The flow of time

A new perspective on the passage of time

Laurențiu Mihăescu

Bucharest, Romania

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1. Definition

To understand what the time really means is equivalent to understand the mechanism that runs the whole Universe and all those processes that move, change and transform its matter. Equally important are, in this perspective, the changes of the space itself (i.e. that particular medium in which all these things are happening). We could never talk about time if there hadn't been structured matter or if this matter would have been in a state of perfect stillness. The global model created by the current physics to explain the nature of reality has a certain degree of compatibility with the experimental observations, but it is at least incomplete; this model is fragmented on several dimensional intervals and, more important, it does not define the fundamental elements that made up the space and ordinary matter. The laws of transformation and conservation of various quantities that characterize the physical phenomena, from quantum level up to the cosmic scale, try to theoretically reflect more and more aspects of an extremely complex and dynamic reality. Most of the latest theories do not provide a full and rational explanation for the underlying mechanisms behind space and matter, although these two fundamental components of the surrounding reality should be very *simple* and easy to define. We have to better use our imagination in order to develop an abstract model of the nature, to fill in all the blanks if the experiments can no longer give us significant data. We may observe and analyze the whole reality around, but there are *objective* limitations in reaching its biggest and lowest dimensions. Two big parts are therefore missing from any global model of reality, namely the extremes of the dimensional spectrum; consequently, they both should be completed by using the logic and the scientific argument.

Regardless of this universal model that remains to be formulated, one thing is certain: the matter of our universe is transforming continuously, being driven by various fields. Their energy is transferred to matter, and more and more complex structures are created all the time. The interactions between these structures are changing their states and hold them together, allowing some big cosmic objects to be formed and to start moving through space. These sequences of changes (of the state, position and energy) would be better described

mathematically if we introduce a special physical quantity named *time*. It will help us to correctly describe the movement of matter and the speed of its transformation processes. We may therefore identify in these changes a particular moment when a certain event takes place and accurately quantify it. An equation that describes the state of a physical system may help us identify the exact moment of an event, showing its "position" in time. Relative to the current moment called "now", there is something new we may declare about that event: it has happened in the past, it is happening now or it will happen in the future. Thus, it became very easy to associate the quantity *time* with a certain dimensional axis that is oriented from the past toward the future. We've practically created a new physical dimension (beside the other three of the three-dimensional space), a quantity that may help us to better describe the movements of matter.

The modern physics still uses a dual definition of *time*, a classical one (the Newtonian time) and one of relativistic nature (as described in Einstein's Theory of General Relativity):

- Time is a fundamental physical quantity (scalar, absolute and linear) that characterizes the duration of movements, phenomena or of a succession of events; time flows uniformly in any physical system, regardless of the external phenomena.
- Time is also a fundamental physical quantity (scalar) that characterizes durations - but which depends on the concrete system of reference (on its speed actually) and on the *intensity* of the local *gravitational field* (or, in accordance with the equivalence principle, on the *acceleration* of a system); the time dimension represents one coordinate in the four-dimensional continuum known as *spacetime*.

In my opinion, however, time is no longer a fundamental physical quantity! It is in fact a derived scalar quantity, of variable rate, which results directly from the inherent nature of reality: matter, in any form, may freely move through the three-dimensional space. This special quantity therefore depends on the absolute granular motion (which is considered absolute at the scale of our universe or locally, where is determined by the nonuniformity of gravitational fluxes and by

their quantum gravitational fluctuations). The motion of granular matter, from elementary particles and photons up to the complex cosmic structures, has an absolute speed limit; this restriction reflects itself in the proper movements of matter, and this determines in fact the rate of the local time. Generally speaking, matter is subjected to a speed limitation when it moves simultaneously through space and time (Gravity [3], Chapter 5.3: "The simultaneous movements of particles through space and time are therefore limited to the global maximum speed, as it was described by the principles of relativity, and this happens because the *same* entity may travel through space and may also fix the rate of its local time *by the same internal granular motion*"). Although space is granular, the movement of any material body through it may be considered continuous - any intermediate positions on the trajectory being occupied at a moment; therefore, the movement through time may also be considered continuous, regardless of its variable rate of passage.

