

ON MATHEMATICAL CONSTRUCTIONS OF TIME AND RELATIVITY

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Abstract

The mathematical constructions, physical structure and manifestations of physical time are reviewed. The nature of insight and mathematics used to understand and deal with physical time associated with classical, quantum and cosmic processes is contemplated together with a comprehensive understanding of classical time. Scalar time (explicit time or quantitative time), vector time (implicit time or qualitative time), biological time, time of and in conscious awareness are discussed. The mathematical understanding of time in special and general theories of relativity is critically analyzed. The independent nature of classical, quantum and cosmic physical times from one another, and the manifestations of respective physical happenings, distinct from universal time, are highlighted. The role of a universal time related or unrelated to origin, being etc., of universe or cosmos as common thread in all happenings is reviewed. The missing of time is identified and concept of absence of time is put forward. The complex nature of time and the real and imaginary dimensions of physical time are also elaborately discussed together with human time- consciousness as past, present and future.

Key words: classical time; quantum time; cosmic time; qualitative and quantitative times; missing of time; scalar and vector natures of time; special theory of relativity; general theory of relativity; complex time; real and imaginary dimensions of physical time; biological time; time in conscious consciousness; past, present and future in physical and psychological times.

Introduction:

“ *Our present picture of physical reality, particularly in relation to the nature of **time**, is due for a grand shake-up—even greater, perhaps, than that which has already been provided by present-day relativity and quantum mechanics*” [1]. This article is written in this spirit to give a fresh insight of time, its passage and consciousness by critically studying the mathematical constructions of time and the evolution of relativity concept. Time is considered as one of the fundamental quantities in physics. Second, which is the duration of 9,192,631,770 cesium-133 atomic oscillations, is the unit. We generally believe that we know what time is. But our understanding of time is not unique [1-7].

Evolution of concept of time:

Time has many forms, structures, natures and has been viewed, defined and understood variedly [2-7]. Ancient Indian thinking contributed to the concept of time. The essence of ancient Indian thought on time appears to be the identification of three major characteristics of processes i.e., the beginning, the ongoing and the end. Ancient Indians stated that time passes in a cyclic way [6].

Ancient Chinese felt that time is discontinuous. It is with the Greek philosophers, the different and mutually *contradicting* views about time started flourishing. Plato is the first to distinguish time as it is in itself from our awareness of time and from events in Time. He regarded Time as being actually produced by the revolutions of the celestial sphere. Zeno related Time to motion. Pythagoras tended to identify the chronological with the logical. Aristotle, possibly influenced by Pythagoras felt Time as counting of motion in respect of before and after. He regarded Time and motion as reciprocal. He concluded that Time does not exist without motion. Thus for Aristotle, Time is a numerable aspect of motion. Plotinus objects to this aspect of Time when he says “*motion time can not be, since motion takes place in time*”. For Heraclites time signifies the period of world from its function to its destruction and rebirth.

Galileo has represented time as a geometrical straight line. Barrow said that time is the continuance of anything in itself in its own being. Newton felt that an “absolute time” exists, whose equable flow is independent. Thus he says “Absolute, true and mathematical Time of itself and from its own nature flows equably, without relation to anything external. Leibniz felt the order of successive existents as time. Kant perceived time as an aspect of our experience and denied it an existence in external reality. Einstein criticized the classical concept of universal simultaneity. He provided the term relative time. Human experience and observation sense two existences of time. They are physical existence and psychological existence [6]. Modern physicists like Stephen Hawking talk about real and imaginary times and also about the shape of time [3, 5].

Physical existence of time:

Natural sciences such as physics, chemistry and biology understand physical existence of time variedly. Movement, change and becoming as given by Zwart [2] are three classifications of physical time. These may be understood by observing physical, chemical and biological processes as follows.

Physical Time:

Energy is time. Energy transformation through matter or otherwise is passage of time [6]. Energy presence can be potential form of matter, charge or energy. Energy transformation can be continuous or discrete and discontinuous. Dual nature of energy and matter give rise to two associated and simultaneous motions relating to wave motion because of associated wave-nature and translational or other kind of motion of and due to particle nature [6, 7].

Time in theoretical physics: The physical theory of time:

i) *Movement*: Matter and energy are engaged in all natural, man-made or man-initiated processes. Matter can exist as solid, liquid, gas (vapor) or plasma (ionic form of matter) at a given time and space. Energy can exist in many forms. Matter and energy can be in i) a state of rest or ii) in a state of motion. Aristotle opined Time as counting of and reciprocal to motion. Motion associated with matter can be translation, rotation and vibration and periodic or non-periodic. Plato opined Time to be generated by cosmological movements¹. Thus movement has been construed to be Time and also the cause of Time.

Time associated with movement, gives direction to time and sustains it as *vector* time. The same becomes *scalar* time when counting of that duration of movement is done. Position changes with velocity. But velocity need not change with position. (Ex; uniform or constant velocity)

Time of thermodynamics, chemistry, biology and evolutionary biology: Physicochemical, chemical and biological times:

Time is generally defined considering physics and cosmology only [3, 5]. But time occurs and plays a role in the same sense in chemical, biological and other natural sciences also [4, 6].

ii) *Change*: The phase or state of matter is changed by energy and the form of energy is changed through matter [6]. Thus transformation of phase or state of matter or form of energy takes place with mutual influence. Natural or non-natural processes involve transformation of both matter and energy bringing out changes within or without of matter. Heat energy changes ice (solid) into water (liquid). This is the macroscopic change of phase of matter which reflects the microscopic change of phase of matter – atomic or molecular changes within the matter. Changes in the nucleus of an element also take place at the respective Energy and Time scales giving rise to nuclear changes of matter.

The atomic and nuclear changes take place involving rest and change of place (movement) of electrons, atoms and molecules in atomic and molecular spaces relating to respective micro-energy and Time-Scales Human sense organs can not sense all the magnitudes of these micro-energy changes and Time-durations which take place in micro (10^{-6} sec), nano- (10^{-9} sec), pico- (10^{-12} sec), femto (10^{-15} sec) times in micro- and nano- spaces (nm, 10^{-9} m). Only specific sophisticated instruments alone can sense, monitor and gauge these micro – energy changes happening in micro (10^{-6} sec), nano- (10^{-9} sec), pico- (10^{-12} sec), femto (10^{-15} sec) and atto (10^{-18}) times. Time associated with change and course of change gives direction to time and sustains it as *vector* time. The same becomes *scalar* time when counting of that duration of change is done.

Thus all physical, chemical changes are *constructed* as Time with varied durations and intervals.

iii) *Becoming*: Biology is the natural science dealing with living systems. We will be aware of physical changes of an organism – the result of physico-chemical changes within - as growth or decay. A plant *becomes* a tree. A girl *becomes* youthful. These two *becomings* are growth of organisms. Tree *becomes* dead wood. Youthful woman *becomes* an old woman. These two *becomings* are decay or degeneration of

the organisms. The psychological process of a human being *becoming* angry and *being* peaceful after the anger subsides are also biological processes involving changes in and changes of psychic energy. Human knowing, learning, thoughts, perceptions, understandings and experiences are other mental processes which are *becomings* in psychic energy [7]. Evolution of universe; chemical evolution; molecular and macromolecular evolution, evolution of proto-cells, cells, tissues, organs and organisms, evolution of consciousness, all come under physical, physico-chemical, chemical and biological times.

Thus all physical, chemical, biological matter has *phases* of origin, being/becoming and dissolution (cessation) which are *becomings* associated with matter and energy. Thus *becoming* has also been *construed to be* and *constructed as time*. Change and becoming are constructed as *scalar time*; Change in entropy taking place during change or becoming in chemical and biological processes gives direction to time. Thus time associated with change and becoming gives direction to time and sustains it as *vector time*. The same becomes *scalar time* when counting of that duration of change or becoming is done.

The above three insights of time as time essentially concern *changes*. Thus changes of phase or place of matter or change of form of energy can be construed as time. External monitoring of duration of these *changes* are measurements of time and passage of time. All these measurements concern physical time. Thus physical time consists of changes and measurement of duration of such changes. Simply, *change is time* [6].

