Time and relativity

The mystery of time, explanation and conclusion

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Introduction

This article is a short analysis of the methods used to measure time, of the principles of physics involved and of the various equipments specially designed to this purpose. It will also highlight the behavior of these devices while moving at relativistic speed in inertial frames of reference.

What is the basis of time measurement?

Normally, a periodical phenomenon is required to measure time, a cyclic event that repeats at a constant interval; this period should be adjustable, a fine tuning being required to compensate for the action of various environmental factors. As each period T passes, a certain impulse (may be of mechanical, electrical or optical nature) is sent to a special "counting" device, which will turn it into a human-readable format, into a numerical value. Most of these time measuring devices (clocks) feature some restart or synchronization mechanisms; they allow a clock to start at certain moments or to show the same time as another, distant clock.

Note: Although the term "relativistic mass" is no longer used by the current physics, the variation of a mass-like physical quantity (see my article [5]) with speed is still certain.

1. The hourglass

This device can operate with either water or sand, and the measured time interval starts when the bulbs are inverted - the upper bulb being full - and stops once it becomes empty. This interval is proportional, in principle, to the volume of the flowing "fluid" and inversely proportional to the neck width (there are more parameters):

$$\mathbf{T \sim V / D^n}$$

Remark 1: We may presume that the weight of the fluid increases if the hourglass used for tests moves at relativistic speeds (while being in a uniform gravitational field); however, this type of clock is not able to reflect the time dilation stated by the TR.

Remark 2: Similarly, it is not able to reveal any gravitational time dilation (as stated by the GTR).

2. The gravity pendulum

This is probably the first mechanical device used to measure the time. Obviously, it was not a very accurate timekeeper and, even worse, it is affected by the global movement. In brief, the potential energy of a certain weight is periodically transformed into kinetic energy and vice versa, and the whole process takes a certain amount of time, for example one second. Its period of oscillation does not depend on mass:

$$\mathbf{T \sim 2\,\pi\,\sqrt{L/g}}$$

Remark 1: This clock indicates a time that passes at constant rate, regardless of the relativistic speed the whole device might have (in a uniform gravitational field), and therefore it cannot show the relativistic dilation of time (TR).
Remark 2: As the gravitational acceleration gets higher, the period of this clock becomes smaller, and this behavior *does not comply* with the predictions made by the GTR.

3. The mechanical watch

Its central system is an assembly consisting of a balance spring and a balance wheel. Such a simple mechanism oscillates at a certain resonant frequency, and that period is:

$$\mathbf{T \sim 2\,\pi\,\sqrt{I/k}}$$

where by **I** is denoted the moment of inertia of the balance wheel, directly dependent on its mass.

Remark 1: Although the period obviously depends on mass, the dependency is not linear and therefore the displayed time cannot be accurate in case of relativistic speeds.

Remark 2: Its period does not depend on the gravitational acceleration, so it is not consistent with the GTR.

4. The electronic clock

In spite of the *electronic* part in its name, this type of clock is based on the mechanical oscillation produced by a quartz crystal. This oscillator has the period of oscillation given by this formula:

$$\mathbf{T \sim 2\,\pi\, l^2/a \sqrt{12\,\rho/\,E}}$$

where $\boldsymbol{\rho}$ is the density of the material, whose value depends on mass. The remarks are thus identical to those of the above-mentioned case (3).

5. The atomic clock

This type of clock uses as reference the electron transition frequency from certain atoms (Hydrogen, Cesium, Rubidium), which may be in the microwave, optical or UV region of the electromagnetic spectrum. SI has defined the second as the duration of 9,192,631,770 oscillations produced of the caesium-133 element, which thus becomes the standard in time measurement. But a frequency standard can also be obtained from the atom of hydrogen (the 21 cm line, given by the spin of the electron), about 1420 GHz, using masers. Anyway, the formula for this frequency is (Rydberg):

$$\mathbf{f = \pi^2\, m_0\, e^4/h^3\, (1/n^2 - 1/m^2)}$$

It may be easily seen that the period is inversely proportional to the rest mass of the electron; if we were to speculate, a relativistic increase of this mass would lead to a "contracted" time (assuming that the other physical quantities involved remain constant).

Remark 1: All cesium-based clocks that were used in kinetic tests have shown correct deviations, almost identical with those resulting from the TR formulas.

We may come now to a general conclusion regarding the quantum phenomena that occur at global relativistic speeds: they are influencing the transitions of the orbiting electrons in more complex ways, and many other physical quantities are also varying.

Remark 2: This formula does not depend on the gravitational acceleration; however, the emitted photons will exhibit a gravitational redshift. Therefore, this atomic clock may measure the time in accordance with GTR calculations.

6. The light clock

Considering the TR and its postulates, a clock based on a light pulse that reflects on a mirror and then comes back on the same path might show the passage of time in a certain inertial FR - as the speed of light is constant (this is a common example). If this frame is considered fixed, we may measure the value of that period of time, for example **Δt**. If the same light clock is put in a mobile frame (speed **v**), it should measure a larger time interval, **Δt'**, as the light rays have to travel a greater distance until they reach the mirror and come back (the well-known formula of time dilation).

