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SPACE -TIME CONTINUUM OR TIME AND SPACE

[1]Andrzej, Marian Kidawa
[1]40-001 Katowice, skrytka pocztowa1374, Polska, Poland

Corresponding Author:

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ABSTRACT
Criticism of the connection between the rate of passage of time and spatial coordinates in inertial reference frames.

INTRODUCTION

In contemporary physics, there is well-established view that there is so–called space-time continuum in which all the physical laws known to us operate [1]. In meantime , an analysis of the considerations that have led this conclusion indicates that the concept of space should be clearly separated from the concept of time. A position in space is described using static (unchanging) units, e.g. a Cartesian coordinate system using coordinates indicating the distance from a selected starting point in mutually perpendicular directions (x, y, z). Whereas time is a dynamic unit (changing, and moreover in a single incremental direction) and in order to describe it and compare it with time flowing in another coordinate system, time intervals must be compared because the number (t) indicating the hour is constantly incrementing. In other words, to describe time in a given place, it is necessary to determine the rate at which it increases, i.e. to determine the rate of its change in a given place in space. It should be noted that the set of points in so-called space-time continuum is a set of coordinates (in the Cartesian system): x, y, z, t where "x", "y", "z" are static quantities (described by constant numbers), and "t" is a dynamic quantity constantly incrementing. The conclusions drawn in [1] are based on two axioms (look: page 895 in [1]:

Axiom 1

Principle of motion relativity: The laws governing changes in physical states are independent of which of two identical coordinate systems, moving uniformly and rectilinearly relative to each other, are used as a reference. In other words: the laws are the same in identical frames of reference moving uniformly and rectilinearly relative to each other.

Axiom 2

Principle of the constancy of the speed of light: Each ray of light moves in a 'stationary' coordinate system at a specific constant speed V, regardless of whether this ray of light is emitted be a moving body or a motionless body.

MEASUREMENTS OF THE PASSAGE OF TIME IN LITERS.

In [1], the concept of simultaneity was defined for the purpose of describing a parameter (dimension) called time. By specifying the position of the hands on the clock (t) for a given position in space (x, y, z) we obtain a complete determination of place and time (i.e. all parameters/dimension) for a given material point, which is necessary for the description of kinematic and dynamic phenomena in the surrounding space-time continuum.

In order to describe the motion of a material point, it is necessary to determine the values of its coordinates in three-dimensional space as a function of time.

It is assumed [1] that at a certain point A in a three-dimensional space (x, y, z) there is an observer equipped with a clock (t), and at another point in three- dimensional space there is an observer B equipped with an identical clock. Without additional findings, it is impossible to define the time applicable in these two different places in space; it is only possible to determine the time t_A at the place A in the space and the time t_B at the place B in space. For the purpose of making it possible to compare the passage of time at the points A and B in three-dimensional space, the definition of simultaneity has been introduced in [1]. Events are simultaneous when a light ray directed at the time t_A from the point A towards the point B reaches the point B at the time t_B , at the same time t_B , is reflected towards the point A and reaches the point A again at the time t^I_A and the following dependency is fulfilled:

$$t_B - t_A = t^I_A - t_B \qquad (1)$$

referred to as definition of simultaneity (synchronization) of phenomena at points A and B.

The definition of simultaneity of events occurring at points A and B is therefore that the time taken for a light ray to travel from the point A to the point B is exactly the same as the time taken for a light ray travel from the point B to the point A (i.e. in the opposite direction).

The following dependency follows directly from this definition:

$$2AB/(t^I_A - t_A) = V \qquad (2)$$

where respectively:

AB – distance between points A and B
V – speed of light in vacuum
t_A - time indicated on the clock located at the point A at the moment of emission of ray of the light from the point A to the point B
t_B - time indicated on the clock located at the point B at the moment of arrival and reflection of the ray of the light arriving from point A
t^I_A – time indicated on the clock located at point A at the moment of return of the ray of the light reflected at the point B and sent earlier from the point A at moment t_A