The missing of time:

A period is absent in the absence of a process. Duration is absent in the absence of a period. 'Time' is *absent* in the absence of duration. Thus time is *missing* in the absence of a process, natural or non-natural. Time is dependent on a natural or non-natural process for its being. It has no independent existence from the process or event or happening- physical, chemical, biological, psychological, cosmological, social, political, or likewise [6]. Such a physical existence as flow and period of a happening is the physical time. *Thus the being and becoming of matter/anti-matter and energy is physical time. The absence of such happening is the missing or absence of time.*

Qualitative time (Vector or Implicit Time):

Time is thus an implicit physical quantity like mass only in the sense that it is constructed by respective natural forces, phases of matter, forms of energy and interactions among them during the course of the process.. Time is also an inherent physical quantity like velocity, force, energy etc, only when the duration and course of the process are constructed by above mentioned physical quantities. Time differs in *quality* when *constructed* in different processes-physical, chemical, biological and cosmic. Quality of qualitative time depends on nature of phase of matter and natural forces constructing the duration and the nature of energy-forms involved and their range. The durations are *constructed* differently for different processes-physical, chemical, biological, cosmological, psychological etc., *Qualitative time is constructed by the respective process guided by respective natural forces and never pre-exists the process.* Thus time is caused by the processes and follows the course of processes forming its locus and is solely determined by the natural forces that cause the course of the process. *The direction of the course of the process is the direction of time and its passage*

Quantitative time (Scalar or Explicit Time):

Quantitative time is *external* measurement of or count of, elapse of durations of qualitative time created by natural forces involved. Quantitative time never influences the duration or course or otherwise of the processes.

Momentum and velocity can be simultaneously precisely measured for macroscopic bodies because of their large masses and sizes and also “less” velocity associated with them when they are in motion. In addition the energy transformation associated with such processes is *continuous*.

Momentum and position of a fundamental particle can not be simultaneously precisely measured (uncertainty principle) because of the tiny size and small mass but normal values of charge and large magnitudes of velocities attained or proximity in nano- spaces for the exchange of charges associated with ionic phase of matter. Mass plays dominant role in macroscopic world. Charge and velocity associated with the particle play dominant role in micro- and nano-scopic world. We cannot conduct an experiment in reality where ‘a photon’ strikes ‘an electron’. Such an experiment is only a thought-experiment. Existence and consciousness of time and passage of time are of three kinds: Annihilation of time is termination of a process or eternal happening; instantaneous happening or absence of happening.

Duration of time of happening of a process or course of a process changes with energy transformation, energy absorption or energy emission or energy transfer (velocity change, frequency of rotation or vibration etc.), but energy transformation etc., will not change with change of time in a clock. Actually energy transformation etc., create passage of time and time interval. Division of passage of time as past, present or future is only human concern and is the result of human time-consciousness, memory and imagination or expectation. Shape of a wave is locus of mass or particle in motion. Time is created and constructed by physical, chemical, biological, psychological or cosmological processes or changes. Time originates with start of the process, evolves as duration entwined to the course of the process and gets terminated with the completion of the process. Durations of all phenomena (scientific, social, political, etc.,) are correlation of these constructed times as durations with a uniform process going on in a clock or time-measuring device or calendar. This correlation by human mind is time-measurement and time-sense. When this correlation is done as hours, days, years etc., with an egoistic mind time-sense is created within and time-conscious mental world is created within of a human-being. Two differentiations/integrations take place at the same time and energy is expended to cover the distance/ displacement/ angular displacement/ amplitude of vibration

Loci of physical time passage:

Figure I displays various propositions on the locus (Path) of time while ‘flowing’. Ancient Indians proposed cyclic path. We all modern people are following the idea of Galileo that path of time flow is a straight line, i.e., linear passage of time.

Important physical quantities associated or connected with the physical quantity time:

Time is constructed and manifested in different ways in the natural sciences. Velocity (v , m/s); acceleration (a , m/s^2); force (N , $kg \cdot m/s^2$); Watt (W , power, heat-flow rate, J/s); frequency (Hz , $1/s$); becquerel (Bq , $1/s$); catalytic activity (kat , mol/s); inductance (H , Wb/A); magnetic flux density (T , Wb/m^2); Weber (Wb , magnetic flux, $V \cdot s$); volt (potential/electromotive force, W/A); coulomb (C , Electric charge, $A \cdot s$); action ($J \cdot s$) are important structures and manifestations of physical time. See also Table I, to IV and Figure I.

Mathematical constructions of physical time:

The above physical manifestations of physical time associated with various physical quantities can be understood using mathematics as follows:

Calculus:

Time is always explicit to process as external monitoring measurement and never influences the course of the process [6, 7]. *Time only measures the duration of the process and never determines the duration of the process.* Duration of the process is determined solely by phase of matter/anti-matter or forms of energy undergoing change and the natural forces causing the change. The time intervals are only indicators of extent of happenings and are mere numerical measure of such extensions. Differentiation is measurement/counting of time and gives an idea of speed of happening of and the course of the process. Integration gives an idea of duration of the process.

Velocity = change in position/change in time = $v = dx/dt$, the first derivative

Acceleration = change in (change in position/change in time)/ change in time = $a = d^2x/dt^2$ = second derivative.

This is the traditional representation of velocity and acceleration. The same thing can be viewed as follows:

Velocity is integrated acceleration over a time period (with respect to external monitoring of speed and duration of energy transformation causing movement). Distance is integrated velocity over same time period (with respect to external monitoring of duration of movement). Energy or its transformation is integrated entropy over a period of time (with respect to external monitoring of duration of change or becoming). Reaction is integrated rate of reaction over a period of time (with respect to external monitoring of duration of reaction).

An object moves only because of its velocity and not because time is passing (moving). Actually velocity creates time (in a reciprocal way) and acceleration gets integrated into velocity during the same 'time of happening' as provider of 'direction' to elapse of time constructed during the process (movement).

Integration of velocity into distance is consequence of integration of acceleration (by expending energy) into velocity. The time taken to cover a distance is thus constructed by simultaneous (or consequent) to integration of acceleration into velocity and subsequent integration of velocity into time of elapse of process (movement). Depending on acceleration (quicker transformation of energy which moves the body forward) or deceleration (relatively slower transformation of energy which moves the body in the reverse direction) make the velocity increase or decrease and hence the time duration decrease or increase many times during a motion and thus influence the overall period of duration of motion. If the velocity is uniform, then there is a constant rate (in relation to monitoring clock) of transformation of energy as acceleration i.e., constant rate of change of energy transformation reflected as uniform velocity.

Thus velocity integrates over time to cover distance. Acceleration integrates over time into velocity causing movement by converting energy into motion. The 'time' here is specific and absolute to the movement under study and is not related or the effect of passage of external universal time.

If a is acceleration, v velocity and x distance covered or displacement taken place, in time dt , we can mathematically represent,

$$\text{Velocity} = v = \int a dt$$

$$\text{Distance covered or displacement taken place} = x = \int v dt = \int \int a dt$$

Acceleration pre-exists velocity. Conversion or transformation of energy creates acceleration and if the transformation is in the opposite direction, deceleration is created. These further create or de-create increase or decrease velocity. Velocity helps the body to cover the distance or displacement takes place. This reverse construction of velocity and distance covered or displacement taken place as single and double integrals respectively of acceleration which in turn is manifestation of energy transformation is to be studied to have a correct insight of time as constructed in all movements and associated changes. Velocity, the manifestation of acceleration which in turn the reflection of transformation of energy, is responsible for the construction of duration (time-period) of happening; the happening can be covering a distance.

It is well-known that a state of rest or a state of motion is available to a body at a given time. Inertia signifies and represents state of rest or uniform velocity (rotational inertia). Velocity which is indirect manifestation of energy transformation represents the state of motion of a body. Relativity comes into

picture only when human concern of motion of a body sets in. Else left to it, it is just the ongoing of a movement or process.

The relativity concept initiated by Galileo has evolved into special and general theories of relativity profoundly influencing our concept of time and space. Such an evolution and its physics implications are separately dealt in another following section in detail.

