TIME DILATION IN FOURTH SPATIAL DIMENSION

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ABSTRACT

Time dilation can be inferred from the invariance of the speed of light in different reference frames. This paper presents an alternative derivation of time dilation. We introduce a fourth spatial dimension, other than the three accessible dimensions. This paper explains how the period of evolution of any physical phenomenon is affected by the motion of a body in accessible three dimensions.

Keywords Four dimensions · Fourth spatial dimension · Time · Time dilation

1 Definitions and abbreviations

Hyperbody: Any four-dimensional body lying in four-dimensional space.

Hyperfluid: The space we are accessible to is a three-dimensional cross-section of a four-dimensional hyperspace. This hyperspace is a four-dimensional incompressible fluid known as hyperfluid.

x-axis, y-axis and z-axis: Axis of three accessible dimensions.

w-axis: Axis of fourth spatial dimension.

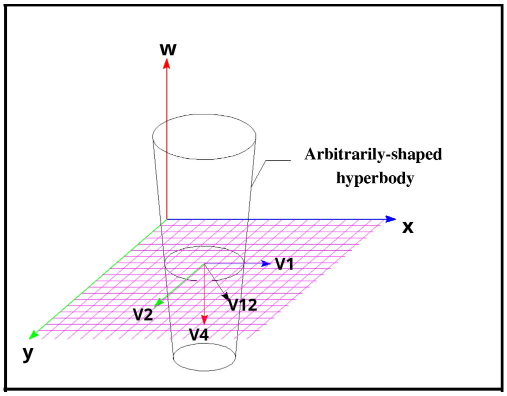
2 Introduction

Special Relativity explains time dilation as the slowing down of a clock as determined by an observer in relative motion with respect to the clock. Time dilation can be derived from invariance of speed of light in different reference frames. Experiments like Michelson and Morley's experiments [1] and Kennedy Thorndike's [2] are often claimed to be the verification of this idea. However, these experiments do not directly test the one-way speed of light. Guided wave measurement [3] of the one-way speed of light and test of the isotropy [4] of the one-way speed of light are the tests that fail to detect the one-way speed of light due to problems with clock synchronization [5]. This thesis contains an alternative explanation of time dilation based on the interpretation of existence of four spatial dimensions. Quantum Hall Effect [6], and Bullet Cluster Experiment [7] are two significant experiments that depicts the existence of a fourth spatial dimension. This theory explains variance in the time period of a system as the result of the motion of the hyperbody in the fourth spatial dimension. Similarly, by using the dynamics of hyperbodies in four dimensions, time dilation formulae are derived.

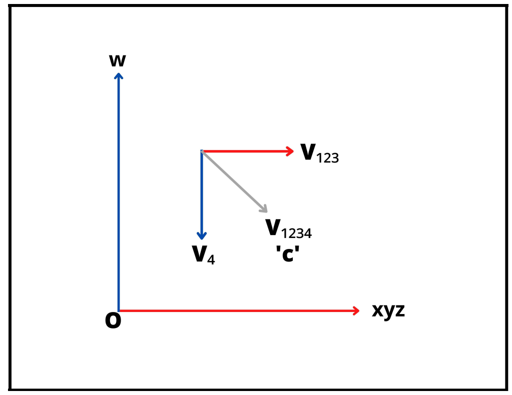
3 Postulates

We have access to three spatial dimensions. Other than forward-backward, left-right, and up-down that we have access to, a fourth spatial dimension exists. All three-dimensional bodies we observe are a three-dimensional cross-section of a four-dimensional hyperbody. Similarly, the space that we perceive is a three-dimensional cross-section of a four dimensional hyperfluid. Hyperbodies are continuously in motion, and the four-dimensional resultant speed of a hyperbody is a constant, c i.e., speed of light in a vaccum. Whatever the speed of a body in three dimensions, the resultant four-dimensional speed is constant. Thus, All the changes in the Motion of a body that we observe in three-dimensional space are mere changes in the direction of its four-dimensional hyperbody.

Time is the evolution of physical change. Physical changes refer to all the physical processes, either oscillation of pendulum or the excitation of atom's electron or any biological process. The time elapsed with any physical change is directly proportional to the speed of its hyperbody in the fourth dimension.



(a) Three-dimensional cross-section of an arbitrarily shaped hyperbody.



(b) Four-dimensional resultant of two velocity vectors.

Figure 1: three-dimensional interpretation of dynamics of four-dimensional hyperbody.

4 Developing intuition for 4D

Before starting any discussion or interpretation of this theory, one must understand a few things about the fourth dimension and its dynamics. The idea of fourth spatial dimension was first suggested by Gunnar Nordstorm in 1914. A few years later, Theodor Kaluza unified general relativity with electromagnetism [8] by using four spatial dimensions and one temporal dimension. The fourth dimension is an extension of three-dimensional space [9]. Our brain can only perceive things in a maximum of three dimensions, which makes it impossible to imagine four-dimensional objects or any four-dimensional mechanism. To develop an intuition for four dimensions, we can replace one of our three accessible dimensions with the fourth dimension. This will help us interpret four-dimensional phenomena as three-dimensional process.

