Derivation of Time Dilation using the Time Spatial Dimension Vector

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Abstract: Modern physics primarily focuses on time in the durational context which we, as humans, are very familiar with and has been historically useful from an evolutionary perspective. However, this experiential bias of durational time may be misleading when trying to uncover the true nature of time and the relationship between the quantum and relativistic aspects of our universe. Here we will discuss time as a spatial dimension through a simple derivation of the time dilation equation utilizing simple conversions of time to a spatial dimension to highlight a new understanding of time.

Key Words: Time dilation, time spatial dimension, infinity, 4D vector

Introduction:

Time as a spatial dimension discussed herein is characterized by the distance vector between an observer and a light barrier resulting from localized radially symmetric acceleration such as gravity at the observer. On a universal level, the time spatial dimension can be characterized by using Hubble's constant as the acceleration associated with the mass of matter which produces the light horizon of our universe. In that case, the time spatial dimension of our universe is the vector distance to the Hubble Horizon as discussed in our previous publication.[1] The connection of gravity and acceleration will not be discussed herein but is important in overall understanding the concept of time and its spatial qualities. Herein, we will discuss the relationship of time and space in reference to light horizons and geometric relationships such as the Pythagorean theorem. Note that the terminology of vectors and dimensions will be used interchangeably here as they are the same concept from two different perspectives and are important for various aspects of understanding the relationship between dimensions in a simple way.

Physical Assumptions, Explanations and Mathematics:

If we want to find a directional dimension vector, d, in 3D space we can utilize the Pythagorean Theorem with regards to x, y and z:

$$d^2 = x^2 + y^2 + z^2 \quad (1)$$

If we consider the linear time spatial dimension vector, d_t, as an additional dimension to 3D space (but represented as the radial distance to a localized light horizon within the x, y, z space), we can create a Euclidean spacetime distance vector dimension, S, which takes both 1D linear time and 3D space into account (2):

$$S^2 = d_t^2 + x^2 + y^2 + z^2 \quad (2)$$

The relationship in (2) is depicted in Figure 1 where we can see the x, y, z axes at different moments in time which create time dimension vector, d_t, and the spacetime dimension vector, S, which takes all motion through space and time into account. As depicted in Figure 1, we can simplify by substituting (1) into (2) to get (3):

$$S^2 = d_t^2 + d^2 \quad (3)$$

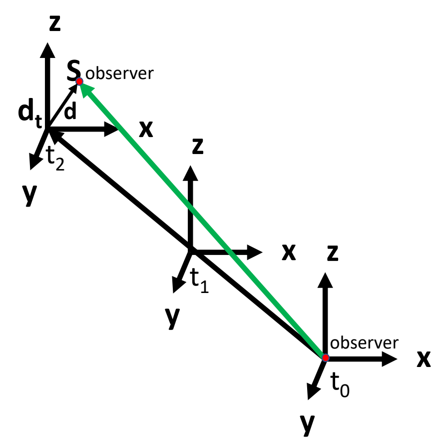

Figure 1: Visualization of the time dimension, d_t, in relation to z, y and z and the resulting spacetime vector, S.

Now let's consider the durational time relationships of the individual variables. We are familiar with the simple kinetic equation (4) for 3D space vector, d:

$$d = t'v \quad (4)$$

Note that v is the observer's velocity in spacetime and t' is durational time unaffected by motion in spacetime which we will call 'normal time' (put another way, t' is independent of local relative changes in the time spatial dimension vector, d_t). Note that since the directional dimension vector, d, is a 1D dimension itself, it only exists in a system when the observer has a velocity relative to its origin in space; however, t', exists regardless in spacetime (this is not necessarily the case for timespace when time takes on a 3D character of its own, this is discussed in my other publications). By contrast, the linear time dimension vector, d_t, exists regardless of observer local velocity, and corresponds to equation (5):

$$d_t = \tau c \quad (5)$$

A dimension defined by the product of light speed motion, c, and a time component, τ, which is the durational component of the time spatial dimension vector, which we will call 'distortion time'. We can think of the time spatial dimension as being the quantized distance between a given number of moments of time, the relationship of the Planck time, l_t, to the Planck length, l_p, on the macro-scale:

$$l_p = l_t c \quad (6)$$

The linear spacetime dimension vector, S, is the product of the constants in space, t', and in time, c:

$$S = t'c \quad (7)$$

Note that S is unaffected by local motion since it represents the distance to the local light horizon via the speed of light for a given time, t'. By substituting (4), (5) and (7) into (3) we can get (8):

$$(t'c)^2 = (\tau c)^2 + (t'v)^2 \quad (8)$$

Subtracting each side by the 3D term yields (9):

$$t'(c^2 - v^2) = (\tau c)^2 \quad (9)$$

Further rearrangement yields (10):

$$t'\sqrt{[1-v^2/c^2]} = \tau \quad (10)$$

We can see that (10) is in fact the time-dilation equation where we can see that the durational component of the time spatial dimension vector, the distortion time, τ, ends up being what we typically think of as the dilated time. The normal time, t', is in fact the stationary time as expected, which does not change relative to local changes in the observer's velocity. Note that as the time spatial dimension vector, d_t, shrinks, distortion time is dilated/slowed via (5). If we apply (5) and (7) to (10) we get the length dilation equation (11):

$$S\sqrt{[1-v^2/c^2]} = d_t \quad (11)$$

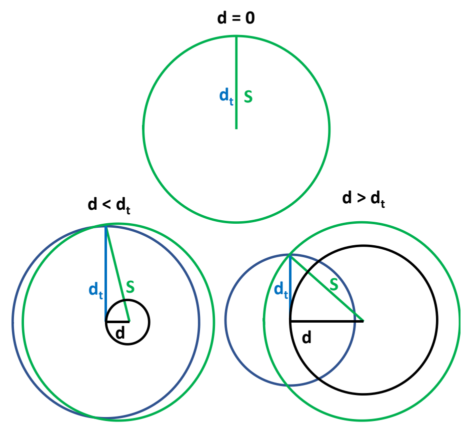

Figure 2: Relationship of the three spatial dimensions and their light horizons

Thus, giving us the relationship between observer velocity, v, the 4D spacetime vector, S, and the time spatial dimension vector, d_t.

In this model, we think of any distance in space or time to be a spatial dimension vector which can be denoted in terms of distance or duration. Therefore, time dilation can be thought of as arising from the formation of a new spatial dimension, d, which is 90° to the more universal and fixed time spatial dimension, d_t, which is always present in our universe and is represented physically as radially symmetric to any given position in 3D space with its 'physical' distance being the distance to the light horizon in a given duration of time. In order to traverse the time spatial dimension (the experience of durational time) we must take into consideration the 90° displaced new spatial dimension; therefore, we move along the hypotenuse between the two spatial dimensions, S, as depicted in Figure 2.

Conclusion:

Through the quantization of time into a spatial dimension and realization of its geometric relationship to space, we can generate simple equations which can reproduce the time-dilation equation using simple algebra. Interesting connections between local and universal light barriers become important factors in this quantization and give rise to simple and elegant relationships of time and space.

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[1] Lesel, B., The Geometry of Space and Time, *viXra*, **2020**. URL: https://vixra.org/abs/2002.0539