Velocity also signifies and represents energy conversion and *passage of time* in rotational and vibration motion. Angular acceleration, angular velocity and angular displacement take the places of their linear counter parts. In vibration motion also velocity plays the same role and in addition frequency also represents and signifies energy conversion. This frequency becomes prominent when atomic, molecular, nuclear processes and transitions, and electromagnetic radiation are considered. Dual nature of matter and energy further turn the concept of time, the insight of manifestation of energy-presence and transformation more complex. Quantum processes are created when energy transformation, emission, absorption or transfer happens in discrete quantities. The discontinuous nature of energy transformation defines structures and manifests time differently in quantum processes. Thus the *quality* of time in and associated with quantum processes is different from the classical nature of time associated with classical processes in which the energy transformation is continuous.

Thus *classical* and *quantum* times associated with classical and quantum transformations of energy and or matter/anti/matter are structured, constructed and manifested differently. The same is true about cosmic time, the time associated with origin etc., of the universe or cosmos. This cosmic time is mistaken as universal time. As is pointed out by Ramabrahmam [7], no universal time exists in an absolute or relative way.

In the light of this understanding, an idea about the evolution of relativity concept and its culmination as special and general relativity and their implications on the construction and concept of time will be useful to comment on theories of relativity, origin of universe and related changes associated with universe become clearer and concept of time will be rid of intellectual confusions, and clarity sets in.

Evolution of concept of relativity:

The evolution of science is a complex process in which every step is determined by what has already occurred. It is difficult to come to a proper understanding of today's problems without a knowledge of the past. The process of understanding external world objectively and dialectically will lead to a framework of living and interacting ideas, images and concepts. The history of physics shows that its evolution involves many different ideas which quite unexpectedly inter-weave to emerge in new combinations and as new theories. The chains of physical thought which are involved in the development of the notions of space-time and gravitation and how they finally led to modern gravitation theory.

Copernicus' publication –*On the revolutions of the heavenly orbs*–, introduced a new theory concerning the universe. It led to fresh concepts of relative motion and physical relativity. It followed that in terms of kinematics, it is equally possible for either the observer or the observed to be in motions. Whilst advocating Copernicus' teachings, Galileo proposed his own principle of relativity, and to illustrate it, he described the motions to be observed in a closed cabin on board a ship at rest and those on board a ship at sea. Galileo's formulation contains a very important physical principle, the Galilean principle of relativity. No mechanical test will reveal whether a system is at rest or is moving uniformly in a straight line. Any movement within these two reference frames is identical.

Newton's concepts of absolute space were the culmination of a long historical process. Aristotle's tenet that "Nature abhors a vacuum" dominated thinking of many intellectuals for many centuries. After a prolonged debate the concepts of the atomists of antiquity regained their place in science, moreover, after the discovery of the vacuum.

Newton considered space to be a void arena of things and phenomena. It was three-dimensional, continuous, static, infinite, uniform, and isotropic. He believed that absolute space, in its own nature and with regard to anything external always, always remains similar and unmovable. . Newton's time was also absolute and independent. He regarded it to be "receptacle of events" and that the course of events did not affect the flow of time. Time was thus uni-dimensional, continuous, homogeneous and infinite. Newton's view of motion was similar. In a reference frame stationary with

respect to absolute space, Newton's three laws must hold: (1) the law of inertia, (2) the law of motions, and (3) the law of action and reaction. The force \mathbf{F} in the second law is due to the interaction between bodies. A gravitational force is an example of such a force.

An absolute frame of reference, fixed with respect to absolute space is an inertial frame and the transition from one such frame to another is accomplished by a Galilean transformation. i.e.,

$$t' = t, \quad \mathbf{x}' = \mathbf{x} + \mathbf{v}t$$

Suppose a particle with a mass m is moving in an absolute reference system S according to the law $m d^2\mathbf{x}/dt^2 = \mathbf{F}$. If now we consider another inertial reference frame S' and using Galilean transformations it can be shown that in the new reference system, since \mathbf{F} and m according to Newtonian mechanics are absolute quantities, i.e., they are the same in both reference frames. This means that Newton's second law is invariant with respect to these transformations. Thus all inertial reference frames are equivalent and there is no way of detection absolute space.

Difficult was the path mankind traversed to its realization that space, or to be more exact space-time, is curved. The development of ideas about the geometry of the world is entwined with the concepts of space and space-time. Euclid's *Elements* remained the foundation of geometrical instruction practically to beginning of 20th century. It explained geometry on an axiomatic basis in the form of propositions or theorems derived from a limited number of basic axioms that are postulated without proof and regarded as self-evident. An evolution of many decades of efforts of intellectuals has resulted in the feeling and discovery and proposition of a new geometry. Lobachevski, Carl Gauss and many other eminent mathematicians have clearly realized the scale of the perturbation in geometry (and not only in geometry) that would be occasioned by the discovery of non-Euclidean geometry. It is important to note that Lobachevski and Gauss did not confine themselves to the mathematical aspect of the discovery but they also pondered about how the new geometry was related to the physical world.

Eugenio Beltrami and Felix Klein worked in this regard and their main idea is to generalize the first non-Euclidean geometry, which was originally constructed for a plane, to a geometry on a three-dimensional hyper-surface with a constant negative curvature (three-dimensional heperboloid) in the framework of four-dimensional Euclidean geometry. It was necessary to replace the notions of straight lines (the shortest lines in Euclidean world) by those of geodesics (external curves) on a hyper-surface. Then all the statements regarding the straight lines in Lobachevski's geometry would be converted into corresponding statements for geodesics on a heperboloid. In this geometry, the space-constant acquires the sense of the radius of curvature of a three-dimensional heperboloid. Thus it became easier to understand that the properties of geometrical figures depend on their size. Concept of relativity and its further advancement seems to be the intellectual efforts of the physicists and is not a physical reality. It does not physically exist when no correlation, which is essential for relativity concept, is done.

Physical present is same everywhere in the universe and only observation and counting are at different instants. Counting of physical present is a function of geographical location. Continuous presence or continuous flow of matter or energy without transformation or change is Time-transcendence or Thought-transcendence or Timelessness. That means continuous state of rest or of uniform motion is Timelessness. Time flow signifies the speed of conversion of energy in a process. Time flow is a measure of *Being* (presence) and *Becoming* (transformation) of matter and energy in space. The concept of time developed by theories of relativity has no relevance in the construction of time in biology and mechanism involved in human consciousness of time and its passage [7].

Concept of passage of time in natural scientific processes:

It is believed that when time changes and progresses, processes take place. But it is proposed by Ramabrahmam [6, 7] that passage of time or progress of time is not a physical reality independent of process. Actually the notion of passage of time is a mistaken identity of energy transformation and/or

change of phase of matter by the aid of energy. The following phenomena are normally assumed as the passage of time and time-flow is *experienced*:

- a) Movement –translation, rotation or vibration– (or transition) of matter in space.
- b) Changes in the state or phase of matter (by the aid of energy).
- c) Transformation of energy from one form to another form either through matter or otherwise.
- d) Being and becoming (growth and decay) of organisms.
- e) The in-built order of happenings guided by natural forces in natural or non-natural processes.
- f) The ability of human mind to perceive, record, retrieve and expect various happenings taking place in physical time.

From the above analysis it is obvious that time and its passage are the *consequence* and not the *cause* of processes. *Processes are not taking place in time but time is evolving together with respective process in tune with relevant natural forces acting and guiding and no independent universal time exists.* Thus time is *constructed* by processes--physical, chemical, biological or cosmic started, guided, sustained and terminated by relevant natural forces and actions and interactions concerning matter and energy involved. Time need not and does not pre-exist processes. Time as duration just evolves together with the processes and when monitored externally becomes counting and metrical aspect of time which has no role to play in the course of ongoing processes which is solely initiated, sustained, guided and terminated by respective natural forces in conjugation with the matter/anti-matter and energies involved and interacting.

In the above study of evolution of concept of relativity (about motion) does not involve any energy transformation of change of phase of matter with the aid of energy in classical or quantum or cosmic way. Thus concept of relativity is the sole creation of physicists in their quest to understand motion, and is not physically or from physics happening point of view is significant or any physics is manifested in such a concept or development of idea or thought.