Seen globally, time actually becomes a more complex quantity; it is no longer an abstract concept, which may describe - for example - a virtual reference frame, but a physical quantity that has to be always associated with *concrete* matter (structures) *and* with its movement (as there is the real origin of time). Therefore, time may have different meanings at different scales (as shown in detail in [3], Chapter 10.2.1). Its rate of passage can be either constant or variable, depending on the scale and on the actual physical system we analyze.

2. My vision

There were several kinds of time introduced in my previous works, but only three of them (the most important ones) will be shown here:

A. *The primary (granular) time* derives from the granular motion, as all the granules in the spatial fluid are moving at the absolute speed ***C***. It is therefore associated with the speed of this uniform motion and, consequently, has a constant rate of passage; this kind of time is in fact a virtual quantity that comes directly from the fundamental constants we have used to describe the granular level (Gravity [3]).

B. *The quantum time* flows in the quantum realm and is associated with the movement of all granular structures. This kind of time cannot be seen just as the proper time of a specific particle, but also as a descriptive element of its interactions with other particles through various fields. As local time, it derives from the fundamental constants of space and thus, indirectly, from the primary time. The source of this time is the specific, dual-type movement of elementary particles: their intrinsic precession and the global translation (which has the speed limit **c**). It should be noted that the entire dynamics of a particle depends on its absolute mass, which depends in turn on the absolute speed and on the concrete distribution of granular fluxes (known as the intensity of gravity). If this type of time is associated to a single (isolated) elementary particle, then it cannot describe the actual mechanics of the quantum level and it would have only a theoretical, abstract nature; this mechanics imply in principle several particles to interact, a system of particles.

C. *The macroscopic time* can be assigned to any structure made of elementary particles, to atoms and to the physical bodies they form. The quantum time, as well as the macroscopic one, shows an *absolute character* (they are directly linked to the real nature of our universe) - when a stationary structure is considered - or a *relative character* - when that structure is in motion. All of the atoms and molecules that are making up a physical body have their own movements (beside the global one); we may therefore see the macroscopic time of a particular body as a resultant, as the arithmetic mean of all its internal quantum times.

Both quantum and macroscopic times are considered by the modern physics as a unitary, continuous quantity of relativistic nature; they will be simply called *time*. As we have already seen, the local time of a particle or of a more complex material structure depends on the absolute speed, its rate of passage being slower close to the speed **c**; therefore, if that particle travels at this exact speed, the local time becomes infinitely slow - it practically comes to a full stop.

Inversely, if that particle or all the particles of a system would be in a state of absolute rest, their local time would reach the maximum possible rate of passage.

Considering this absolute component of time, we might introduce a global temporal quantity, of maximum rate, to use for the entire universe. Even if the granular density is not the same in all regions of space, even if we would ignore the massive stars and all the galaxies, this kind of time cannot have a constant rate of passage. Paradoxically, even the rate of time changes over time! These changes are due to the variable granular density of the universe - which varied significantly since the Big Bang and which continues to decrease. Although the fundamental constants we previously postulated (Gravity [3], Chapter 9) are truly *absolute constants,* this phenomenon induces a global relativism in our universe. As the granular density varies over time, some other quantities, such the mass of elementary particles and their maximum speed (the speed of light) will also change. This entails different variations of the internal parameters of all our time-measuring devices. What can we do to ensure that our observations directed to distant cosmic objects are uniform? As previously proposed, we can agree on a unique rate of time - resulted from a repetitive, actual quantum phenomenon - which could be used for all observations of the cosmic objects, and to extrapolate the absolute values of all the other quantities in accordance with the estimated variation of the granular density.