The dependence (2) results directly from adding the distance AB calculated for the path of the ray of the light from point A to B:

$$AB = V\,(t_B - t_A) \qquad (3)$$

and this distance calculated along the course of the radius in the opposite direction:

$$BA = V\,(t^I_A - t_B) \qquad (4)$$

Substituting the definition of simultaneity (1) into (3) we obtain as a result indicating AB=BA and adding the sides (3) and (4) we obtain relation (2), where the points A and B are the origins of the Cartesian coordinate system of the stationary (A) (x, y, z) and (B) (x1,y1,z1) where the coordinate axes (x, y, z) and (x1,y1,z1) of both systems are mutually respectively parallel. The speed of light **V** in the stationary system (A) and the moving system (B) remains constant. The author of the paper [1] , denoting $I=r_{AB}$ has specified that, taking into account the principle of the constancy of the speed of light (2nd axiom) the following dependencies are satisfied:

$$t_B - t_A = r_{AB}/(V-v) \qquad (5)$$

and

$$t^I_A - t_B = r_{AB}/(V+v) \qquad (6)$$

where:

v – denotes the speed along the x-axis of the relative movement of the moving system (B) relative to the stationary system (A)
t_A – clock reading at the moment when the ray of light leaves the end A of the rod $r_{AB} = I$
t_B – indication of the clock at the moment when the ray of light reflects from the end B of the rod $r_{AB} = l$
t^I_A – clock reading at the moment when the reflected ray of light returns to the end A of the rod $r_{AB} = l$

It can be noticed that only when v=0, i.e. when the systems A and B do not move with respect to each other, is the definition of simultaneity of evens in a stationary and moving system, previously defined by the equation (1) fulfilled. In any other case where v>0 it can be found that the definition of simultaneity (1) is not fulfilled if the dependencies (5) and (6) given in the paper [1] are correct.

We are verifying whether the above dependencies (5) and (6) from the paper [1] fulfill the axioms 1 and 2, i.e. : what happens to the dependencies (5) and (6) when the coordinate systems A and B move relative to each other in uniform rectilinear motion at a constant speed?

A rod with a length l cannot change its length during translational motion because, according to the axiom 1, 'the principle of relativity', all physical laws in the systems moving relative to each other in uniform translational motion remain not changed. It is therefore not possible to measure, for example, the length of a rod in a stationary coordinate system and then in a moving coordinate system, to conclude that its length has changed, and thus to infer the speed of the moving system relative to the stationary system. All physical laws are indistinguishable in such systems. Therefore, the measuring rod r_{AB} will have the length l in both stationary and moving systems, because the physical laws do not change and are indistinguishable in two coordinate systems moving uniformly and rectilinearly relative to each other. Therefore, in equations (5) and (6) $r_{AB} = l$ should be placed. Furthermore, based on the of axiom 2 concerning 'constancy of the speed of light', the speed of light at which we measure the length of this rod l does not add the translational speed of the rod itself, because otherwise the principle of constancy of the speed of the light would be infringed and a speed greater than the speed of light (V+v) could occur, which contradicts the principle of constancy of speed of light.

The time t_B on the clock at the point B on the rod r_{AB} , will be the time indicated on the clock at the point A on the rod increased by the time needed for light to travel the distance $r_{AB} = l$, and therefore equals r_{AB}/V regardless of whether the rod is moving or not.

The speed of light is independent of the speed at which the source of the light is moving. The rod l measured using light will have the same length expressed in meters or seconds to travel from one end to the other, and therefore the equation (5) will have the correct notation.

$$t_B - t_A = l / V \qquad (5^1)$$

Likewise, when determining the time required for a ray of light to return to the point A after reflecting from its and B. The time needed for the return of the reflected ray from its and B to its beginning A will be the time indicated on the clock located at the point B, increased by the time needed for the light to travel the distance l at the speed V of light, which is independent of whether the point B is moving or not. Therefore, the correct notation of the equation (6) is as follows:

$$t^{I}_{A} - t_{B} = l/V \qquad (6^{1})$$

A comparison of the equations (5^1) and (6^1) thus corrected shows that the definition of simultaneity of evens in a stationary and moving system is fulfilled, which means that the time flows at the same rate in both a moving and stationary system. We obtain the same dependencies regardless of the choice of movement along the x-axis, y-axis, or z- axis. The choice of direction of movement is arbitrary.

