CONCEPTS OF TIME AND SPACE (AND SOME OTHER ENIGMAS)—FROM VEDIC TIMES DOWN TO THE PRESENT DAY

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1.1. Time and Space have been great puzzling enigmas for man from time immemorial. Even primitive men are known *to* have looked up towards the sky in awe and wonder in order *to* watch celestial phenomena. They also observed the procession of seasons, the alternation of day and night etc., and realized that behind all these lay the mysterious ***flow of time***. It is therefore not surprising that the great ancient Indian sages of the *Vedic* times had devoted considerable thought on these two primal wonders-time and space-as well as *to* other related concepts..

1.2 . The Indian subcontinent can legitimately be proud of its very ancient civilization, dating back to millennia before the start of the Christian era. Among the ancient world's great civilizations (Egyptian, Babylonian, Sumerian, Assyrian, Indian, Chinese. Mayan, Inca, Aztec, etc.), some sort of cultural continuity, from very ancient times down to the present day, can be claimed only by two, namely Indian and Chinese.

1.3. It is well known that ancient India excelled in the fields of philosophy and literature. What about the sciences and mathematics? Concepts of Time and Space are intimately related to mathematics, physics and philosophy. Before we come to Time and Space, let us have an overview of the contributions of the ancient Indians in the domains of mathematical, physical and cosmological sciences:

2.1. The Concept of Zero.

The concept of" zero' has been acclaimed as one of the most brilliant ideas in mathematical

thought. It is indeed one of the foundation stones of the entire edifice of mathematics. It was the ancient Indians who" invented' this concept.

2.1.1. It may here be remembered that other ancient arithmetical systems did not have a place for zero. For example, there is no zero in Roman numeral system (I, II, III, IV, V, VI, VII, VIII, IX, X etc)

2.2. The decimal System

This is another great Indian invention. The so-called Arabic numerals we now use

(0, I ,2,3,4,5,6,7,8 and 9) are truly Indian inventions. The Arabs borrowed it from India and the Europeans came to know of it from the Arabs. That is why the system is called the "Arabic numerals" by the westerners.

2.2.1.It is interesting to recall a personal anecdote here. During a discussion in an intellectual circle abroad, we were talking about the modern decimal system of numerals. Then, a friend of mine, an Iraqian professor, turned to me and said: " I do not understand why you Indians call them *Arabic numerals!* We Arabs call them" *raqm -al-_hind'* , that is, Indian numerals!".

The Arabs learned about the number systems from India; the Europeans learned from the Arabs and so they called them the "Arabic numbers"" And we Indians, "more loyal than the king", continue to call them "Arabic Numerals!"

2.2.2. About this number system, an Arab mathematician who lived in the 10'h century exclaims: *"It* is *mind—boggling* to *see how the Indians are able* to *represent any number, however large it* be, by *just 10 symbols!*

2.3. The concept of infinity

The *Vedas* contain a famous hymn, which runs as follows:

Om poornam idam, poornam ata: Poornad poornam udachyate Poornasya poornam adaya / Poornameva/vashishyate

Roughly translated, this would be as follows: This is infinity; that is Infinity:

Infinity derives from infinity;
If one subtracts Infinity from Infinity,
Only Infinity remains!

2.3.1.Philosophers have opined that" *poornam"* refers to God. But mathematicians would gladly have it as infinity! In any case, there are several indications that ancient Indians had notions of' infinity", "than which no greater number can be conceived". This was another brilliant mathematical idea ofthe ancients.

2.4. Big numbers

The ancient Indian texts show that big numbers were familiar to the scholars of the day. In Vedas and other ancient literature we find mention of numbers like *pray uta* (106), *samudra* (109), *parardha* (1012), and *tallakshana* (1053). Let us remember that the biggest number mentioned in Greek literature is only" myriad" which was equal to just ten thousand! They also had a systematic nomenclature for big numbers. Thus, 60,699 was read as .. *shashtima sahasra navatim nava"*. Fractions were well known too. We find that 3 3/8 is referred to *as traya trayashtaka,* and 1/24 of 5 is described as " *panchasya chaturvimsaka"*

2.5. Mathematical Series

Number series were also known. The series 6,12,24,48,96,192... is called" *swarna manasa shreni". The Gregory series has recently been renamed correctly as the Madhava-Gregory series.*

2.6. *BoudlllIJ!JIIUI'S* theorem

Boudhayana had stated, earlier than Pythagoras, that" The Square of the diagonal of a rectangle is equal to the sum of the squares on its sides". Pythagoras said: "The square on the hypotenuse of a right-angled triangle is equal to the sum ofthe squares on the other two sides". Both amount to the same; but isn't Boudhayana's theorem the simpler and more elegant of the two?