4.1 Dimension and dynamics of hyperbody

This theory is based on the existence of extra spatial dimension. All the objects we observe in a three-dimensional space are a three-dimensional cross-section of a four-dimensional hyperbody. The hyperbodies are capable of moving in any direction in four dimensions. So, a body can be at rest in one dimension while in motion in the other three dimensions. Similarly, a body can be moving in one dimension while resting in the other three dimensions. For instance, when you see an apple at rest on your study table, it can be in motion in the fourth dimension. If so, the apple moves perpendicular to x, y and z-axis.

The four-dimensional speed of the hyperbodies is constant c, i.e., the speed of light. As the four-dimensional resultant rate is known, we can sort out the speed at which a hyperbody travels in the fourth dimension by using the resultant velocity in three dimensions. Thus, when you see an apple at rest on your study table, it is moving at the speed of light in the fourth dimension with its direction perpendicular to the axes of the other three dimensions.

5 Varying Speed of hyperbodies

The theory specifies that the resultant speed of any hyperbody in four dimensions is a constant, c. Thus, the motion of hyperbodies in three accessible dimensions affects its speed in the fourth dimension. The faster a body moves in three dimensions, the slower it moves in the fourth dimension and vice versa. Therefore, A body at rest in three-dimensional space is moving at its maximum speed, c in the fourth dimension.

Figure 1 is a three-dimensional interpretation of four-dimensional phenomenon. This is done by replacing one of three perceivable dimensions with a fourth dimension where hyperbody moving in four dimensions is represented by a three-dimensional body.

In Figure 1b, xyz and w represents the axes of a two-dimensional plane. xyz is in the direction of the resultant velocity of a hyperbody in three accessible dimensions. w is the axis of the fourth dimension. v_{123} is a three-dimensional resultant velocity of a body. Similarly, v_4 is the velocity in the fourth dimension, and v_{1234} is the resultant velocity of the four dimensions. We have, v_{1234} is always equal to c. Thus, v_4 varies with v_{123} such that v_{1234} remains constant.here,

$$v_{1234}^2 = v_{123}^2 + v_4^2 \tag{1}$$
$$v_4^2 = v_{1234}^2 - v_{123}^2 \tag{2}$$
$$v_4 = c\sqrt{1 - \frac{v_{123}^2}{c^2}} \tag{3}$$

When resultant velocity of three dimensions, v_{123} is written as v,

$$v_4 = c\sqrt{1 - \frac{v^2}{c^2}} \tag{4}$$

Equation 4 is the expression of how v_4 changes with varying v_{123}, i.e., resultant velocity of three dimensions.

From Equation 4,

$$v_4 = \frac{c}{\gamma} \tag{5}$$

where, γ is the mathematical equivalent of Lorrentz factor [10].

$$\left(\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}\right) \tag{6}$$

When the body is at rest in three dimensions, Equation 4 turns to be,

$$v_{4_0} = c\sqrt{1 - \frac{0^2}{c^2}} \tag{7}$$

where, v_{4_0} is the velocity in the fourth dimension when a body is at rest in three accessible dimensions.

$$v_{4_0} = c \tag{8}$$

where v_{4_0} is the velocity of hyperbody in fourth dimension when at rest in other three dimensions.

Substituting Equation 8 in Equation 5,

$$v_4 = \frac{v_{4_0}}{\gamma} \tag{9}$$

$$\frac{v_{4_0}}{v_4} = \gamma \tag{10}$$

6 Time dilation

Time dilation is the slowing down of any physical change due to the motion of a system in three-dimensional space. It happens as the result of a consequent change in the speed of its hyperbody in the fourth spatial dimension. Physical change stands for all different physical processes, from microscopic phenomena like the excitation of an atom's electron to astronomical phenomena like the revolution of a planet around its star.

From the postulate, the time elapsed with any physical change in a body is directly proportional to the speed of its hyperbody in fourth dimension. Let T_0 be the time measured by a system moving at velocity v in three dimensions and T be the time measured by a system at rest in three accessible dimensions.

Due to proportionality,

$$\frac{T}{T_0} = \frac{v_{4_0}}{v_4} \tag{11}$$

$$\frac{T}{T_0} = \gamma \tag{12}$$

$$T = \frac{T_0}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{13}$$

Equation 13 is the expression of time dilation in terms of three-dimensional resultant velocity of body.

7 Conclusion

This paper begins by noting that the time dilation can be alternatively explained based on the hypothesis of the existence of a fourth spatial dimension. As this paper has shown, Time dilation can be interpreted as the consequence of the constant speed of hyperbodies in four dimensions. We have derived formulae for time dilation that do not require the assumption of invariance of the speed of light in all reference frames. Also, we presented how motion in our three accessible dimensions affects the motion in the fourth spatial dimension.

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