Considerations concerning the simultaneity of evens were deemed particularly important and were cited in [2] ,however their evaluation was omitted. The considerations presented in [1] and [2] on the rate of time increase in a moving and stationary system are described in a comparative manner in [3], chapter 15-4, entitled "Time Transformation". The authors [3] compared the time indicated by two identical clocks placed respectively: one in a stationary coordinate system and the other in a moving coordinate system, moving relative to the first in a uniform motion at a constant speed **v** along the X-axis of a rectangular coordinate system. The clock is a rod (a one meter ruler) equipped with a light source and a mirror at one end, and a mirror at the other end. If a light signal is sent from the source along the rod, it will travel back and forth between the mirrors placed at its ands, whereas each time it reaches the lower mirror, we will hear crack, just like in a regular clock. Two identical clocks are synchronized and positioned (one along the Y-axis of the stationary coordinate system, the other along the Y^I –axis of the moving coordinate system) perpendicular to the direction of the movement (along the axis X and X^I). An observer in a moving vehicle (coordinate system X^I , Y^I) does not notice anything particular. However, according to the axiom 1, the clocks in bath coordinate systems operate in an identical manner and measure time at the same speed, and it is impossible to determine which clock is moving and at what speed based on the readings of either cock. Meanwhile , an observer outside the moving coordinate system perceives that the light in the moving clock leaves a light trace along a zigzag line from the lower mirror to the upper as the meter-long rod of the moving clock moves along the X-axis at the speed of **v**. It is difficult to agree with the authors statement in [3], that the light ray from the moving clock moves along a zigzag line visible to an observer in a stationary system at the speed of light **V**. This is not case. The ray from the moving clock is always directed along the Y^I- axis, and the zigzag line is generated by the trace of this ray as a result of its source being additionally moved along the X-axis. The zigzag line is the resultant (superposition) of the mutually perpendicular speed vectors, namely the speed vector **V**, in the direction of the Y^I –axis and the speed vector **v** oriented along the direction of the X and X^I axes, describing the relative mutual speed of movement of the two systems of reference (moving and stationary). It is not possible to justify that the geometric sum of these two speeds is the speed of light **V**. According to the axiom 2, the speed of light in a moving system is not added to the speed of movement of the source of that light, since if this were not case, it would mean that it is possible to reach a speed greater than the speed of light. Moving at speed **V** along the Y^I –axis of a moving system of reference, the light ray hits the X^I –axis (lower mirror) at exactly the same moment as a ray moving at the speed of light **V** along the Y-axis in the stationary system of reference hits the X-axis, which means that time flows at the same speed in both the stationary and moving system of reference. The construction and principle of operation of the clock used in [3] are also described in detail in the paper [4]. The paper [4] also indicates that the zigzag trace left by the light ray from moving clock, visible to an observer in a stationary system, enables that the observer to measure the distance between the light source in the moving clock and the trace of its arrival, and thus to determine the speed of propagation of the moving system relative to the stationary one.

In this paper, though, I would like to highlight another significant and important detail. In the paper [4] the correct path of a light ray in a moving system is shown as being parallel to Y^I –axis of the system. The light ray moves exactly along the direction of the Y^I –axis at the speed of light **V**, which visually confirmed by the observer situated in the moving system. The zigzag trace visible to the stationary observer is not the path of this light ray in tee moving system, but its projection (trace) resulting from the superposition of the light ray in a moving clock, visible in the stationary system, moving constantly along the Y^I –axis and simultaneously shifted along the X^I-axis. Should the moving system suddenly stop at **v=0**, then the path ray in the stationary and moving systems would be identical (synchronized clocks), and when one of the systems starts moving again at a constant speed **v>0**, again, for the stationary observer, the image line in the moving clock would be visible as an inclined line with an angle of inclination that increased with the speed **v**. This has no significance for counting successive pulses in the clock, because the counting take place when the light ray reaches the lower mirror. The fact the light ray moves along Y^I direction at the speed of **V** indicates that time in a moving and stationary systems flows at the same speed, because in a stationary system the light ray also moves along the Y axis at the speed of light **V.** Therefore, the considerations presented in the papers [1,2,3,4] concerning the propagation of the light in systems for measuring the passage of time, taking into account two axioms:

- The laws governing changes in state of a physical system are independent of which coordinate system in uniform motion they apply to.
- A light ray in a 'stationary' coordinate system at a specific constant speed, regardless of whether it is emitted by a stationary or moving light source,

Leading to the same conclusion, namely that time in inertial coordinate systems flows at the same speed.

ADDITIONAL FINAL NOTE.

When considering the relativity of motion, it is necessary to take into account which coordinate system can be considered stationary and which can be considered moving, because in the case of a system with an electric charge, we are always able to determine whether the system is moving in the space under consideration or not. In this case, the determining factor is whether the system generates a magnetic field around itself during its movement. As is known, only moving charged particles generate a magnetic field around themselves. By contrast, when moving around a stationary electric charge with a magnetic field meter, we will not detect a magnetic field in the vicinity of that charge.

SUMMARY

Time measured in inertial systems is independent of the system of reference, i.e. of space. Time in all physical, inertial systems of reference increases at the same rate.

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