2.7. Some other examll.les

Manava sulba sutra gives methods for" squaring the cycle". In it we find 'IT calculated as 3.16. We also find numerical values for _2, _3, _5, _7, _II, _13 etc.

Brahmagupta and Bhaskara " stated that the area of a triangle was given by

A = _ (s) (s-a) (s-b) (s-c). (Of course, they used Sanskrit letters instead of s, a, band c!) 2.S.Astronomy

The study of astronomy had made great progress in ancient India. Aryabhata (born AD 476), who was likely to have been a keralite, had stated that the earth revolves around the sun and not vice

versa. (This was independently re-discovered by Copernicus in the 15 the century, about 1000 years after Aryabhata!). Varahamihira, Brahmagupta and others"had also made great contributions.

2.8.1. Ancient Indian astronomy books contain poetic expressions like :" the borrowed light of the moon" and" the fantastic march of the sum through the *ksheera pathal".* Eclipses, seasonal fluctuations, equinoxes were all calculated accurately. The stars and zodiacal signs were identified and classified and named.

2.9. Cosmology

2.9.1.The ancient Indians had developed a cosmology of their own. They conceived of a *brahmanda,* which gave birth to the universe. (How similar is this to the idea of Lemaitre who thought of a" cosmic egg", and whose ideas led to the Big Bang theory!)

2.9.2. The Indians also considered a" cyclical universe", with the Day of the Brahma, the Night of the Brahma, and an endless repetition of these. Each cycle was a *"kalpa".* Professor Carl Sagan says: " The similarity between our modern cosmological theory of the cyclical universe and the ancient Hindu concepts of *kalpa* and *kalachakra* is really astounding!"

3. Let us now come specifically to Time and Space. From a philosophic point of view, time and space were discussed in the *Vedas* themselves. We find that in some places, the same word *'kshetra'* was used to represent both time and space! Did the ancient *Rishis* know (instinctively

or intuitively?) that time and space have a common denominator? In the *Bhagavad Gita,* we find lord *Krishna* telling *Arjuna* : .. *Kala /smi"*(" I am Time") . In *Jnana Vasishta,* we find indications of spatio-temporal travel. In *Ramayana,* we have the mysterious logic of *Sita* asking *Rama* : " In all the previous *Ramayanas , Sita* had always accompanied *Rama* into the forest. So, why do you discourage me this time?". In the *Upanishads,* we find *Yajnhavalkya* explaining these and related concepts to his knowledge-seeking wife Maitreyi.

3.1 .It is interesting to note that ancient Indians divided the day into 60 units called "ghatika" (in Malayalam. *na::hikas):* each *na::hika* into 60 *vina::hikas* etc. Modern chronometry divides the day into 6 x 4 = 24 hours. an hour into 60 minutes and a minute into 60 seconds. The early Indian astronomers divided space into 6 x 60 = 360 degrees. The celestial zodiac is divided into 6 x 2 = 12 signs. The magic number 6 (which is a product of the first three prime numbers. I x 2 x 3) recurs. An interesting number pattern is evident here.

3.2. From a scientific point of view, we find references to time and space in the atomistic thought. The atomistic school, *Vaisheshika,* founded by *Kanada* (3rd century BC), analyzed reality into six categories: substance, quality, activity, generality, particularity, and inherence. The universe is made up of nine kinds of substance: earth, water, light, air, ether, time, space, soul (or self), and mind. Here we find that time and space are included in the fabric of the universe. But the *Vaisheshika* atomism differs radically from modern atomism in one important point. *Vaisheshika* atomism avers that the functioning of atoms is guided or directed by the *will of the Supreme Being.* It is therefore a theistic form of atomism (We know that modern atomism is linked to modern *relativity,* and *ipso facto* , to time and space.).

4. Albert Einstein(1879- 1955) was the first great scientist who clearly stated that time is <u>not really linear,</u> as commonly experienced by us humans. His famous dictum, " *The distinction between past, present and future is only an illusion,*

although a very tenacious illusion!" may be recalled here! The non-linearity of time follows from his relativistic theories. But, it seems most likely that even in this respect, Einstein was anticipated by the ancient Indian Rishis. How else can we explain terms such as " *kala chakra"* (cyclical time) found in ancient Indian philosophical thought? The cyclical (*read,* non-linear!) nature of time must therefore have been recognized by the ancient Indians.

