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AN INQUIRY INTO TIME

Meera Chakravorty

The notions of Time which have till now obeyed the conventional understandings, may not find it easy to do away with the prevalent elegant sets of equations supposed to have been its excellent criteria so far. A notable precursor in this field of conventional time sense, in which various findings are gradually replacing the established rules, is the theory of quantum physics which appears to take the logic of the state of exception to an unsurpassed extreme. Scientists have discussed the birth of time or when the time was born. To the question what is time, the different studies show that it rarely obeys any fixed pattern and theory. This question may appear redundant to many. Nevertheless it is meaningful to investigate the path Time has treaded through diverse areas which in turn may or may not provide us with one absolute criterion regarding it's nature.

It is not easy, in fact, to make an assessment of Time in few paragraphs. The most concise effort in this context may leave out a lot of things but this is how the efforts are to be made. The areas of investigation may be cultural, philosophical, linguistic and other diversities in various contexts. Besides, they may appear interconnected and hence multidimensional in nature. As for instance, at some stage of enquiry Physics may seem to be at the threshold of philosophy. Today, there are many who are well qualified both in physics and philosophy and their speculations cannot be ignored by both disciplines.

Scientists have hailed achievements of the human intellect to pin down the age of the Universe. Astronomers claim that they can persuade people to believe that the astronomer really does know the age of the Universe, no mean achievement when

you recall that it was only in the nineteenth century that scientists began to appreciate that there was a beginning for the Earth and Sun, let alone the cosmos at large.

Did Time begin at some point? To this question, a panorama of references from various disciplines point to both the extremes of Time having begun and Time as beginningless. The earliest and most widespread view of Time in cultures as the Hindus and the Buddhists saw it in terms of cycles of birth, death and rebirth. Like the changing cycle of the seasons, in which the earth itself is constantly renewed, the Universe was seen as being reborn, but changing in a regular rhythm. Also, many thought that it is our vivid ideas that have been continuously projected and determined our thinking on Time. The concept had attracted it's complement of myth well before the scientists made their map regarding Time. Nevertheless, this mapping is so diverse that sometimes it appears a reality and at other times it is dimly discernible through experiments.

Time was fancied in the Hindu cultural site as the witness of all activities. Besides playing many roles of being an eternal substratum for everything possible Time was conceived as a healer, a philosopher a teacher and a guide. This helped to engender the myth of science fiction, *Around the World in Eighty Days* from Jules Verne. From this flight of fancy based on folk experience and culture came the understanding of Time as an all encompassing phenomenon which is never going to be extinct. Combined with this idea as a frontier forerunner Time was soon to be vivified as one of the significant choices that gave substantial results to scientific investigations at various stages that the scientists were reasoning to understand. James Hutton in a paper published by the Royal Society of Edinburgh in 1788, wrote that the result of our present enquiry is that we find no vestige of a beginning—no prospects of an end.

Time has been posing an enigma since long. The problem was not that the physicists did not know what was going on. Quite the reverse is the fact. Lord Kelvin, for instance, was the towering figure in physics in Britain in the second half of the nineteenth century, and almost as dominant in the context of European science. Among his many achievements in science Kelvin laid the foundations of thermodynamics (the second law of thermodynamics in 1851, which says that heat cannot flow unaided from a cooler object to a hotter one), and helped to develop the theory of the electromagnetic field. It was through his study of thermodynamics that he was led to ponder the question of the ages of the Earth and the Sun. The most important thing that thermodynamics teaches us is that nothing lasts for ever. All things must pass, and everything wears out. In 1852, Kelvin wrote, within a finite period of time past the earth must have been, and within a finite period of time to come the earth must be again. This was speculated with absolute confidence

by the Buddha in the sixth century BC when he said that everything is of the nature of flux.

The school of Nyaya-Vaisheshikas (NV) in the Indian Philosophical context refer to Time as a Substance, (*Dravya*, for which the English term provided conventionally is' Substance') different from action, something which measures things in action. Before describing their position I will like to mention the point of view of the linguist philosopher Bhartrihari who elaborate this position in his treatise Vakayapadiyam. He explains that it is Time which measures the course of the Sun and we get such expressions as month (*masa*), year (*samvatsara*),et al. Time acts as the cause of origin, existence and destruction, the three states that any object go through. It is also due to Time that there is sequence of things in the Universe. Things appear at a particular way due to Time factor. Time is an agent of action. Time is differentiated due to association with the different actions of the objects of the Universe. The actions of objects are the associates of Time and it assumes distinctions due to this association. Motions of the Sun, of the planets and the stars are the associates of Time. Due to the differentiation in their motion, different measurements of Time result. Day and Night, fortnight, month, season, age, era are the conventional measurements. The interval between the rising and the setting of the sun is a day. Night, fortnight, moment et al says Bhartrihari, are similarly conventionally defined (*vyavasthanam*). At every stage of activity Time is discernible. Hence, Time is identified with activity itself.

