar with at gross levels. Even concepts like position, momentum, localisation of charge, energy, causality etc. would just not be applicable in the way we are familiar with. In short they became very abstract entities which somehow in conglomeration give rise to the pieces of matter like dust grains or sand particles that are more tangible and we can see with our eyes. In this sense, matter itself in the final analysis has become very mysterious. In fact, there are aspects of these fundamental particles which are baffling. The same entity behaves in

one situation like a localised particle and at another as an extended wave. By a spontaneous fluctuation particles and anti-particles can suddenly pop up. Determinism and exact predictability which were held as *sine qua non* of science no longer hold and many things depend on the observer and the equipment with which he makes observation.

Is there then no objective reality? "What is the thing-in-itself?" Bohr and Wheeler talked of the "Participatory universe;" science cannot tell us "what is"; can only tell us "what will happen when we observe." Reality gets tied down to observation!

According to Wheeler, "reality may not be entirely physical. Our cosmos is a participatory phenomenon requiring act of observation. Truth in some sense is imagined rather than apprehended". Erwin Schrödinger wrote: "The world is a construct of our sensations, perceptions and memories. It is convenient to regard it as existing objectively on its own. But certainly does not become manifest by itself; by mere existence."

In the same strain, Wolfgang Pauli has said:

... The only acceptable point of view appears to be the one that recognises both sides of reality, the quantitative and the qualitative, the physical and the psychic as comparable with each other and can embrace them simultaneously. It would be more satisfactory if all of physics and psyche (matter and mind) can be as complementary aspects of the same reality". This trend of oneness is reflected by many scientists hailing from different disciplines. The Nobel Laureate Prigogine says: "Biological life instead of being a pack of strangeness gazing at a cold and sterile universe is embedded in a living universe.

How far down can we carry this concept of oneness?

The reductionistic method of science which progressed over the last few hundred years by discovering more and more fundamental particles as the basis of matter and interactions between these matter particles, finally came up with the recognition that all these are manifestations of one substratum – vacuum – which for technical reasons has been called quantum mechanical vacuum, which is also identical to the four dimensional space-time continuum. It is best to quote the two masters Paul Dirac, the physicist who was the first to recognise the significance and content of this quantum mechanical vacuum, and the other Einstein who introduced the space-time continuum idea and spelled out the connection between this continuum and matter and established the identity of matter and energy ($E = mc^2$).

Dirac: All matter is created out of some imperceptible substratum – nothingness, unimaginable and undetectable. But it is a peculiar nothingness out of which matter is created.

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

In science, the chief advantage of this concept of an all-pervading oneness is the removal of the barrier between different entities that enters in our attempts to understand the mechanism by which they interact with each other.

For example, right from the time of Newton himself, we had the problem of action at a distance. The challenging question was – How is the gravitational force between the Sun and the earth negotiated? What is exactly happening in the intervening space? Now with the grand idea that the Sun and the earth and the space in-between are all one and the same, the sun being a location of a higher curvature of space than that of the earth, with the space in-between having the property of transmitting the gravitational force carrying "gravitons" between the two sites, the barrier difficulty is removed. The "gravitons" (gravitational waves) have not been detected experimentally yet. Major effort is going on in this direction. Large number of 'gravitons' are expected to be released during the explosion of stars – supernovae explosions. These rare celestial events are monitored for recording "gravitons."

To summarise, the quantum mechanical vacuum (the four dimensional space-time continuum) is the ultimate substratum which is the reservoir of all fundamental particles which exist in a state normally non-detectable. Spontaneous fluctuations of this substratum does give rise to virtual pairs of particles and anti-particles. Very occasional violent fluctuations can give rise to detectable particles. This space with all the special properties was created at the time of the Big Bang and is continuously expanding since the last 20 billion years. Over the last fifty years, increasing number of fundamental particles have been discovered at the accelerators, and to accommodate these the properties of the vacuum are correspondingly redefined. It is perhaps true to say that not all the properties of vacuum have been uniquely and finally determined.

This concept of oneness – existence of a substratum which is responsible for everything – all creation, all actions in the universe, pervades many philosophies both in the west and in the east. Evidently the detailed specifications, contents and mode of action of the substratum is different in the different systems.

In an exhilarating article entitled "The Debate between Plato and Democritus", the Nobel Laureate Heisenberg discusses the concepts of matter in ancient philosophy and according to modern science.

Heisenberg emphasises:

I think that on this point (Democritus or Plato) modern physics has definitely decided for Plato. For the smallest units of matter are, in fact, not physical objects in the ordinary sense of the word; they are forms, structures or – in Plato's sense – Ideas, which can be unambiguously spoken of only in the language of mathematics. Democritus and Plato had both hoped that in the smallest units of matter there would be approaching the "one", the unitary principle that governs the course of the world. Plato was convinced that this principle can be expressed and understood in mathematical form. ... Plato's symmetries were not yet the correct ones, but he was right in believing that ultimately at the heart of nature, among the smallest units of matter, we find mathematical symmetries. It was an unbelievable achievement of the ancient philosophers to have asked the right questions. But lacking a knowledge of empirical details, we could not have expected them to find answers that were correct in details as well.