4.1. The ancient Indians had developed a cosmology of their own. Their concept of a *"brahmanda"* , which gave birth to the universe is similar to the much later idea of Lemaitre (1800-1876) who thought of a" *cosmic egg"*, and the modern Big Bang theory!) *(see section* 2.9 *of this paper)*

4.2. Let us now briefly review our modern scientific concepts of time and space. We now know that the universe is spatially *"finite, but boundless"*. We also know, thanks to Einsteinian theories, that time is really just a fourth dimension, like the three dimensions (length, breadth and height) of space. (Why do we humans experience time as very different from the space dimensions? For example, we have bi-directional freedom of movement in the spatial axes; we can move forwards or backwards, to the left or to the right, and upwards or downwards. But we can only move forwards in time, never backwards. This is our *subjective limitation!.)* Real time *(Tr*) is indistinguishable —as a dimension— from *I, b* or *h*. What we experience is an imaginary timer *TJ* (For us, subjectively speaking, however, imaginary time, *Ti* ,is the only thing we experience as time and so we think that it is the real time! All our confusion is the result of this subjective illusion! This is what Einstein meant when he said that our concept of linear time (past, present, future) is an illusion. Stephen Hawking also propounds similar VIews.

4.3. Relativity also teaches us that we must speak of a space-time continuum, rather than separate space and time. *Events* are points in this continuum.

4.4 There are awesome philosophical implications here. If Real Time(T r) is a fourth dimension, just like the three dimensions of space, viz., 1, band h, then, we can consider 1, b , hand T r as the equivalent dimensions of the space-time continuum. If the 1, band h dimensions of rigid bodies are fixed, their Tr must also be fixed. What does this mean? This implies that their dimension in the time axis, viz., Their *life span,* is also fixed! *Does this remind us of the concept of afate? Could we extend this to living beings too?* 4.5 What about" time travel"? It should be as possible as travel in space! Of course, we humans cannot travel backwards in time. But this is due to our subjective limitations! 4.6. Finally, let us invoke quantum mechanics, especially as expounded by Niels Bohr (1885-1962) and Werner Heisenberg(190l- 1976) We may note the enormous significance of Heisenberg Uncertainty Principle and Bohr's Complementarity Theory and his concept the Observer-Observed- Interaction. A philosophical corollary of the HUP is the inevitability of the "Heisenberg Error", which makes *all measurements at least infinitesimally inaccurate.* All knowledge obtained through measurements will be imperfect! Bohr's CT and 001 imply that *objectivity* (so proudly paraded by scientists till recently as the primal criterion of scientific knowledge)is a myth! Bohr explained that when we try to observe something, our very attempt to observe the thing changes it. What we see is therefore not what we wanted to see! Here Bohr has a kindred soul in the 18th century German philosopher Immanuel Kant (1724- 1804). Kant considered two types of truth- "noumena' and "phenomena". Noumenon represents absolute truth and is unknowable. (A *thing-in-itselfis* unknowable). Phenomena are relative truths and can be known through methods of science. The same view was expressed centuries earlier by Adi Sankaracharya (788- 820 AD). Sankara spoke of *paramarthika satta* and *vyavaharika satta*. (The former is equivalent to Kant's Noumenon and the latter to his phenomenon) THE FORMER IS *BRAHMAN* AND THE LATTER IS *JAGAT. BRAHMA SATYAM; JAGANMYTHYAI*

5. The part and the Whole

Werner Heisenberg, the celebrated propounder of the uncertainly principle, has posed another *primal* question. His arguments can be approximately condensed as follows: Man is part of the great cosmos. *He cannot stand apart from it; because he is part of it I* Now, it stands to reason that a part cannot ever comprehend the whole fully! In order to comprehend something, one has to be on the outside, studying it objectively. Man cannot stay outside the universe and therefore he cannot ever fully comprehend it.

It is interesting to note that Heisenberg's autobiographical book, in German, is named "Der Teil und die Ganze"(in English, " The Part and the Whole")

6. Conclusion

It is obvious to unprejudiced minds that the ancient Indian seers (rishis) had a profound understanding of the universe. They knew about the non-linearity(cyclicity) of time and of the boundlessness of space. Their theories about the *kalpas* and *kalacakras* closely mirror modern views about the oscillating universe and cosmic cycles. Unfortunately, due to the absence of sufficient records and our limited ability even to interpret the available records, the modern scientist is not in a position to appreciate the heights of glory of the ancient thoughts. It is imperative that more research work has to be done in this field.