The logicians of the NV school speculate Time (*Kala*) to be one of the nine categories beginning with Dravya, enumerated in their philosophical treatise. They too accept on the line of Bhartrihari that Time is expressed as seasons, day, night, and so on. Here, Time as Substance and Time as action appear to be merging on one plane like mass and energy in Eienstein's equation! If Sun (*Tejas*), is the Substance and also responsible for notions like priority, posteriority et al then the ticking of clock on the wall, showing the time as 9 o'clock are two manifestations of one and the same event. Likewise, the Sun as a 'substance', a large ball of gas and it's energy which is the result of atoms and molecules colliding with one another engendering energy are also not two events. Sun the mass and Sun the energy are two sides of the same coin. Sun is action (*Gati* i.e. motion), and action is Time.

If Time is perceived as activities revolving round the Sun referred to as Tejas and categorized as 'substance', it's motion are considered as *Gunas* (Qualities), inhereing in the 'substance'. These two, as observed earlier appear to have merged as one. The strict margin between 'dravya' and 'guna' does not exist anymore. Bhartrihari (III.9.46) puts the puzzle of dravya and guna together coming up with this new time-scale, the sun and it's energy source in one package. Further, Time

is considered to have three powers on account of which the appearance and disappearance of objects take place. Of these three powers, past and future hide objects whereas the present reveals them.

The power called Future does not stand in the way of the power called Present which is associated with the birth of objects. What is called Future is that which is something in time will become present. But the power called Past does stand in the way of power called Present. What is Past is Past. It does not become Present whereas it is what was Future, which in time becomes Present. These three are also described as paths and they are like light and shade, without sequence. In them, objects acquire sequence. Vyasabhashya which is an elaborative treatise on Yogasutra (III.13), it is mentioned that though these three powers exist in Time, they are without any sequence, yet they operate like light and shade on objects hiding them or manifesting them according to necessity and thus bring about their sequence. In this respect they are like the three elemental characteristics (called *Gunas*), *Sattva*, *Rajas* and *Tamas* that are constituted in *Prakriti* (Matter), always present but operate through co-ordination, as explained by the Sankhya school of thought. The past and future hide objects and so they are called darkness (*Tamas*). It is the function of darkness to hide (Sankhyakarika.13.). The present enables us to see the object and so it is the effect of *Sattva* or light and *Rajas* stands for activity and is Time itself in general.

This application of Time can throw an interesting question as to how the past and the present being opposites, be the same thing? Vakyapadiya's stand in this context is (III.55) that when the causes are active and functioning, a thing becomes present and when its causes have stopped functioning it is not visible any more, it is to be taken as past. To elaborate further, it is when the causes are all ready and mature and produce their effect then the object becomes manifest, does it work and is said to be present. When the causes cease to function and the object has also fulfilled its work, it becomes invisible and is said to be past. When the causes of an object are not yet ready to produce it, it is said to be in the future. Thus one and the same thing acquires different names on the basis of external circumstances according to the presence or absence of purposeful activity.

There are yet other dimensions to Time. In 1771, Buffon, a French naturalist came up with the first scientific (at that time) explanation for the origin of our planet and thus the beginning of Time, suggesting that it had formed from a molten material, torn out of Sun by the impact of a comet. The question this raised was "How long time would have taken for this molten ball of rock to have cooled to the state it is in today?" In fact, a century before Buffon, Isaac Newton had mentioned in his Principia that a globe of red-hot iron as big as the earth would take 50,000 years to cool down. The next step was taken by another Frenchman, Jean Fourier (1768-1830)

whose contribution to science was the development of mathematical techniques for dealing with what are known as time-varying phenomena (Fourier analysis can be used, for example, to break down a complicated pattern of pressure variations in a sound wave into a set of simple waves or harmonies which can be added together to produce the original sound).

He improvised on Buffon's theory realizing that although the earth is cool on the outside today, it is still hot in it's intrinsic (as the activity of volcanoes demonstrate). His equations could describe how heat flowed outwards from the hot interior of the planet through the layers of cooler material at the surface layers of solid rock which acts as an insulating blanket around the molten material inside the earth holding the heat in and ensuring that the planet takes much longer to cool down than Buffon had estimated. The number that comes out of Fourier's equations was so staggering that it is said that he never brought himself to write it down. What he did write down in 1820, and leave for the posterity was a formula for the age of the earth, based on these arguments.