Two more c*onclusions* (Gravity [3], Chapter 8) have to be mentioned here, as they both are related to the time measurement (with atomic clocks and light clocks) in relativistic conditions:

- "... only the quantum processes should be used to measure time; at the macroscopic level, time it just a reflection, a sum of the relativistic changes that are happening at the atomic level and below."

- "The primary time emerges from the first level of matter, being connected with its granular constants (kinetical and dimensional); it embeds itself in all granular structures (elementary and composite particles, atoms etc.) and their quantum interactions."

3. Entropy and time

Why disorder has to always win in our Universe? Why entropy always tends to increase, is this really a universal law?

First of all, let's take a look at the granular level: here, space may be assimilated to a perfect fluid, evenly distributed, whose entropy-like property does not vary on short intervals (the volume of space increases continuously, but we choose to ignore this change now).

The structured matter lies at quantum level (elementary particles and atoms are bound together by different fields); there, space loses its uniformity and may directly interact with the granular structures. Let be a spatial region in the proximity of a star, a place where the gravitational field is very strong. In addition to the *quantum gravitational fluctuations* (described in [3], Chapter 11), that area is continuously crossed by the radiations and particles originating from that star; we may also consider the incomplete photons and the granular remains produced when some particles annihilate. Any material structure that would exist in this fluctuating medium will be subjected to *random transfers of energy*. We may therefore conclude that space itself, over time, could increase the entropy of all quantum structures - no matter how isolated they seem to be.

However, we cannot declare that any transformation of matter, as compact or granular essence, has always increased the degree of disorder (if this concept can be applied in that place and time) - giving in this way a direction to the *arrow of time*. For example, there were two special moments in the early universe when matter has spontaneously organized itself; first, the emergence of the simplest granular formations and, later on, the moment when these formations have joined together in composite structures. The continuous action of the granular fluxes and of those fluctuations on the structured matter, over billions of years, have had two seemingly opposed effects:

- Large amounts of energy were transferred to matter by the granular fluxes, allowing the creation of all sorts of heavier atoms (the fusion reaction inside the stars was maintained in this way).
- The same granular fluxes increased the entropy of some complex structures these atoms have built eventually, then broke and recombine

them in other forms; this is in fact the natural process behind the very complex, highly organized structures (see the living cells and life in general) - apparently dominated by order.

The space itself, by using its own granular energy, have shaped and built complex material things, proving to be very creative over time! Two important factors, the emergence of a *huge* number of granular structures in the early universe and their *stability* over time, have allowed this simple mechanics to work continuously and to generate a great diversity of particles, atoms and molecules. The first building blocks of matter, the Hydrogen and Helium atoms, have clumped together and formed distinct systems - the stars and their formations - which continued to concentrate the primordial energies in billions of cosmic laboratories named galaxies. This process may repeat itself: a star is born, burn for a while and then has a destiny that depends on its mass and composition; for example, it could explode (went nova), become a red dwarf, a neutron star or a black hole. The matter that is spread around in case of explosions may constitute the fuel for new stars, and thus the whole process may be restarted.

At any scale, all material system are evolving continuously, changing and passing through different states. As it was specified in my previous work (Prime Theory [1], Chapter 10), the mechanics involved here is always causal and deterministic: *"Clearly, the current state of a system determines in a causal way its future states; this happens at any level, as it is the true nature of things, setting up the direction of the arrow of time".* The perpetual motion of the spatial granules at a constant speed (***C***) allows in fact the movement of any material structure at an absolute speed ranging between **0** and **c**. Time, as a physical quantity of variable rate, reflects how all of these structures travel through space and, simultaneously, interact.