Riemann mathematics and geometry: Influence of curvature of space on physical world:

The next substantial step in the development of the geometry of space was by Bernhard Riemann. It is about the hypotheses lying at the foundation of geometry. He incorporated into his theory the mathematical apparatus available then for describing the geometry of two-dimensional curved surfaces and his own new concept of a multi-dimensional manifold (multiply extended geometrical objects). A surface is thus a two-dimensional manifold; a space is a three-dimensional manifold. All the ideas and methods used to describe two-dimensional surfaces can be directly applied to three-dimensional curves spaces. Among the notions used, the most important one is the metric, i.e., the quadratic form for the differences between coordinates, which describes the length of the interval between two neighboring points in a curved manifold.

This successful integration of ideas enabled Riemann to advance when constructing both particular cases of non-Euclidean spaces and a theory of arbitrarily curved spaces. Riemann's gets the credit for the development of our ideas about the relationship between geometry and physics. Einstein emphasized that this contribution of Riemann led us to the challenging idea that the geometrical relationships between bodies might depend on a physical cause, that is, on forces. Thus, by way of a purely mathematical analysis he discovered that geometry and physics might combined. (This was actually realized seventy years later in the general theory of relativity, which combined geometry and the gravitation theory). Earlier William Clifford developed the idea that the physical properties of matter and the properties of curved space were related. Clifford wondered whether we could be wrongly interpreting as physical changes that in reality arose due to the curvature of space. He felt that it might be that all or some of the forces that we call physical originate from the geometry of our space. Ernst Mach clearly understood the weaker aspects of classical mechanics and was close to the general theory of relativity. He played an

important role in the preparation of the conditions for the creation of the general theory of relativity. His idea was that geometry is brought to life through mathematics applied to our experience gained with relation to space.

In 1903, i.e., on the very threshold of the creation of general relativity, Mach gave a detailed analysis of the mathematical and physical aspects of the geometry of space in a paper called *Space and Geometry from the Viewpoint of the Natural Sciences*. In the same article he cited and explained the contributions of the appropriate scientists such as Lobachevski, Bolyai, Riemann, and Gauss. His idea was that geometry is brought to life through mathematics applied to our experience gained with relation to space. It is interesting that Einstein's creative genius was influenced by Mach's ideas. Whilst he was working on the general theory of relativity, he was convinced that he was realizing Mach's ideas.

In retrospect we can say that early in the 20th century all the ground work necessary for the formulation of the general theory of relativity had been laid. The scientific community of the time was ready to assimilate the physical manifestations of the curvature of space. A number of outstanding geometers had developed the necessary mathematics of curved multidimensional manifolds (Riemann geometry), but two elements were still missing. First there was the unification of space and time in the framework of a four-dimensional manifold, which was completed in the special theory of relativity.

Secondly, the theory of gravitation was to catch the eye of physicists. Finally, both elements came into being Henri Poincare in his *About the Dynamics of the Electron*, took the first step since Newton towards a real gravitational theory; he attempted to build it into the framework of the space-time of the special theory of relativity.

A close study and further contemplation of the above presentations about evolution of relativity and Riemann mathematics and geometry together with the discussion about kinds of time- classical, quantum and cosmic- discussed in the earlier part of the article, informs that mathematics has to only help in expressing physical phenomenon and can not and should not replace physical natural forces present and associated with matter, anti-matter, charge and relevant energy forms and their transformations. And when it does not tell anything about physics involved, it ceases to help in the further understanding of physical phenomenon. Thus physical significance about physical phenomenon must not be allowed to be lost in advanced and higher mathematical representations. Mathematics must highlight and express and explain the physical phenomenon and must not obscure or confuse understanding of physical realities. At no time geometry of space can determine about matter, anti-matter, charge and their actions, reactions, interactions and the like but only relevant physical forces and energy transformations which initiate, guide, sustain and terminate physical phenomenon must get attention, prominence and priority. This aspect is further discussed as follows.

In all the above presentation, the matter or energy or their transformation are not at all referred to. All this is completely mathematical with no physics involved. These are mere Gedanken experiments and intellectual exercises with no physical significance. This clearly shows the dominance of advanced mathematics over physical principles and physics insight of processes, time and passage of time.

Special Theory of Relativity:

Special theory of relativity professes that the laws of science should appear the same to all freely moving observers. The freely moving observers measure the same speed for light, no matter how fast they were moving. The speed of light is independent of the motion of freely moving observers and is the same in all directions. Theory of relativity is about measurement of time period of an event and is only interested in the counting aspect of time under special circumstances and metrical in essence. *Thus special theory of relativity can not be taken as a theory of physical nature of time.* It does not say anything about the structure or manifestation of time. Time dilation is only an *appearance* and not a reality and is the result of relative motion between the event and observer. Watches or clocks slow down or run fast only when the speed of energy-conversion available within the clocks which is responsible for time measurement and time-flow has decreased or increased. And at no time such time measurements

and time flows are connected to or in tune with the universal time, since the process going on in the watch or clock is never influenced by the universal time. The unification step of space and time in a four-dimensional manifold occurred as a result of another chain of ideas, hypotheses and experiments.

Also depending on the nature of energy transformation in the process, time can be classified as *classical time*, *quantum time* or *cosmic time* [7]. Classical time is created and constructed when energy absorption or emission or transformation is continuous. Quantum time is created and constructed when energy absorption or emission or transformation is discrete or discontinuous. Cosmic time is created and constructed by respective natural actions and interactions when happenings to Universe are concerned and observed. And it should be noted that these “*times*” are created and constructed by respective natural forces causing respective actions and interactions involving matter or anti-matter in respective processes taking place in respective ranges of space and durations of time-periods, and exist simultaneously independent of one another without influencing one another in any way, and observed just as durations of respective processes. There is no single independent universal time whose equable flow is absolute, or relative, true and mathematical of itself and of its own nature, flowing equably without relation to anything external. All “*times*” are the reflection and result of energy transformation taking place through matter or change of phase of matter or anti-matter by the aid of energy or otherwise.. Acceleration manifests and represents *passage of time* during motion or movement. Change of entropy manifests and represents *passage of time* in all other natural or non-natural systems. Systems change not because time is progressing but because of and under the influence of respective natural forces, forms of energy, nature of energy-transformation, absorption and emission, and phases and properties of matter involved.

In the light of understanding the nature of time in this way, it becomes essential to have an idea of the energy transformation during a process more, than the notion of progress of time. The progress of or passage of time is just the result of processes taking place or phenomena happening or occurring and human concern and observation of such happenings, involving processes-physical, chemical, biological, cosmic, psychological, social etc., and there is no passage of time in an universal way and sense and such a passage even if cultivated, monitored and *felt* is not physically real [7]. The insight that time is energy and energy transformation is passage of time, creating a sense of time and consciousness of time are further advanced to understand the creation and functioning of various human conscious states or phases of mind and functional and cognitive states of consciousness and mind.

Concept of time can not be based on pure mathematics and geometry without reference to matter/antimatter, energy and their actions and interactions under the influence of respective natural forces. Any time conceived ignoring or not considering physics involved will be at most a mathematical time and can not be a physical time.

General relativity: Relationship between geometry and physical world- Modern understanding of the space-time, gravitation and scientific picture of universe:

Einstein’s theory of general relativity, which agrees with a large number of experiments, shows that time and space are inextricably interconnected. .General relativity combines the time dimension with the three dimensions of space to form what is called space-time.

The mathematical model of general relativity predicted that the universe, and time itself, should have a beginning or end. The general understanding shared till then that time should be infinite in both directions is challenged.