Retrospecting on the Indian philosophical context, one may say that one of the key contributions of Bhartrihari is to take the number technique to indicate Time factor. Anything which is an existence (*Satta*) is said to have number. Things are characterized by difference and number expresses this difference. As mentioned in an earlier context, for the NV logicians things are said to be different if there is separation between them and they are distinguished as one, two, and so on, on the basis of number. Even in complex formations, the meaning of the secondary word being a thing is cognized as something having number, as distinct from the meaning of the individuals which has no number (that number is called Abhedaikatvasamkhya,— the number one in general). NV speculates number as a quality (*Guna*) residing in Substance. They further explain saying that some may argue that when a thing is by itself it is considered 'one' and when it is with others, we talk about them as 'two', 'three', and so on. It is a question of whether a thing is in company or not. However, this is not the right position say these logicians (NV). Our cognitions differ in the two cases. It is not the same thing to perceive a thing as being in company or to perceive it as one of two or more objects. Numbers like hundred etc. exist in several things together. They are inhering in more than open (*Vyasajyavritti*) and they are perceived by intelligence which makes this distinction (*Apekshabuddhi*).

Those who do not agree with this position of the NV logicians argue that number can never be perceived apart from the things where it is found. Things are perceived as qualified by numbers and this can never be so if number were absolutely different from it's base (*Ashraya*). The school of linguistics (The Vyakarana) is not concerned with what things really are. They are concerned with the notions which help in the

explanations of the forms of words. What ultimately is the nature of the meaning which the 'numbers' represent. From these numbers we understand some property which helps us to distinguish things. Number is one such property. It helps us to speak about things (*Samchashte*). Hence it is called number (Sankhya).Further, it really belongs to Substance (Dravya), but the expressions of language sometimes present it as existing in other categories such as, Qualities(*Guna*), Universals(*Samanya* or *Jati*) and also in the category of (*Abhava*) Non-Existence per se! There can be comprehension of language as not only expressing real things but also attributed things. A unit or 'one' is the source of duality etc. because all distinctions are preceded by it. When two things are seen we see a unit in each of them. Thus two units, depending upon this cognition, produce the sense of duality which inheres in the two things which are their substratum. The concept of number in this context appears to be a manifestation of yet another dimension of Time.

It remains to be seen whether the association of numbers mentioned above helps to determine the enigma of Time or is it once again the part of the problem itself. If the sun had a small number of atoms and molecules it would not have been possible to radiate heat but millions of atoms do make the same possible. It is one of the insights from the thermodynamics that heat is associated with millions of atoms and molecules moving about and colliding with one another—the faster they move the hotter the object is. If you imagine all the innumerable numbers of atoms that make up the sun disposed into a thin cloud in space then falling together under the influence of gravity to make the sun, it is easy to see how gravitational energy will be converted into heat as all the atoms and molecules move faster and faster and collide with one another. Indeed, this is still the way that astronomers believe stars form and get hot in the first place. The relevance of this is that the numbers may be tangential and really matter to reflect the importance in the understanding of Time. In round numbers (to the nearest hundred million tons) 600 million tons of hydrogen are converted into 595 million tons of helium every second in the heart of the sun with the other 5 million tonnes or so being converted into pure energy. I have emphasized these details says John Gribbin, in order to just how well astrophysicists do understand what goes on inside stars. You cannot change these numbers by even five or ten percent and still get everything to match up. The importance of all this is, of course, that the stars are the oldest things in the Universe, and the Universe itself must be surely older than the stars it contains.

From the above it may lead one to ask with surprise whether Time has a history of it's own, whether it can be regarded as a single enterprise which has no equal as a systematic account of how it itself is constituted. The different approaches described earlier may only display themselves as astonishing accessories to comprehend Time to a very limited extent through economy of synthesis, vividness of detail and

an acute sense of cultural differences yet whose signature is so bold and striking and is something like the sky from which no one or nothing can escape.

Still a kind of functional understanding of the enigma of Time may arise after going through the epic span of events that are all the time happening. They are more self-standing with features that mark them off from their predecessors. The process of measuring from one event to the other allows a seemingly consistent scheme, classically traditional in it's logic. Events can be perceived and Time in this senses of events experienced and perceivable. This peculiarity was faced by the logicians of the Nyaya School. Some of them hold that Time is a form of experience and is perceived by the sense organs as a qualification/adjectives of objects perception for example when we cognize objects as existing at present, Time also may be said to be perceived. In the perception of the jar (ghatam) as existing at present (*idam ghato vartate*), present Time also enters into the perception of the object. Every object is perceived as existing in Time, though Time is never perceived by itself. Temporal relations are dependent on the terms related. There is no sooner or later, before or after apart from events and actions. Time is perceived as a qualification/ adjective of objects and is therefore a substantive reality.