4. Temporal symmetry

We know all about the symmetry of physical laws under the simultaneous change of electric charge and parity, also about the time reversal symmetry. However, if we consider the previous description of the "arrow" of time, it would seem unreasonable for all the laws of physics to remain the same if the sign of time changes. The universe, i.e. all forms of structured and unstructured matter, is continuously transforming; if we speak of a closed system and fixed dimensions, we may have a large-scale conservation of *all* quantities related to motion. But this system is not fixed; space undergoes a continuous expansion process, which automatically imposes a certain asymmetry to the movement of matter. This thing has determined a few big changes of the granular entropy over time and has led to the emergence of the structured matter - which is another significant asymmetry seen at the cosmic scale (The Universe [2], Chapter 2). The entropy of the normal matter remains constant or increases over time, according to the second law of thermodynamics; however, this is just a consequence of the special consistency of matter. In other words, our universe came out of its initial "frozen" state of stability and order at a certain moment (known as Big Bang), then it built a virtually infinite number of small stable "islands" - the elementary particles and their structures. Without going into detail, we may notice how matter keeps forming structures in an irreversible process that is powered by the force of the granular fluxes (now in a mature and quasi-stable universe). The dynamics of this process is based on a fundamental asymmetric phenomenon (which is also reflected by the arrow of time): the spatial fluxes have only a *constructive effect*, compressing and condensing the matter. If our closed universe is expanding and if the intensity of the spatial fluxes is proportional to the granular density, the global constructive effect of these fluxes will decrease continuously over time. *This is where the real source of the arrow of time hides in fact, as fundamental asymmetry; it is the global ratio between the granular material and the structured matter, which in our universe is constantly growing* (this can be seen in the growing number of black holes and in their increasing mass). If the future will hold a state of equilibrium between the expansion of space and the concentration of matter, it is difficult to say now. Considering the currently available data, a never-

ending expansion and an oscillating universe seem to be now two equiprobable speculations...

5. Time and relativity

The local time, as quantity that depends on the local absolute speed (if there are gravitational fluctuations) and on the local gravitational field, passes at different rates for different bodies, even if we take into account only the averaged values. A very accurate clock that would be placed near a certain body does not measure, in fact, its local time... There are some small differences caused by several phenomena, mainly by their different positions within the gravitational field. And things differ even more for individual atoms and molecules, as their current time changes with the thermal agitation and with the random directions of their movement. However, we may use a standard clock and assume a constant rate of time for all of macroscopic objects around (those with nonrelativistic speeds). Important adjustments should be made only if the gravitational field has significant variations (as in the case of the global positioning system GPS) or if the speed of that object is in the relativistic speed range. Two important conclusions were formulated in The Universe [2], Chapter 3.2:

1. The local time of a body depends on absolute speed; its rate of passage decreases when that body accelerates in regard to the ASR and reaches a relativistic speed, according to the TR formula we may apply in this context.
2. The local time also depends on the absolute direction of travel; a regular clock that would be using oscillations on opposite directions will therefore compensate these intrinsic deviations. However, the quantum scale particles will experience bigger time variations if their direction of travel changes.

The well-known formulas of time dilation are:

$$t_0 = t_f \sqrt{1 - v^2/c^2}$$

$$t_0 = t_f \sqrt{1 - 2GM/rc^2}$$

where

$\mathbf{t_0}$ is the proper time between events A and B for a slow-ticking observer

$\mathbf{t_f}$ is the coordinate time between events A and B for a fast-ticking observer (at rest or respectively, at a large distance from the massive object)

G is the Gravitational constant

M is the mass of the object creating the gravitational field

r is the radial coordinate of the observer

c is the speed of light

v is the velocity

6. The mechanics of time

We should assign some special attributes to the local time in order to describe "how fast" a body moves or if its internal state has changed significantly. As we previously postulated that matter has a *continuous* movement, at any scale, the flow of time must have the same characteristic. Therefore, if we "look" beyond the units of measurement and the actual measurements, several concepts connected to the "dynamics" of time may be identified:

- *Time interval* represent a finite time duration that is measured between two distinct events, or between the physical changes (for example the state, position) of a generic body.
- *Time rate* is the rate at which the local time actually flows; it may be established in relation to a fixed rate that is measured in another system, considered as reference. The measure of the passage of time could be given by a repetitive phenomenon of constant frequency that takes place in both systems. Its unit of measurement may be arbitrarily chosen (anyway, it is linked with some fundamental constants), but the value will always tend to zero in systems traveling very fast, close to the speed of light.
- *Moment of time* - is an exact position in the time continuum, an infinitely short period of time during which a certain event does happen. We may also use the term "now" for a specific point in this infinite chain.