The theory incorporates the effect of gravity by saying that the distribution of matter and energy in the universe warps and distorts space-time so that it is not flat. Objects in this space-time try to move in straight lines, but because space-time is curved their paths appear bent. They move as if affected by a gravitational field. *But it is surprising that these distortions taking place in the universe to space-time do not influence the simultaneously occurring infinite number of happenings on earth and remaining astral bodies in the universe and at no time their space-times are curved and times are warped. This observation clearly establishes the reality that events relating to the universe are true but such events do not create a universal time that influences all the other processes taking place simultaneously in the universe.*

Also according to general relativity, time and space do not exist independently of the universe or of each other. They are defined by measurements within the universe, such as the number of vibrations of a quartz crystal in a clock or the length of a ruler. It is quite conceivable that time defined in this way, within the universe, should have a minimum or maximum value—in other words, a beginning or an end and this concerns only the finite processes taking place in the universe. It was thought that in a real body, collapsing under its own gravity, pressure or sideways velocities would prevent all the matter falling together to the same point, where the density would be infinite. Similarly, if one traced the expansion of the universe back in time, one would find that the matter of the universe didn't all emerge from a point of infinite density, which is called a singularity and would be a beginning or an end of time. *But to talk in finite proportions like this about infinite happenings though is an attempt to unravel truth, may not be yielding truth.*

Shape of Time: Time has no independent shape or locus:

Just as time does not exist separate from space, time does also not exist separately from the process either in macroscopic or microscopic or cosmic processes. There cannot be a purely mathematical time devoid of or unrelated to any physical event even if such a one is constructed it remains only a mental conjecture.

The shapes or loci or forward and backward movement of time just as engine on a rail track, future meeting past etc., are mere human logical guesses and descriptions given to time in an attempt understand its nature. There is no path for time as there is no time independent of process. All paths of time are actually the courses taken by the processes. What appears bent is moving matter, when we talk about curling of time-space or warping of time. Here time is viewed as associated with motion or time is solely defined by motion or observation of motion (of matter). Time is just not motion but is also change or becoming. Merger or absorption of time dimension with the three space dimensions considers time to have an existence. Concept of time is only a creation of human mind to observe or follow the course of processes. Time is only a human notion. Time is only a human sense - the seventh sense. Passage of time is only ongoing of processes. Time needs processes for its being. In the absence of processes time is missing. Such a reality associated with time gives to time so many shapes, forms, loci and figures and all these attributions are human intellectual exercises only.

Time has no shape of its own. Just as liquid takes the shape of the vessel containing it and we assume that is the shape of liquid so also time takes the shape and locus of the process which is under observation and is studied to understand the nature of time. Events happening, processes taking place involving respective changes in matter/anti-matter and/or energy *in universe* are finite phenomenon.

Events happening, processes taking place involving respective matter and/or energy *to universe* are *infinite*. Accordingly time becomes finite or infinite in relation to observed phenomenon.

Finiteness and infiniteness of time are relative to the domain of activity and the observer. Presence of observer is responsible for speculation and counting of time. Absence of observer to phenomenon relieves the necessity for time to exist in all its aspects. Time then is only the duration of start or initiation, going on and cessation of a phenomenon, the duration being solely controlled by the respective natural forces acting in relation to matter, anti-matter, energy and nature and contents of surroundings involved. Passage of time and *speed* of passage of time concerning an event are functions of the presence of an observer and also relative motion between the frames of reference holding event and observer.

Thus the time occurring in various branches of physics and other natural sciences can not be defined and structured in the same way though in measurement may be gauged as the duration of occurrence in seconds or fractions of second depending on the forces; the energies involved are different in nature and magnitude. Time and processes are intertwined with space. Also time is intertwined with processes. Space is necessary for processes to take place. Time need not pre-exist for processes to take place. Time is not responsible for processes to take place but *time starts, evolves and ends in tune with state or phase of processes*. The four natural forces concerning matter/anti-matter and energy are responsible for the initiation, sustenance and cessation of processes. Time is a *consequence* of actions and interactions among matter, anti-matter and energy.

Real and imaginary times: Origin of universe etc. and nature of cosmic time:

Origin of the universe or other phenomenon concerning universe as expansion or contraction or beginning or end seem to dominate the expressions about the concept, nature and structure of time¹². Concerning time solely with the universe is side-stepping the study of nature of time. Deciding nature of time in relation to universe alone is incomplete assessment of nature of time and understanding of time. Our imprecise understanding of origin etc., of universe need not prevent us to have a clear understanding of the nature of time. The notion that higher and advanced mathematics alone can lead us to definiteness about the nature of time seems to be not in tune with the reality. Clubbing time with details of universe can be unnecessary. Nature of time can be conceived independent of origin of and other matters related to universe. Understanding the nature of time is different and separate to understanding the nature of origin of universe etc.,.

On observation of nature including cosmos, it is evident that what can have a beginning and/or end is process, event or happening and not time. Time is as long as the process lasts and is absolute to the process. Zillions and zillions of such absolute times exist simultaneously associated with zillions and zillions of respective processes going on in the universe simultaneously, some affecting each and one another and most others not affecting any other at all.

What exists, therefore, is ongoing of processes - physical, chemical, physico-chemical, biological, cosmological etc.,; that is all. There is no passage of time. The time associated with the origin etc., of universe is solely associated with the respective phenomenon concerning universe. String theory, M-theory, imaginary time, etc., can not make sense when time in music or ageing process or evolution is studied, defined and counted. Universal time in the sense we are keeping can in no way influence the zillions and zillions of physical and chemical and other natural and non-natural processes taking place in

the universe. Only the natural forces initiate, sustain and cause cessation to the processes. *Time period of happening is the consequence and not the cause of the processes.* The shape of time etc., relating to time concerning the universe can not be a model for times associated with the infinite number of various other macroscopic and microscopic simultaneous processes taking place in the universe untouched by the happenings to or in the universe. Theories of relativity, quantum gravity, String theory, M-theory, brane theory etc., have no relevance when nature of time is to be understood and expressed and explain the happenings, their sustenance and cessation in various living and non-living systems taking place in the universe individually, independently and simultaneously.

Just as different biochemical and biophysical processes take place in the human body simultaneously and parallel in a related or independent way so also zillions and zillions of physical and chemical and physico-chemical processes take place simultaneously in the universe independently or affecting one another together with changes to universe.

Physical present is the real time. Both past and future are imaginary times. The real time becomes past as memory and real time becomes future as fear, imagination, apprehension, doubt or worry. Both past and future are thought forms in the physical present (Figure I). Imaginary nature of time is psychological; it is neither real nor physical. In the absence of human concern or monitoring or memory or apprehension or planning no past or future exist. Then even their imaginary nature becomes extinct. The reality which was, is and will be, is simultaneous ongoing of process, physical, chemical, biological, cosmological etc., unrelated or unconnected or non-influencing, each other or one another. Classical, quantum and cosmic times are originated, created, constructed, sustained and terminated depending on the phases of matter, forms of energy, their actions and interactions in the domain of activity, solely initiated, guided, and terminated, by relevant nature forces.

Discussion:

Time's nature when studied reveals two aspects of itself – durational (period) and metrical (counting). We are aware of both these aspects in our daily worldly and scientific usage. We have pendulum clocks, mechanical watches, clocks, quartz crystal clocks, electronic clocks, atomic clocks....calendars, almanacs...to monitor and measure time as a duration, count of the period of existence of such a duration and also passage of time as a function of and series of seconds, minutes, hours, days, months, years, decades, centuries, epochs....etc. Counting of Time as a period of pronunciation of alphabetical letters is also available to us. When we analyze it would be interesting to note that in all time-measuring devices, internally an energy transformation takes place. This energy transformation within such devices takes place as aperiodic, linear or periodic (harmonically), in the form of mechanical-, electrical-, electronic- or atomic energy form. This energy transformation is the result of mechanical-, electrical-, electronic- or atomic process taking place and going on within and the same is manifested as movement of hands or display of digits on the dial depending on the technology used. Thus Energy-Presence and transformation of that energy from one form to another form are essential for time-measurement and monitor passage of time and even for time to exist. Energy-Presence gives scope for durational aspect of time. Thus Energy-Presence is Time-Space. Time-space as Energy-Presence can be termed Static Time or Time at Rest. Transformation of such an Energy-Presence creates time-flow or passage of time. This time-flow within a time-measuring device monitors time-flow or time-taken concerning an external ongoing process-physical, chemical, biological, astronomical, cosmological or psychological. Arrow of time or time's direction is: acceleration or deceleration or entropy change

Energy Transformation is the time-flow aspect of time which when divided as seconds etc., becomes metrical aspect and is dynamic aspect of Time. So energy-transformation is Dynamic Time or Time in Motion. The rate of this Energy-Transformation decides the speed of respective time-flow.