The Nyaya and the Buddhist logicians had always had a clanking of theoretical armour. Without concealing the distaste towards the view of the Madhyamika Buddhist who say that there is no present Time (*Vartamanakala*) apart from the past and the future, the Nyaya searing this line of thinking asserts that the past is defined as that which precedes the present, and the future as that which succeeds it. But the present has no meaning apart from the past and the future.

This sympathy towards one's own ideology is forthright. They are sure that this Madhyamika view is partly a matter of confusion in understanding the relation of space and Time. For instance, when the object falls, we have the time taken up by it's traversing a certain distance and the time that will be taken up by it in traversing the remaining distance, and there is an intervening distance which the object can be said to traverse at the present time. Space traversed gives the idea of past time, space to be traversed that of future and there is no third space which could give rise to the present time. But Time (*Kaala*) is not manifested by space (*Adhvaa*), but by action (*Kriyaa*). We have the conception of Time (as past) when the action of something falling (for instance) has ceased... When the same action is going to happen, we have the conception of Time (as future) and lastly, when the action of the thing is perceived as going on at the time, we have the conception of (present) time. In the circumstances, if a person were never to perceive the action as 'going on', at the time, what could he conceive of as having ceased as going to happen? At both the points of time (past and future) the object is devoid of action, whereas,

when we have the idea that the thing is falling down, the object is actually connected with action, so then what the present time apprehends is the actual existing connection of the object and the action and it is only on the basis of this (existing connection and the time indicated by it) that we could have the conception of the other two points of time, which latter, for this reason, would not be conceivable, if the present time did not exist. Again, perceptions arise in connection with things which are present in time. There cannot be perception, if there is no time.

A survey of the intellectual scene in the area of Sankhya school of thought cannot conceal prejudice for Matter (Prakriti), mitigated by admiration for it's titanic capabilities. Matter is uniquely juxtaposed against Consciousness (*Purusha*) according to the Sankhya school. However, excepting consciousness everything else in the cosmic evolution is pervaded by Matter and is characterized by action, change and motion (*Parispanda*) Time and Space are not exception to this rule. All things undergo infinitesimal changes of growth and decay. In the smallest instant of time (*Kshana*), the whole universe undergoes a change. In the empirical world, Space and Time appear as limited and are said to be conditioned by co-existent things in space and moving bodies in time. In fact, Space and Time are for Sankhya more conceptual than empirical phenomena.

This is elaborated here by one of the scholar exponent of this school, Vijnanabhikshu in his work Sankhyapravachanabhashya. He speculates that eternal space and time are of the form of Matter and are the specific modifications of Matter. Hence, the universality of space and time, he thinks, is established. On the other hand, space and time which are limited are produced through the association of this or that limiting object (*Upadhi*). These are known as the modifications of Matter. Space and Time are by themselves abstractions. They are not substances as the Nyaya envisaged but relations binding the events of the development of Matter. Events stand in relations of time and space. We have no perception of infinite time or infinite space, and so they are said to be constructed by the understanding. From the limited objects of perception which stand to one another in relation of antecedence and sequence, we construct an infinite time-order to represent the course of evolution. Yet another spokesperson and scholar Vyasa (in his *Yogabhashya*) whose signature is like the sudden bolt of electricity says, just as the atom is the minimal limit of Matter, so the moment (*ksana*) is the minimal limit of time or the time taken by an atom in motion in order to leave one point and reach the next point. But the continuous flow of these is a sequence (*Krama*). Moments and sequences of these cannot be combined into a real (Vastu). Thus, Time being of this nature, does not correspond to anything real, but is a product of mind, and follows as a result of perception or of words; but the moment is objective rests on the sequence. The sequence (*Krama*) has for it's essence an uninterrupted succession of moments which is called Time (*Kaala*).

Two moments cannot occur simultaneously, since it is impossible that there be a sequence of two things, since it is impossible that there be a sequence of two things that occur simultaneously. When a later moment succeeds an earlier, there is a sequence. Thus, in the present there is a single moment and there are no earlier or later moments. Therefore, there is no combination of them. But these moments which are past and future are to be explained as inherent in the changes (Parinama). Accordingly, the whole world passes through change in any single moment; so, all the aspects of the world are relative to this present moment.