- *Time*, regarded as a physical quantity related to our universe, can only exist if there is structured matter and this matter interacts. The *time* "passes" because all matter from our universe is dynamic, moves, transforms and its state changes continuously. If these processes would stop, or if matter would be destructured to its granular state (or condensed into amorphous forms like black holes) in a distant future, then this macroscopic time will no longer have any meaning, it will also come to a stop.
- As time is an "elastic" quantity, we may simply compare it with a rubber band that extends itself under certain conditions of speed and gravity; however, this band can revert back to its normal form and size if those special conditions cease to exist.

Granular mechanics describes the perpetual motion of those spatial granules (and their collisions), being centered on the idea that these phenomena conserve the granular kinetic energy; therefore, this spatial fluid will automatically induce all the other conservation laws of the mechanical quantities from the higher scales. All these laws will have a logical and causal connection with the quantity named *time*, which is in fact another image of the elementary kinetic energy. In conclusion, we can say that the properties of time depend on the fundamental constants of motion; moreover, if this mechanical energy would not have existed - as continuous movement of matter through space - we could not talk now about the concept of time! The causal link described here is extremely important, as it actually reveals the true nature of time. We have presumed that the granular movement conserves the total granular energy (the state of motion at granular scale); therefore, the granular time - as indirect source of the quantum time - should conserve its "flowing" state. Consequently, the absolute macroscopic time *can never be stopped*, and, moreover, *its rate of passage cannot be changed* (it is determined by the fundamental constants). The inner relativism of the local time flowing in any physical system is also caused by the granular movement (whose elementary energy is also conserved in structures, no matter their size).

7. Time travel

As time is not something reversible, we cannot act directly on it; also, we cannot consider it *an independent entity* that exists apart from the organized matter. The local time of a body moving at relativistic speed or of a body lying in a strong gravitational field slows down in comparison with the absolute time. Let's say now that the structured components - meaning the matter and fields from all over the universe - have a certain global state S1 at a certain moment T1, a state that includes all characteristics of their movement. As matter moves and interacts, at a later moment, T2, there will be a different global state, S2. The distribution of energy (in any form) has changed between the two moments, whatever close they might be. However, the total amount of energy did not change; the energy has just been *redistributed*. Locally, a certain amount of energy might have been consumed, but this exact quantity was absorbed somewhere else, in another form. The global process that took place between T1 and T2 is irreversible and continuous; the transformations of matter, starting at granular scale, may be neither stopped, nor reversed - they simply happen, and this is a kind of "mechanical given" of our universe.

At the quantum scale, however, there could be atoms having the same state and position between two moments of time; this does not mean that a certain atom could "freeze" time or could travel back in time! It surely had some interactions within this period of time, and its electrons continuously moved inside their orbitals - so the local time has passed in a normal manner. Extrapolating these things, we may reach the same conclusion for the macroscopic realm. A certain body continuously changes its internal state and its local time may only slow down under those special conditions. In extremis, at the speed of light or in a gravitational field of infinite intensity, time would simply stop - and the whole body would turn into an amorphous granular mass, for which time itself no longer has any meaning!

As movement is the cause for the flow of time and as movement is present at any scale, anywhere in the universe, we may conclude that the rate of the absolute time (its mean value) cannot change significantly and perceptibly (we are considering here the intrinsic relativism of a closed universe). At a local level, a

certain physical system X may have the same state at two different moments, but its local time has passed anyway - even if there are no visible traces - and it also passed for all the other systems around!

System X cannot "travel" into the past, for example, because the universe as a whole cannot stop moving or make a global "jump" into a previous state.

