The Nature of Time and the Systems of the Universe

by

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Summary

The time-dimension is freely used in physics, although its nature is still a matter of conjecture. Newton's time-interval is fixed in time and space, but the theory of relativity assigns it an elastic property. This paper shows that the direction of time and the length of time-intervals are determined by the velocity of light *in vacuo*, and if this is a Universal constant, there is no possibility that they can change whatever the circumstances. The methodology used is input/output analysis of systems. The argument is developed with reference to astronomy, but the conclusions apply to all the physical, chemical and biological processes of the Universe, the ultimate system of which we are part.

A. Introduction

The nature of time has remained a perpetual mystery over the centuries not only to philosophers but also to anyone who stops to reflect on it. The general conclusion reached so far is that time just marches on, and there is nothing more we can know about it. Scientists too simply accept the dimension of time as given and treat it algebraically, following the mathematical physics of Newton. Even followers of the theory of relativity accept time as a phenomenon; they just believe that it is elastic, whatever it is.

I addressed the dimensions of physics and their role in Newtonian mechanics in a previous paper (1). The target was time, but I approached it through distance because it is a more obvious dimension to us; we can see it with our own eyes. The surprising conclusion is that time is not a continuous thread running through history, but only a concept. This is compatible with Einstein's dictum that time is the interval between events, but it makes explicit that there is nothing in the "interval". Mathematical physics in fact deals not with time but with numbers of time-intervals; indeed the algebra requires it. But the corollary, shocking to some, is that time as a mere notion cannot dilate or take part in some kind of space-time continuum.

A subsequent paper showed that it is the speed of light which decouples physical systems and allows them to operate independently in different locations. In effect the constant velocity of light *in vacuo* determines the nature of time and space as we know them (2).

The present paper takes the final step of linking the constant velocity of light *in vacuo* directly to the processes of which the Universe is composed. This provides crisper, alternative arguments by a different route, most clearly by treating processes in their simplest, generalised form as systems. All that is required is two hypotheses: first, that it

is a Universe of ceaseless change, and secondly, that there is one ultimate constant amid the change, which is the velocity of light *in vacuo*. The velocity of light *in vacuo* has been measured so many times as to be beyond doubt, and found always to have exactly the same value. The new technology of recent years reveals a Universe in perpetual turmoil as far as the apparatus can see, which is now a great distance. The hypotheses are in effect indisputable.

The sequence of arguments is as follows.

B. The direction of time

- Natural processes are detectable, if not yet by us then by other parts of the Universe with which they interact; they influence or are influenced by their environment. Otherwise they would be Universes of themselves.
- It is the result of natural processes i.e. their outputs, which form the interactions with other parts of the Universe.
- The corollary is that they must also draw on inputs. Otherwise they could not continue to produce their outputs; they would eventually run out of inputs to process.
- The simplest way of describing the essentials of processes is as systems. Systems take inputs in the form of materials and energy, and transform them into outputs.
- Outputs are also materials and energy, though different from the inputs because of the processing which took place inside the system.
- There is no stock of non-interacting "raw material" on which to draw; if it was non-interactive, it would indeed be in a universe of its own.
- It follows that the inputs of every system are the outputs of other systems.
- Systems are by definition separated from each other, or they would be parts of the same system.
- The maximum rate of transfer between systems is the speed of light *in vacuo*.
- The outputs of one system cannot therefore be received by another system simultaneously with their emission from the first.
- Thus there is a direction of flow which is always from the outputs of one system to the input into another. Or to generalise, the direction of flow is from the outputs of all systems to the inputs of all systems.
- The fact that the speed of light is not infinitely fast i.e. transmission through space is not instantaneous, is what separates the outputs of every physical system from the inputs into other physical systems.

It is the direction of flow from outputs to inputs which marks the passage of time, or what may be conceived of as time itself.

C. The length of time-intervals

- There is no possibility of reversal of the passage of time, because nothing can send all the inputs of all systems back where they came from.

- Nor is there any way in which the energy changes which had occurred during processing could be reversed. The flow is one way only, from outputs of one system to inputs into others.
- The velocity of light *in vacuo* is not only finite but it is also constant throughout the Universe i.e. the distance covered per unit time is the same, wherever, whenever and however it is measured.
- Thus the minimum time-interval between emission of outputs of one system and reception by another is proportional to the distance between the systems.
- If the distance between systems increases, light takes longer to travel between them at its constant velocity *in vacuo*.
- This presents a problem for the concept of cosmic redshift caused by an expanding Universe. Consider a beam of light which contains f oscillations from the front of the beam i.e. the light which first leaves a system as an output, to the end, at which the beam is cut short. A redshift means that the number of oscillations f which is in the length of the beam spreads out over a greater distance.
- There are three possible ways in which this could happen mathematically: changes in the distance-interval, changes in the time-interval and decoupling of the process of oscillation of electromagnetic radiation from its translational motion through the medium of space.
- To consider the first possibility, the beam of light could stretch in length, so that the number f oscillations is contained not in a length of d but in a length of $d + \Delta d$ where d is distance This would need an increase in the velocity of light *in vacuo* to enable the light at the front of the beam to move away from the source even faster than usual. This is not permitted.
- The second possibility is that the time-interval t stretches, so that the number f oscillations occurs in time $t + \Delta t$, thus leaving a reduced number in time t, which is what we call frequency. The physical basis for such a phenomenon is questionable, especially since the observer of redshift would have to be immune from it.
- The third possibility considers the frequency of oscillation of a single particle of light as opposed to the whole beam. Redshift would occur if the number f per unit time was reduced as the distance through which it travelled increased. This is not impossible but it has to be explained how frequency i.e. the number of oscillations per second, could be decoupled from the distance travelled per second.
- An explanation proposed in another of my papers is that light is composed of rotating electromagnetic dipoles or REDs, and their rate of rotation is progressively reduced by electromagnetic induction during transit through the medium of space (3).
- Changes in the phenomenon of the length of time-interval or distance-interval are not permitted, because the velocity of light *in vacuo* is accepted as constant in every model of physics, including the theory of relativity.