The above observations can lead us to look at the nature of time in an interesting way. Energy Presence (Time at rest) can be potential, example: wound spring in mechanical watch, height of water in water clock or in a kinetic form ex: pendulum- oscillations in a pendulum clock or crystal oscillator in a quartz clock. And Energy-Transformation (Time in Motion) that moves the hands of clock or display of digits as the case may be, can be linear (unwinding of spring in a mechanical watch) or (periodic) cyclic (crystal oscillator motion in a quartz clock). The linear or periodic transformation of energy takes place in a regular way in the Universal Time-space to measure the duration and monitor the Time taken for a physical, chemical, biological, astronomical, cosmological, social, political, ...etc process or event. Thus Energy- Presence, Energy –Transformation, Time, Time-Flow, Passage of Time and Measurement of Time are closely related. Time at Rest as Energy-Presence exists infinitely with possibilities to become Time in Motion as Energy-Transformation as many times at as many places with or without actions/ interactions with matter.

The property of a physical quantity is a function of its nature defined and constructed by natural forces guiding it and matter /charge with which the physical quantity is associated and the material with which matter is made up of and kind of matter with which charge is associated; and the physical quantity is not a function of observer's position or velocity or relative velocity.

A time interval is decided by phase of matter undergoing change and nature and amount of energy transforms or transfers type of natural forces that supervise such a transformation or transfer

The property of a physical quantity representing matter/charge is a function of the material/fundamental particle, its phase and its nature which is initiated, nurtured and given form and a state of rest or motion by natural forces that cause, sustain and dissolve/stop it; and never is a function of observer's presence and monitoring. When we remove the observer and/or one's consciousness, it will be that a time interval is decided solely by the nature and amount of energy transforms or transfers and the natural forces acting on; and no "*external passage of time*" has role to play. Attributing such a role to time-passage is human mistaken identity. The monitoring of course of the monitored process is confused as passage of time.

Time has no independent existence or shape from the monitored process-physical, chemical, biological or the like Time also has no independent existence as past, present and future from human consciousness. Thus time is a function of the existence of matter, energy and space and human perception of these and their changes and courses. Passage of time is a function of transformation of energy from one form to another and also is change of phase or place of matter with the aid of energy. Biological clocks in living systems are the result of rhythmic physical or chemical or physico-chemical actions, interactions in the system and reactions of the organism to the environment and atmosphere of the planet where they have evolved. Time is a sense cultivated by human civilization. One-way view (the *Arrow of Time*) and the cyclic view of time, popular in the philosophy of history of time, are the result of observations of irreversible and cyclic processes. They have nothing to do with the *passage* of an independent, individual and universal time which does not exist [6].

There is no path for time as there is no time-passage different and separate from course of the process monitored. What appears bent in cosmic studies is moving matter. Here time is viewed as associated with motion or time is solely defined by motion or observation of motion (of matter). Time is just not *movement* but is also *change* or *becoming*. Merger or absorption of time dimension with the three space dimensions still considers time to have an existence. This is not the reality because time is *created* by presence or transformation of matter or energy in space guided solely by natural forces-gravitational, electro-magnetic, strong and weak nuclear forces. Concept of time is only a creation of human mind. Time is only a human notion. Passage of time is only ongoing of processes. Processes are unaffected by

our notion of presence and passage of time. Processes are affected only by actions and interactions concerning matter, anti-matter and energy and their environment in space. Acceleration, deceleration and entropy change form passage of time Irreversible thermo-dynamic processes make us talk about arrow of time and particle physics studies talk about time-reversal. Rate of reaction and velocity describe nature of time similarly.

Velocity/rate of reaction and acceleration/entropy/quantum action are physical manifestations and measures of energy transformation and are inherent to motion/change/becoming and are responsible for the course of the process. Passage of time, which is only our notion, is non-inherent and explicit to process and can in no way influence the course of the processes. Just as different biochemical and biophysical processes take place in the human body simultaneously in a related or independent way so also zillions of physical, chemical, biological and cosmological processes take place simultaneously in the universe independently or affecting one another. Time is constructed differently in different physical, chemical, biological and cosmological processes in structure, magnitude and direction. *A single theory about time can not explain the differently constructed times-classical, quantum and cosmic.*

Time is the consequence of processes and not the cause of processes. Time needs processes for its being. In the absence of processes time is missing. Time does not exist separately from the process. Origin of the universe or other phenomenon concerning universe as expansion or contraction or beginning or end need not and can not monopolize concept, nature and structure of time. Concerning time with the universe alone is side-stepping the study of nature of time. Deciding nature of time in such a way is only to mislead ourselves. Our imprecise understanding of origin etc., of universe need not prevent us to have a clear understanding of the nature of time in other disciplines. Higher mathematics can alone lead us to definiteness about the nature of time is not in tune with the reality. Clubbing time with universe is unnecessary. Nature of time can be conceived independent of origin of the universe. Understanding the nature of time is different and separate to understanding the nature of origin of universe etc,. The sense and consciousness of time and experience of time-passage are felt because of the presence of the observer - the human mind, its concern and consciousness.

Insight gained by above presentation and discussion:

1. Truth is simple. Use of complex mathematics is not necessary if the concept is clear. Then expression about Truth and Reality will be in simple language and without confusion.
2. Time is classified as movement, change or becoming. As movement the phenomenon create vector time. As change and becoming, the processes create, also vector time,- the manifestation, reflection, direction to the course of process and influence of relevant natural forces by energy transformation and entropy change-but is considered as scalar time. Physical Time is of three kinds- classical, quantum and cosmic. Time is both analog and digital as duration or counting. Time measurement is a correlation of courses or on-goings of two parallel unconnected processes, the measured and the measuring. The course of the measured process is solely guided by respective natural forces and the course of the second, the time-measuring processes is manifestation and division of energy transformation from one form into another in the clock that is counting and exhibiting time-flow and time-period as fractions of second, seconds, minutes etc.,.
3. Continuous presence or continuous transformation of matter, charge or energy is manifestation of physical timelessness.

4. The property of a physical quantity is a function of its nature constructed and defined by natural forces influencing and guiding it and material with which it is made up of and is not a function of observer's relative position or relative velocity.

5. The extension of a time interval is decided by nature and amount of mass or charge or energy that is transforming or getting transferred and the natural forces acting in that domain.

6. The time interval is constructed along with, and does not pre-exist or shapes, natural or non-natural processes.

7. *Kinds of Time:*

Physics is a natural scientific discipline which studies and contemplates on actions, reactions and interactions concerning mass and charge and also matter and energy in time and space. We have idea of space. But our concept of time is varied and exact nature of time is unclear. Equivalence of mass and energy is established in fundamental particle physics. Energy is time. Energy transformation is time flow or passage of time. Transformation of energy takes place through contact of matter or by induction (Field) through a material medium or vacuum. Depending on this we have 'digital' and 'analog' nature of time. Activity is time. Cessation of activity is extinction of time. Eternal activity is Timelessness. Activity is manifestation of transformation of energy. If the transformation of energy is continuous and has *finite* duration *classical time* is created. If the transformation of energy is discontinuous, discrete and has *finite* duration, *quantum time* is created. The changes of and to the universe which are *infinite* in nature create *cosmic time*. None of these times is universal time being kept and followed by us.

Qualitative time is constructed by the respective process guided by respective natural forces and never pre-exists the process. Quantitative time is *external* measurement of or count of, elapse of durations of qualitative time created by natural forces involved. Quantitative time never influences the duration or course or otherwise of the processes.

Classical time is analog in nature. Chronons and Quantum time are digital in nature.

Quantum time-discretization of time in tune with discontinuous and discrete transformation, transmission, transfer, emission or absorption of energy; Digital nature of time; Squeezing of time-interval packing with energy

Cosmic time is time associated with the origin, being, oscillation, etc., associated with universe.