System X cannot "travel" into the future either, as the universe cannot "jump" into a future state without passing through all the intermediate states. At fundamental level, matter has a speed limit and, consequently, *nothing can happen instantaneously*! All events are lining up on a time axis and they can no longer be moved or changed if the "now" moment has jumped over their current position. The current events cannot affect the past events; moreover, any kind of influence might exist between certain events - it cannot propagate faster than the speed of light **c** (we have to include here the quantum entanglement, which is in fact a pre-configuration of two different quantum states - spin, polarization - whose future observation will not affect them in any way).

Let's compare two different material systems. System X is at absolute rest, while system Y is moving away at relativistic speed. As the system Y's local time flows slower, the events produced in these two systems may be added on two axes and spaced differently. A certain event called "now" may happen simultaneously in those systems, but all of the subsequent events will happen at different rates. This phenomenon is known as "the twin paradox" (The Universe [2], Annex 2, where you can find the traditional variant and my explanation based on the absolute motion), but time having different rates of passage is not exactly the same thing as the time travel. If we are to exploit this phenomenon using some relativistic speed rockets, humans could travel faster this way into a global "future" - as they pass slower through the time continuum. These astronauts would experience a different time, a time that passes slower than the absolute time; all their biological processes would be changed, and they will age less than their relatives on Earth.

However, time would not flow differently in two identical galaxies, on identical planets. Even if these galaxies would have a big relative speed, their local absolute - which is imposed by the granular fluctuations - should not differ and thus the rates of their local time will have the same value.

In my opinion, a time machine, or the time travel as a jump into the past or into the future, are just utopian ideas, good subjects for the SF movies - which are allowed to elude the laws of physics for "artistic reasons".

8. Perception

We know that all humans, as conscious beings, have the innate capacity to realize the passage of time - as a result of their biological processes and of their adaptation to the environment. There are biological processes helping us to perceive the external environment through senses and, consequently, playing an important role in setting the rate of the information we receive. For example, the sense of sight has the largest informational flow, giving us images from the surrounding environment at the maximum speed of 10..20 frames per second; our brain can easily process this string of data in real time, analyzing and comparing them with the stored images and patterns. Therefore, there is a perception speed limit imposed right by our eyes (by those sensors in the retina), and some faster events could be lost from sight (or they are unconsciously perceived). However, the adaptation of humans to the various environmental conditions is almost perfect; we depend entirely on the major changes in nature, we have a circadian rhythm, a lunar one, the seasons etc. As intelligent beings, we fully perceive and understand the changes caused by the passage of time in all living organisms. "Now" is deeply embedded in our conscience, and we almost perfectly realize the passage of time as a continuous line of moments in this sequence: past - present - future. All of the biological processes, as direct results of the laws of physics and chemistry, have a specific pace (of relatively constant value) that can even dictate the speed of our thoughts. But there are other physical limitations to consider, such as the speed of the electrical impulses through neurons and the complex connections of these special cells.

Therefore, all human beings have a nearly identical perception on the rate at which time passes. There are some variations of subjective nature which are mainly depending on our current activity, on our mental condition and on the pace of our social life. The technology advancements play an important role as well; also, the human age may alter or enhance the accuracy of the time

perception. On the other hand, the continuous changes of the environment lead us to a clear mental representation of the *arrow* of time. Moreover, as we all realize the finite duration of our existence, time gets the highest possible value for each of us. In conclusion, due to the human power to perceive and understand the most complex things, the illusion of time (as Einstein formulated) may be turned into a major factor of social and personal progress.

9. References

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Abbreviations and Acronyms

"Abc" - Figurative language
QGF - Quantum Gravitational Fluctuations
AFR - Absolute Frame of Reference
FR - Frame of Reference
IFR - Inertial Frame of Reference
SR - System of Reference
TR - Theory of Relativity
GTR - General Theory of Relativity
TA - Theory of the Absolute
PT - Prime Theory