This perspective on things is wrong, as it was previously stated in [2]; a correct view has to be based on the new definition of space, on the new structure of elementary particles and of the absolute nature of motion. Therefore, considering all the TA premises [2], we will consider next an AFR called A (Figure 1) and an inertial frame called B that moves with the absolute velocity **v** along the OX axis. The light rays are represented by blue arrows, vectors symbolizing the relative velocity of the light in regard to the O points. We may easily write down the formulas for all relative speeds in those frames of reference:

$$\mathbf{u} = \mathbf{c}$$

$$\mathbf{u_1} = \mathbf{c} - \mathbf{v}$$

$$\mathbf{u_2} = \sqrt{\mathbf{c}^2 - \mathbf{v}^2}$$

$$\mathbf{u_3} = \mathbf{c} + \mathbf{v}$$

If **α** would be the angle of the light pulses (relative to the OX axis), the general formula would be:

$$\mathbf{u} = \sqrt{\mathbf{c^2 - 2cv\cos\alpha + v^2}}$$

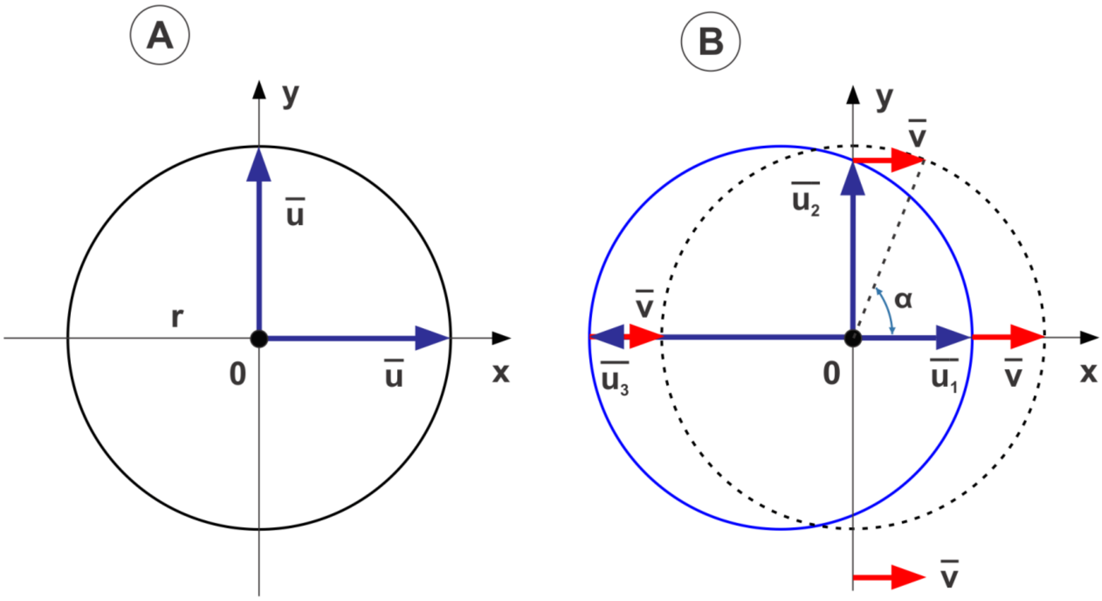

Figure 1 - *Inertial frames of reference*

Even if the light ray (reflected by a mirror) would be used in both directions, the time indicated by this device (of radius **r**) would have a significant dependence on the angle **α**. We may write:

On OX and OY: $\mathbf{\Delta t = 2\,r\,/\,c}$

On OX: $\mathbf{\Delta t' = 2\,r\,/\,(c - v)}$

On OY: $\mathbf{\Delta t' = 2\,r\,/\,\sqrt{c^2 - v^2}}$

Taking into consideration only the OY axis, we will find the classic formula of the time dilation:

$$\mathbf{\Delta t' = \Delta t\,/\,\sqrt{1 - v^2/c^2}}$$

Remark 1: This clock (operating in vacuum) can measure the time in accordance with the TR.

Remark 2: It can measure the time in accordance with the GTR if we would use the Doppler.

7. Conclusion

A general conclusion may be simply drawn at this point: the time cannot be accurately measured at macroscopic level - as its rate of passage is set at a different scale, namely at the quantum level (this was explained in my article *Mass-energy equivalence* - Chapter 5, where all started with the granular time). Therefore, only the quantum processes should be used to measure time; at the macroscopic level, time is just a reflection, a sum of the relativistic changes that are happening at the atomic level and below. The clocks of type 1 to 4 do not actually measure the real time; they just use some physical characteristics of the macroscopic objects to obtain different delays or oscillations that are not directly linked with the "source" of time.

The primary time emerges from the first level of matter, being connected with the granular kinetical and dimensional constants; it embeds itself in any elementary structure (particle or field) that acts, moves or propagates at the quantum level and beyond.

8. References

[1] Laurentiu Mihaescu, 2014. *Prime Theory*, Premius Publishing House

[2] Laurentiu Mihaescu, 2016. *The Universe*, Premius Publishing House

[3] Laurentiu Mihaescu, 2016. *The Theory of granular gravity*, article

[4] Laurentiu Mihaescu, 2017. *The formation of elementary particles*, article

[5] Laurentiu Mihaescu, 2017. *Mass-energy equivalence*, article

Acronyms and conventions

AFR - Absolute Frame of Reference

FR - Frame of Reference

TR - Theory of Relativity

GTR - General Theory of Relativity

TA - Theory of the Absolute

PT - Prime Theory

"Abc" - Figurative language