

Nano-time intervals in bio-systems - Their relevance to nano-bio-science and nano-bio-technology

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Abstract

The nature and structure of time and time-intervals in physical, chemical and biological systems will be elucidated. The relation and dependence among time, energy and taking place of natural processes will be critically analyzed. The bio-processes taking place in nano-time intervals will be identified. Their relevance to nano-bio-science and nano-bio-technology will be developed and nano-time interval-aspect of nano-sciences and nano-technology will be advanced.

Key words: nature and structure of time; nano-time intervals; nano-bio-processes; nano-bio-science,; nano-bio-technology; nano-science; nano-technology

Presentation at 2nd National seminar on New Materials Research and Nanotechnology (NSNMRN2013) held at Department of Physics, Government Arts College, Stone House Hill, Ooty-643 002, the Nilagiris District, Tamilnadu, India, between 25-27, September, 2013.

Introduction: Biological Processes, Evolution and Ageing- Entropy change:

Biology is the study of life. All living organisms are made of chemicals which they package into cells. Biology can be studied at many different levels—from chemical and physical processes which take place within an organism to the whole groups of organisms (populations) and the way in which they interact with each other and the environment. The processes and products in biology are:

Cells: Chemical constituents of cells; Movement of substrates into and out of cells; Cell structure; Cell control and cell division; Energy and enzymes; Energy release; respiration; Energy capture; autotrophic nutrition; Heterotrophic nutrition

Energy: Energy and enzymes; energy release and respiration; Energy capture: autotrophic nutrition; Heterotrophic nutrition;

Movement and regulation of body fluids: Gas exchange; animal body fluids and their transport; Regulation of body fluids in animals: homeostasis; Transport in plants; the defence against disease: immunology.

Coordination and movement: Control and coordination in animals: hormones; control and coordination in animals: nerves and the nervous system; Control and coordination in animals; receptors and effectors; Control and coordination in plants; Support systems and movement.

Reproduction, growth and development: Reproductive strategies; sexual reproduction in mammals and flowering plants; patterns of growth and development;

Diversity: Inheritance; Genetic changes in populations: evolution; species, their formation and classification; Prokaryote and protocista; fungi and plantae; Animalia

Ecology: Populations and factors controlling their size and distribution; energy flow through ecosystems; ecosystems and nutrient cycles; ecosystem pattern.

Many physiological processes are nano- both in space and time-periods' sense. They occupy spaces of nano meters and take place in nano- times (10^{-9} sec) and can be safely called nano-processes both in space and time measurements.

About time: Penrose, 1989 [1] has said that: “*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*”. This article is written in this spirit to give a fresh insight of time, its passage and consciousness by critically studying the mathematical constructions and structure of time in physics, chemistry, biology and cosmology. Time has many forms, structures, natures and has been viewed, defined and understood variedly. Time is having two existences: *physical and psychological* [6]

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. Physical present is same everywhere in the universe and only observation and counting are at different instants. Count of physical present is a function of geographical location and religious and cultural back ground. 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 measure of conversion of energy in a process. Time flow is a measure of **Being** (presence) and **Becoming** (transformation) of matter and energy in space

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. Stephen Hawking has given a brief history of time and discussed the nature of time and universe [3,5]. 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 movements [2]. 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. 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. 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 physicochemical 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. 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, physicochemical, chemical and biological times. Thus all physical, chemical, biological matter has *phases* of origin, being/becoming and dissolution (cessation) which is *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.

Conclusions: 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].

Physics deals with macroscopic, microscopic and cosmic worlds. Chemistry deals with microscopic world. Both consider nano-space to define nano-science. Biology deals with microscopic world and also macroscopic world (ageing, evolution etc.,). Biology is the study of living systems and it consists of following branches: nano-science of biology and its technology is nano-in nature in many ways in relation to time and space.

Biological matter exists in all the phases in proximity and energy transformations are very fast and actions and reactions are very quick. The mechanism itself is different from physical and chemical phenomenon. Biological changes come under physicochemical processes when chemical changes within them are observed. Humans, other vertebrates, mammals, animals, insects, etc., when are in motion, gravitational forces control their movements. Thus all intervals of time are associated with bio-systems including nano-times. The quantum mechanical approach, though is successful in describing the motions of fundamental particles and photons, it will be of no use while dealing with the physicochemical changes associated with various types of biological matter in living systems. Sizes, types and phases of matter, changes, time-periods, energies and energy transitions associated with different nano- and biological materials and methods used to monitor various biological phenomena are special to biology. Not only different physical techniques are necessary to monitor various changes in bio-systems but also the energies to probe the various aspects of bio-processes are not the same. Also the time periods of various bio-transformations are varied over a wide range [atomic transition (10^{-15} sec) to generation of bacteria 10^3 sec]. The primary vision is of the order of 10^{-12} sec, the hinge motion in proteins is of the order of 10^{-9} sec, the unwinding of DNA helix is of the order of 10^{-6} sec, enzyme-catalyzed reaction is of the order of 10^{-3} sec and the synthesis of protein happens in around tens or hundreds of seconds. **Time is also to be considered when defining nano-, in bioscience and technology in addition to space.**

TABLE I

(a) EVOLUTION OF BIOLOGICAL TIME

Evolution of universe; chemical evolution; molecular and macromolecular evolution, evolution of proto-cells, cells, tissues, organs and organisms, evolution of consciousness

Biochemical evolution:

Earth Formed	Micro-Organisms	Euka-rytes	Atmosphere Oxygen -forming	Macro-Organisms	Amino Acids	Humans
4.5	3.5	2.5	2	1.5	0.5	0
Billions of years						

(b) Interesting Time periods:

<i>Chronon</i> = 10^{-24} sec.	<i>unit of quantum time</i>
Nuclear transition = 10^{-23} sec.	nuclear time
Atomic transition = 10^{-15} sec	atomic time
Primary event in vision = 10^{-12} sec	visual cortex time
Hinge motion in proteins = 10^{-9} sec	protein activity time
Unwinding of DNA helix = 10^{-6} sec	nucleic acid activity time
Enzyme-catalyzed reaction = 10^{-3} sec	bio-catalyst activity time
Synthesis of a protein = 1 sec	macromolecular time
Generation of bacterium = 10^3 sec.	Biological time
Time elapsed since the Origin of the Universe = 10^{17} sec.	Cosmic time

(c) Concepts of nature of time: Matter or energy at rest or in motion or under transformation is the physical manifestation of time and constitutes physical time. 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. Matter- or Energy-Presence is **Time at Rest** or **Static Time** or **Time-Space** or **Durational** aspect of time. Matter- or Energy-Transformation is **Time in Motion** or **Dynamic Time** or **Time Created** or **Metrical** aspect of time. 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. 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. Rise and fall of and flow of conscious states of mind and thoughts and other mental functions constitute psychological time. 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. [Ramabrahmam, 2005].

TABLE II

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 Θ/d ω.*

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/v*

Time = *Electric charge/current density x area*

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

Time = *mol/catalytic activity*

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, v), 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 v frequency, Time = wavelength/ velocity of wave. Time=Planck's constant (h)/energy (hv)

Mental Time: Present, past and future: [Ramabrahmam, 2003, 2007]

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————— **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 III

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

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