Energy is manifested in stationary or moving matter or anti-matter or mass or charge. Time has two aspects – durational and metrical.

Time is the consequence of processes and not the cause of processes.

We need transformation of energy to happen for action to take place. Transformation of energy can be change of form of energy through matter or anti-matter or change of phase or state of matter or anti-matter by the aid of energy.

8. *Uncertainty principle: Complex Time:*

| | | |
|---------------------|---|---|
| Complex conjugates: | position x $a+ib$ | momentum p $a-ib$ |
| | a = value of position relating to present | b = value momentum relating to past or future |
| | Energy E $x+iy$ | Time t $x-iy$ |
| | x = value of energy relating to present | y = value or instant of time relating to past or future |

7. Time of conscious awareness and mental time: Present, past and future are the real and imaginary dimensions of physical time in human time-sense, time-awareness and notion of passage of time. *Present is real dimension and past and future are imaginary dimensions of physical time.*

8. The concept and notion that processes take place in time is not the reality. *Time does not pre-exist processes-natural or non-natural- and is only constructed as duration by natural forces initiating, sustaining and terminating such respective processes.* The reality that change - as movement or change or becoming – defines, manifests and constructs time is to be realized. Time is a consequence and not cause of processes. The presence of a universal time passing either absolutely or relatively is to be denied. A lot of contemplation about the non-presence of time: annihilation of time; eternity; instantaneous happening; Absence of happening must take place for arriving at a clear insight of nature of time.

Conclusions:

The role of mathematics in understanding and expressing the physical phenomena is well-known and the same is true for the physical quantity, time and the concept of relativity. The ideas of calculus applied in defining velocity, acceleration; geometry, trigonometry and wave theory in defining and understanding phase and frequency associated with translational, rotational and vibrational motion are discussed. The integration approach to understand time, distance covered, velocity, acceleration, entropy, rate of reaction etc., , rather than currently in vogue differentiation approach, is presented.

Transformation of energy constructing time in movement, change or becoming of processes-physical, chemical, biological, cosmological, psychological- is stressed.

The continuous and discrete or discontinuous nature of transformation, emission or absorption of energy and change of phase of matter with the aid of energy is used to classify time as classical, quantum and cosmic.

The same consideration of energy transformation as time is used to comment the ideas of time presented in theories of relativity. Thus role of mathematics in understanding the physical nature of time and evolution of concept of relativity together with its Gedanken nature bereft of physical significance is presented.

The role of advanced mathematics in making concept of time and concept of relativity unintelligible to non-physicists is pointed out. The highly advanced mathematical nature, its inadequacy and incompleteness of such an understanding in advanced mathematics terms about time in the construction of time in chemical and biological systems is brought out.

The mental conjectures associated about the nature and influence of time as dealt in present cosmology and non-maintainability of similar paradoxes associated with concept of time, its passage, shape, real and complex natures in conjunction with psychological aspect of past, present and future and delineation of past, present and future in relation to Hisenberg's uncertainty principle are presented . The limitations of such mathematical representation to give an idea of nature of physical time and time-consciousness are pointed out. The physical nature of time is separated from the metrical aspect and absolute, relative or cosmic nature of time is critically analyzed. A single, unique, universal or absolute process creating, manifesting sustaining the being and passage of physical time influencing processes is questioned and denied.

Table I

EXPRESSIONS ABOUT THE NATURE OF TIME THROUGH GENERATIONS

- 1) *Plato*: Time is produced by revolutions of celestial sphere.
- 2) *Zeno*: Time is related to motion.
- 3) *Pythagoras*: Time is the identification of the chronological with the logical
- 4) *Aristotle*: Time is counting of motion in respect of before and after and is reciprocal to motion.
- 5) *Polonius*: Motion time can not be, since motion takes place in time.
- 6) *Heraclites*: Time signifies the period of world from its function to its destruction and rebirth.
- 7) *Galileo*: Time is a geometrical straight line.
- 8) *Barrow*: Time is the continuance of anything in itself in its own being.
- 9) *Newton*: Absolute, true and mathematical Time of itself and from its own nature flows equably, without relation to anything external
- 10) *Leibniz*: Order of successive existents is Time.
- 11) *Kant*: Time is an aspect of our experience and time has no existence in external reality
- 12) *Einstein*: Special Theory of relativity: Time is relative (because of motion between event and observer).
- 13) General relativity: Space and time are always together and inseparable. Space-time continuum is the reality.
- 14) *Stephen Hawking*: One cannot say what time actually is and all one can do is to describe what has been found to be a very good mathematical model for time and say what predictions it makes. Time has a beginning and end. Time has shape. Past can be visualized by the concept of light cones.
- 15) *String theory*: If original strings are viewed as uninterrupted in history in time, the resulting strings are a string world sheet.
- 16) *M-theory*: There is a web of relationships, so-called dualities that connect all five string theories as well as eleven-dimensional super-gravity. The dualities suggest that different string theories are just different expressions of the same underlying theory.
- 17) *Imaginary and real time*: One can construct a mathematical model in which there is an imaginary time direction at right angles to ordinary real time. The model has the rules that determine the history in imaginary time in terms of the history in real time and *vice versa*.
- 18) *Brane theory*: 3-brane—a four dimensional (three space plus one time) surface that is the boundary of a five dimensional region, with the remaining dimensions curled up very small.
- 19) Time is movement, change or becoming.
- 20) *Ramabrahmam*²: *Es gibt keine Zeit. Es gibt nur prozesse*. There is no time. There is only ongoing of processes. There is no passage or consciousness of time unconnected with a process or phase of mind.

Table II

DIFFERENT VIEWS, CONCEPTS, SENSES

(a) Views

a) Idealist: Time is nothing but a concept and therefore dependent on (human) consciousness only.

b) Realist: Time is self-sufficing entity, which is not dependent on anything else.

c) Relational: Time is also a concept, and therefore dependent on consciousness, but at the same time it is a function of the events happening in nature.

(b) Concepts:

a) Time of theoretical physics

b) Time of thermodynamics and of the evolutionary sciences such as biology.

c) Time of conscious awareness.

© Senses:

a) A moment, an exact date, a point of time.

b) Period of time, a span of time and time interval.

c) Duration, the length of time period.

d) An all embracing period of time.

(d) Other Insights: [6]

Classical time is continuous time. Quantum time is discrete time. Both are Finite times

Cosmic Time is Infinite time

Cosmic time construed as mathematical time is real or complex (possesses real and imaginary components)

Time at rest (Static time) Time-space aspect

Time in motion (Dynamic time) Metrical aspect

(e) Universal Time - The metrical aspect of time and time-keeping:

Universal time being kept by us as 2008, October, 2, Thursday etc., and followed is not physical in nature and *is set by us* in clocks. Universal time set and kept by us can not influence the remaining simultaneous and parallel happenings in the universal space. The rest of the happenings other than the universe expanding, contracting or oscillating happen and their times of duration as flow or passage of time are monitored by clocks absolutely and independent of cosmic time. The energy-transformation taking place within various clocks is never affected by the passage of universal time which is created by us and is completely arbitrary, fictitious and non-natural. Universal time kept by us at no time represents the period of happening as the universe is expanding, contracting or oscillating

(f) Nature of time: [6]

1. Matter or energy at rest or in motion or under transformation is the physical manifestation of time and constitutes physical time.
2. The physical manifestation of flow of time or passage of time is ongoing of processes involving transformation of energy through matter or change of phase of matter by the aid of energy.
3. Matter- or Energy-Presence is **Time at Rest** or **Static Time** or **Time-Space** or **Durational** aspect of time.
4. Matter- or Energy-Transformation is **Time in Motion** or **Dynamic Time** or **Time Created** or **Metrical** aspect of time.
5. Time-Space is defined, created, controlled and ceases to be depending on Energy-Presence and the energy/matter available and amenable for and cause of transformation.
6. Time is not a physical quantity. Time is mere awareness. Time is a sense. Passage of time is an observation and a mental experience in a particular conscious state of mind.
7. Rise and fall of and flow of conscious states of mind and thoughts and other mental functions constitute psychological time.
8. Psychological past is a record of happenings and psychological future is an apprehension about happenings caused by the egoistic mind during the passage of physical time.
9. Both psychological past and psychological future are thought-forms in the physical present involving psychic energy transformations in the wakeful and dream conscious states of mind.
10. Physical present is same everywhere in the universe and only observation and counting are at different instants.
11. Count of physical present is a function of geographical location and religious and cultural background.
12. Continuous presence or continuous flow of matter or energy without transformation or change is Time-transcendence or Thought-transcendence or Timelessness. That means continuous state of rest or of uniform motion is Timelessness.
13. Time flow signifies the measure of conversion of energy in a process.
- 14 Time flow is a measure of **Being** (presence) and **Becoming** (transformation) of matter and energy in space

(g) Assumptions of passage of time: [6]: The following phenomena are normally assumed as the passage of time.