At this level of enquiry the interesting and fundamental principle of General Relativity (GR) Einstein's radical idea concerning the nature of space and time is significant to note. As it is well-known, in classical Newtonian physics, space and time are a fixed backdrop against which particles move, fields oscillate and so on. If we took away all the particles and fields we would still be left with space-time. Einstein's Special Theory of Relativity, which preceded GR, retained the fixed backdrop, but changed it's geometry in such a way that spatial distances and temporal intervals were no longer absolute, but relativized according to the observer. An absolute notion of 'distance' between events in space-time formalized by the mathematician Hermann Minkowski. Then with GR, Einstein introduced the idea of a variable geometry in which the curvature of space-time interacts with it's material contents. Geometry was now dynamic and the fixed backdrop abandoned. This was a revolutionary move.

In the area of quantum physics a novel idea was introduced to understand Time. That in general, particles don't have positions. Rather, in some mysterious way, sharply defined classical quantities 'fluctuate' so that 'particles' become probability distributions, described in terms of the famous Schrodinger wave function, which generates the probability of finding a particle at a given position if one were able to observe it. But the wave function dealt in ordinary, unquantized space and time, i.e. with a background assumed to be fixed. So how could one do Quantum Theory (QT) against the variable geometry of GR? Somehow fluctuations would have to be introduced into the underlying geometry itself, which seemed to make a nonsense of QT's formalism, remarks (Redhead). QT's other great innovation was the idea that some physical magnitudes (though not spatial extensions) could exist only discrete or 'quantized' amounts. In GR meanwhile, the variable geometry is used to describe the force of gravity, so that to quantize GR would mean developing a theory of quantum theory.

Physicists like Lee Smolin's account of understanding of theories for explaining quantum gravity has been expended trying to find an answer to this problem. It is crucial to assessing and inventing a theory which would explain the problem adequately. The important point is that though the empirical predictions of GR can

be recovered in string theory, it does not accommodate the fundamental idea of GR, it's variable geometry. The string is still imagined vibrating against fixed background (typically with a large number of spatial dimensions than Minkowski space, the extra dimensions so tightly 'rolled up' that their presence is revealed only at extremely short distances). However, there have been space-time premises of exotic discovery of 'M' theory (the quip is that 'M' stands for mystery) from which a proper quantum gravity might emerge.

The relevance of this we need to remember is to quantize geometry. To the obvious question what is geometry, the standard answer may not be tangential or may be. But people like Smolin are sure that the notion of a 'point' has no place in the space-time of GR. It sounds weird to have geometry without points. The fact is that the school geometry teaches us that lines are made up of points. But suppose we think of lines as fundamental entities in their own right, we could then define a point as specified by a pair of intersecting lines (if the lines are parallel their point of correspondence will be at infinity. The points will then be dragged along with the lines, so that they can't' be identified with fixed points on the paper. Their identity is constituted by the activity of the lines.

This is further explained differently (Redhead) as the two lines can be used to specify an elementary shape, such as a small square if they are orthogonal. Different pairs of lines will specify shapes with different orientations, so our new sense of 'point' can be understood as a shape with a particular orientation, but no fixed location. In three dimensions we might, for example, have a collection of little cubes each with it's own orientation. Now draw a diagram in which each cube is represented by a point, with lines joining the points representing the rotations or 'spins' that turn one cube into another. Such a diagram is called a 'spin network', and quantified versions of spin networks were introduced some thirty years ago by Penrose to produce a geometry of 'quantized directions'. The remarkable thing is that while the volumes and areas in the spin network have definite but discrete (i. e. quantized) values, there is no such thing as a definite length. So, the curved spatial geometry of classical GR is recovered in this new theory as a 'fabric' woven out of loops, knots and links of spin networks. As time unfolds, the spin networks mutate, producing a structure to which the epithet 'spin foam', has been aptly applied. Space-Time has become spin foam.

Like one of the explorations in Indian schools of philosophy mentioning Time as events, Smolin too appears preoccupied with a similar idea. For him to talk about Space-Time points would be to introduce unacceptable elements of 'fixity' into the geometry. There are events, but they don't occur at space-time points because there aren't any. What we call spatial distances and temporal intervals are relations between events, not between space-time points. Thus, if there were no events there

would be no space-time – a point of view famously expounded by Leibniz against Newton at the beginning of the eighteenth century.

If there are no points in space-time, what does this imply about the nature of Time? To some, including Julian Barbour, in The End of Time (1999), it implies that Time is an illusion. To recite, 'the clock struck one and the mouse ran down' is to establish a correlation between two physical events, the descent of the mouse and the striking of the clock. But we must not be tempted to think that the clock measures the Time at which the mouse runs down. Changes and processes do not occur in time, they are Time.

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