The above remarks of Heisenberg are true for many of the philosophical approaches of the Orient.

In Mahayana Buddhism, which is one of the later versions of Buddhism that spread to Tibet, China and Japan, the concept of *sunyata* (void, emptiness) was introduced to represent "not a state of nothingness", but as the "very source of all life and activity and essence of all forms". The *Avatamsaka Sutra* of this School of thought emphasises the unity and interaction of all things. Lao Tzu, a Chinese philosopher and contemporary of the Buddha and the founder of Taoism in China, spoke of the Tao, as the ultimate reality – a unity of opposites Yin and Yang, whose dynamic cyclic interplay generates all the activities of the world. It is a philosophy of continuous change and harmony.

In the Vedanta philosophy, this all pervasive oneness is identified with Brahma; which is everything (*sarvam khalu idam Brahma*). In the Advaita philosophy of Sankara, the Brahman is also identified with *Atman* (the individual soul, i.e., self) and consciousness.

The self is looked upon as pure consciousness itself and it is when this consciousness interacts with the mind, which in Advaita is treated as material (the sixth sense), that awareness of something arises.

We all have the experience of three states – the waking, the dreaming and the deep sleep states and make experiential statements like "I" ran, "I" dreamt, "I" slept, implying that the "I" – "the self," "the experiencer" is common to all of them. This we do despite the very different space-time frames in the waking and dreaming states and the absence of space-time in the deep sleep state. The experiencer, the witness that is common to all the states and provides the continuity, is the absolute consciousness since, as glimpsed in the deep sleep state, it has transcended space-time. In the deep sleep state there is nothing other than a unique experience of oneness. Therefore it is justifiable to equate absolute consciousness with Brahman and *Atman*.

While we all get a glimpse of this oneness in the deep sleep state, there are the *siddha purusas* (the realized souls) who can reach this state of unification through Yoga, meditation, Zen, Tao, Sufi praxis, etc.

There is a confusion that is often created by some who say that according to Sankara's Advaita or Non-dual philosophy the world is not real but is something of an illusion. How can the world that is experienced by all of us day in and day out be an illusion? What needs to be emphasised is that Sankara makes a clear distinction between the transactional state (*vyavaharika* state) and the transcendental state (*paramarthika* state) of human beings. In the transactional state, which is the normal state of all of us in everyday life, *the world for all intents and purposes is real and not an illusion*. However in the transcendental state we become aware of the supreme reality that is behind and beyond all the worldly activities and in that state we recognise the unification of all the multiplicity that we see around us. In that sense, the illusion – namely, the world – disappears for the one who has realised the truth, namely, the oneness. Until then the illusion persists. Sankara brings out this with the most beautiful and yet very simple illustration of the "rope and snake" – what in reality is a rope is mistaken in the darkness to be a snake. As long as one is in darkness the "snake" and the attendant fear persist. True knowledge of the rope dawns on shining light. The realisation is of the form "the snake does not exist; it did not exist even before the shining of light. It only appeared to exist due to ignorance. What existed and continues to exist unfettered by darkness or light,

ignorance or awareness is the rope and nothing but the rope – the underlying substratum." The explanation of the causal connections between this substratum and the multifarious entities and activities of the universe can at best be called dicey in all the different standpoints that we have discussed above – be it in science, be it in western philosophies, be it in Buddhism or in Advaita. The reason is that when we seek explanation of anything from the transactional point of view, it has necessarily to be in terms of what is completely, known, what is just familiar. The process by which something that is indescribable in terms of what is known is transformed into something concrete like the world, must itself be indescribable. It has been termed *anirvacaniya* (cannot be delineated by words). As we have seen in science too the same thing is true for example of the very first moment of the Big Bang and the creation of the space – time continuum with all its properties.

The question naturally arises whether this incomprehensibility, this abject helplessness is a limitation of the human mind at its present stage of evolution. Will a new type of comprehension become possible after, say, another million years of evolution? Or can the human mind be trained even now by special methods and practices to achieve this comprehension? Wheeler has said, "As the island of knowledge grows so does the share of our ignorance". This certainly is true of scientific knowledge. In science, the more we know the more we realise that there is far more to be known. We have to search for that type of knowledge which conquers all ignorance. The fact that science creates new knowledge and also new ignorance does not detract the merit of science, nor does it warrant the abandonment of science. It only highlights its limitations.

Aa no bhadrarah kratavo yantu visvatah!

Let noble thoughts come to us from every side. (*Rigveda*)