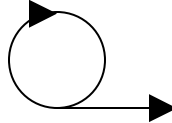
- a) Movement –translation, rotation or vibration– (or transition) of matter in space.
- b) Changes in the state or phase of matter (by the aid of energy).
- c) Transformation of energy from one form to another form either through matter or otherwise.
- d) Being and becoming (growth and decay) of organisms.
- e) The in-built order of happenings guided by natural forces in natural or non-natural processes.
- f) The ability of human mind to perceive, record, retrieve and expect various happenings taking place in physical time.

FIGURE I

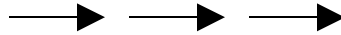
DIFFERENT LOCI AND GEOMETRIES OF PHYSICAL TIME AND ITS PASSAGE

Physical time: Classical, quantum and cosmic times (Quantitative and Qualitative):

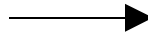
i *Ancient Indian View* - Cyclic



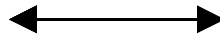
ii *Chinese View* – discontinuous:



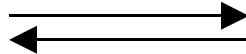
iii *Modern View* – linear



iv *Thermodynamic View* – reversal of a process



v *Fundamental Particle Physics View* – Time reversal



vi *Quantum time:* $\Rightarrow \Rightarrow \Rightarrow \Rightarrow$ $\Uparrow \Downarrow$ **Energy-time bits** transmitting, emitting and
 chronon $=h/E = 10^{-24}s$ $\Leftarrow \Leftarrow \Leftarrow \Leftarrow$ $\Uparrow \Downarrow$ absorbing photons / phonons/sub-atomic particles

vii *Special Relativity:* Speed of passage of time is a function of relative velocity between event and observer. And *no energy transformation or change of phase of matter* is under consideration.

viii *General Relativity:* Time-space inseparability –Possession of Shape; Warping

ix *Cosmology: cosmic time* (past) Imaginary and (present) real time

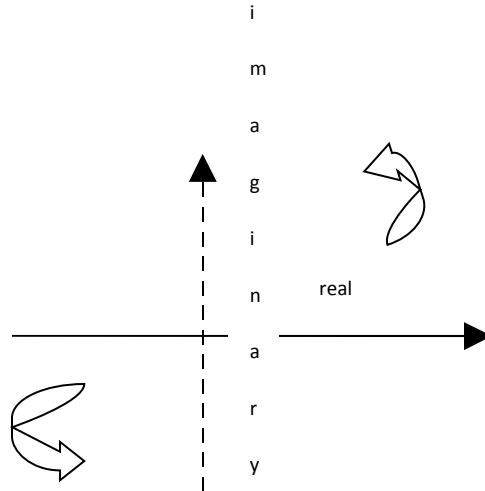


TABLE III

DIFFERENT STRUCTURES OF TIME

Physical and Mathematical forms of qualitative time:

Time = *Distance/ speed; Time = Displacement/ velocity;* $dt = dx/dv$

Time = *velocity /acceleration*

Time = *angular displacement /angular velocity* $dt = d\Theta/d\omega$.

Time = *angular velocity /angular acceleration*

Time = *Mass x displacement/momentum*

Time = *Mass x velocity/force*

Time = *mass x velocity x distance/energy*

Time = *Impulse/force*

Time = *Electric charge/current*

Time- period = *1/frequency* $1/n$ or $1/f$ or $1/\nu$

Time = *Electric charge/current density x area*

Time = *force/electric charge x length x magnetic induction*

Time=*Action/Energy being transformed*

Angular velocity, angular acceleration, angular momentum, phase, angular frequency, torque etc., contain and define time in rotational motion; Speed, velocity, time-period, frequency (n, f, ν), wavelength of a wave (λ) phase (Φ) etc., contain and define time in vibrational motion. Time = Time period, t ; Time = $1/n$ or f or ν frequency, Time = wavelength/ velocity of wave. Time=Planck's constant (h)/energy ($h\nu$)

Mental Time: Present, past and future: [6-7]

Psychological time is three dimensional as - past, present and future. *Of these only present is real. Both past and future are imaginary. Psychological past and future exist only in and as thought forms.*

PRESENT *Reversible mental energy transformation* PAST OR FUTURE

Pure Consciousness *Being* \longleftrightarrow ***Becoming*** **Awareness self-consciousness**

Phase of Cessation of mental functions *Thoughts-Memory-Experience -Urges- Sense-Ego*
Understanding -Insight-Volition - Apprehension - Phase of mental functions

TABLE IV

DIFFERENT MANIFESTATIONS OF TIME

| Manifestation | Physical Quantity Manifesting | Physical quantity changing | Locus/ Shape | Nature of change | Existence | Role of Universal Time |
|---|---|-----------------------------------|-----------------------------|---|-------------------|-------------------------------|
| Movement | Speed | Energy | Linear Cyclic | Finite / not reversible | real | Nil |
| Linear, rotational | Velocity | Energy | same | same | real | Nil |
| | Acceleration | Energy | same | same | real | Nil |
| | Phase of motion | Energy | Cyclic | same | real | Nil |
| | Impulse | Energy | Linear | same | real | Nil |
| Rotation Vibration | Velocity/ acceleration Wave/pulse | Energy | Cyclic | Finite periodic | real | Nil |
| Vibration | Frequency | Energy | same | same | real | Nil |
| Change and Becoming | Phase of matter | Energy /Entropy | Linear/ cyclic | Finite reversible | real | Nil |
| Physical | Action | Energy/Entropy | same | same | real | Nil |
| Chemical | Action | Energy/Entropy | same | same | real | Nil |
| Biological Evolution/ageing Other processes | Action Same | Energy/Entropy Same | Linear Linear /cyclic | Finite Irreversible Reversible too | real | Nil |
| Cosmological | Action | Energy/Entropy | Not Clear | Infinite Reversibility Not known | Imaginary | Creates Cosmic Time |
| Psychological or Mental | Action | Energy/Entropy | Linear /cyclic | Finite Reversible | Real Imaginary | Nil |

REFERENCES:

- [1] Penrose, R, (1989), *The Emperor's New Mind* (Oxford University Press,), p. 371.
- [2] Zwart, P.J., *About Time*. (1976),(North-Holland Publishing Company, Amsterdam-Oxford).
- [3] Stephen W. Hawking, (1989), *A Brief History of Time* (Bantam Books, New York).
- [4] Peter Coveney and Roger Highfield, (1991), *The arrow of time: A voyage through Science to solve Time's greatest mystery* (Fawcett Columbine, New York).
- [5] Stephen W. Hawking, (2001), *The Universe in a Nutshell* (Bantam Books, New York).
- [6] Ramabrahmam, V., (2005), 'Being and Becoming: A Physics and *Upanishadic* Awareness of Time and Thought Process', *Ludus Vitalis*, **XIII**, (24), pp 139-154.
- [7] Ramabrahmam, V, The myth of keeping universal time- The absence of absolute, true and mathematical time: A physics and physicochemical insight. *Communicated*
- [8] Ramabrahmam, V, (2003), The Significance and Use of Absence, *Bharatiya Bauddhika Sampada* , November, pp. 7-9.
- [9] Ramabrahmam, V., (2007), The science of human consciousness, *Ludus Vitalis*, **XV**, (27), pp 127-142.