There is no possibility that the length of a time-interval can vary at any location.

- In practice it is not convenient for observers to measure time-intervals using the velocity of light *in vacuo*.
- The solution is to use other processes such as the regular motion of stars and planets, or the swing of the pendulum with the force of gravity or the frequency of light (as opposed to its velocity).
- Insofar as time-intervals when measured by these methods, oscillate or change with conditions in the same location, then it must be caused by variation in the response to that environment of the phenomenon employed or in the method by which it is observed, not by changes in the velocity of light *in vacuo*.

Thus both the direction of time and the length of time-intervals are determined by the velocity of light *in vacuo*, which is finite and constant under all circumstances. Since the distances from which time-intervals are derived are additive, there is no limit to the number of sequential time-intervals which can be added to form a longer time-interval. Similarly there is no limit to the subdivisions of a time-interval which can be made to form a smaller time-interval; it is simply the shortest distance which light can travel *in vacuo*.

D. Timeless phenomena

- Natural phenomena are not processes, because they need no inputs of energy and/or materials; they are not systems, but rather interactions through the medium of space.
- Thus forces which act between two bodies at a distance from each other require no energy to sustain them. So it requires no energy for us to feel the gravitational pull of the Earth, or for the Earth to reciprocate to exactly the same extent.
- The same is true of forces between two electric charges or between two magnetic poles; any energy associated with these lies in their initial generation, not their maintenance, leaving aside leakage from imperfect apparatus.
- There are no limits to interactions through the medium of space, because space is infinite.
- The corollary of this is that there is no cut-off point to the influence of these forces.
- The converse is also true: space is infinite because there is no cut-off distance at which force between any two bodies becomes zero.
- Thus every body has gravitational attraction towards every other body in the Universe with a force which diminishes according to some function of the distance between them. This is consistent with Newton’s Law of Universal Gravitation.
- Since such forces occupy the whole of the medium of space all of the time, they are timeless.
- The passage of time occurs when the locations of bodies change with respect to each other i.e. as a result of physical movement, as in Newtonian mechanics. This alters the distances and so the forces between them and all other bodies in the Universe.

- Movement of bodies may be considered as events, which is consistent with Einstein's observation that time is the interval between events.
- The rate at which such changes are transmitted between bodies through space cannot exceed the speed of light *in vacuo*, because nothing can.
- In fact the velocity of light *in vacuo* must be the velocity at which changes of all these forces are transmitted through space, because it is a property of the medium of space, which is common to them all.

E. The scope of natural systems

The analysis is much broader in scope than may appear from the context in which it has been developed. Since the argument has been set out in terms of interactions rather than specific natural processes, it applies to all systems at every level, not just astronomy where the velocity of light *in vacuo* is most evident. Systems are composed of subsystems which interact as described. But subsystems are also systems, and so they are composed of sub-subsystems which interact. It is usual to omit the additional "sub", because every system in the Universe is sub-something, and it becomes cumbersome, but it means that the argument is valid not only for astronomical systems *in vacuo* but also for systems on Earth: physical systems, chemical systems at the atomic level, nuclear systems, biological systems, in fact every process down to the level of fundamental particles.

In addition, the interactions take place through the medium of space, which permeates everything in the Universe except the fundamental building blocks themselves, that by definition. The term *in vacuo* is the simplest way of describing what we observe at our level in the scheme of things. If light appears to travel at slower speeds in gases, liquids and solids, it is because of the successive interactions of particles of light with the particles of matter in transit, which delay its progress. All particles of matter are not only entities which are separate from each other in the medium of space, but they are also permeated by it, because atoms are almost entirely composed of void which is *vacuum*, and even nuclei contain void because they are assemblages of nucleons. There is a further argument that nucleons too contain void. Thus all these levels of matter are permeated by the medium of space, and so the velocity of light *in vacuo* is also the velocity at which it travels between atomic and subatomic particles. Any hold-up which light undergoes is at the locus of particles of matter, not between them. The corollary is that the arguments of this analysis apply to all of the natural systems of the Universe.

Moreover, the same is true of the three forces which act at a distance between particles i.e. electric, magnetic and gravitational. Changes of forces between particles occur as a result of changing distances between them. Such changes are transmitted from one to another at the velocity of light *in vacuo*, because the rate of propagation is determined by the properties of the common medium of space.

The corollary is that these four phenomena themselves are timeless. Light does not undergo a period of acceleration to get up to speed, and it requires no further input of energy to keep it moving *in vacuo* after being generated.

F. Conclusions

The passage and direction of time are built into every system of the Universe. Whereas physical processes may be considered as reversible, their analysis as systems shows that they are definitely not. The concept of reversibility is a convenient summation of a whole process, based on the homogeneity through time of the components. In fact the transformation of individual items goes one way, and that is the direction of time. The velocity of light *in vacuo* is the regulator.

The model which has been described is a Universe of systems in dynamic equilibrium, perpetually interacting through the medium of space. Every part of the Universe is constantly changing, but the Universe itself which is the system as a whole, does not change.

In such a Universe, which can scarcely be denied in view of the extensive observations that have now been made, snapshot analyses and arguments based on bulk parameters such as entropy are unnecessary and misleading when they purport to show that the Universe is inexorably running down. They have their use in analysis of parts of the system, but extrapolation to the whole system is unjustified. The Universe is not simply the sum of its parts.

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