International Journal of
Science and Engineering Investigations
vol. 10, issue 113, June 2021
Received on June 11, 2021
ISSN: 2251-8843

Gravity Visualized through the Field of Reference Frames Approach

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***Abstract*-**Einstein's special theory of relativity, describes a fabric of space-time in which the speed of light is the same for all observers regardless on their inertial frame of reference (might also be referred to as reference frame or frame of reference). Based on that assumption, Einstein concluded in his special theory of relativity that two observers in two separate frames of reference will measure a difference in the flow of time, in length and in the exact time that events occur (relativity of simultaneity). A new approach that will enable to visualize the structure of this unique fabric of space - time in a single four dimensional (4D) space – time image, will be the key to unify gravity with the quantum world.

Keywords- *Reference Frame, Relativity, Gravity*

I. Introduction

Let us try to visualize the twin's paradox [1] scenario. Twin A stays in his original reference frame A for a proper time sequence of t while his twin brother B leaves reference frame A and travels during that same time through reference frames B and C until they meet again at reference frame A. Although the symmetrical relativistic relationship between all the reference frames, twin B will age slower than twin A, just because he did not stay the entire time in his original reference frame A. This is the main difference between the twin brothers. The only way to visualize this non intuitive result while keeping a symmetrical approach, is to visualize a field of different symmetrical reference frames in which, each reference frame behaves like a different space time dimension and each observer will age symmetrically the same like all the other observers in all the other dimensions as long as he never leaves his own frame of reference (his space - time dimension) .In order to visualize in one symmetrical image a field of reference frames (can be referred to as reference frames field or frame of reference field), we need to go one bold step ahead and suggest that the fabric of space-time is quantized into local space time units ,and add an extra four dimensional (4D), non-local (not quantized) grid like dimension (grid dimension) between these 4D quantized local space–time units. Based on these new assumptions, we can visualize the fabric of space as a field of quantized (discrete) reference frames staggered together (figure 1, 2&3) and a field of discrete time lines (arrows of time) that lead through the field of reference frames as it evolves with time [figures 4 and 5]. The proper quantized units for space time as measured by a standing still observer in each reference frame, are Planck's length and Planck's time, since these are the limits to our physical understanding of space-time [2]. Light will always travel one unit of quantized space in the size of Planck length for each pulse of Planck time in all the reference frames. This explains why light travels always at the same speed of light in all reference frames, why nothing can travel faster than light and why we cannot define physical behavior in scales smaller than Planck length and Planck time. Between these local quantized space time units lays an extra 4D (space and time) non local grid like dimension (or dimensions) connecting these quantized units of space-time together. The non-local grid dimension connects in space and time between the quantized units of each reference frame and between the different reference frames in the reference frames field. Using this new approach enables to visualize multiple reference frame dimensions (the "reference frame field"), staggered together in the grid dimension (figures 1, 2 &3). When an observer in reference frame A will observe Planck length or Planck time measurements done by an observer in reference frame B he will not agree with the measurement results (due to length contraction and time dilation) and vice versa. The farther these reference frames (A&B) are from one another in the reference frame field, the larger will be the disagreement between them on these basic measurements. This enables us to visualize and illustrate a 4D structure in space-time (based on figure 1, 2 & 3) which obeys to Einstein's special theory of relativity.

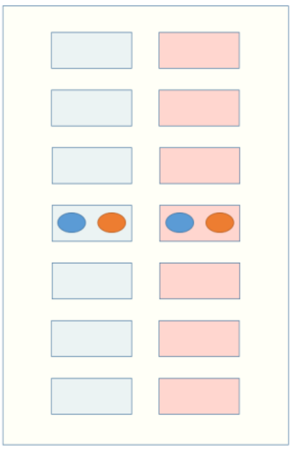

Figure 1. at t_0 , a 2D illustration of a small region in the quantized field of reference frames ,where A (blue color) , B (red color) represent only two out of the multiple parallel reference frames, staggered next to each other, in the staggered field of reference frames, at t=0.

In figure 1, A&B represent a different relative velocity in the vertical Y axis direction and they are staggered together in the non-local grid dimension. Each rectangle represents a 3D Planck sized quantized unit of space, and the grid dimension (or dimensions) is the bright yellow colored grid like space between them. Observers A which is at rest in reference frame A (blue circle) & B which is at rest in reference frame B (red circle) cannot measure directly the extra non local grid dimension since it is not part of the reference frames field. The grid dimension is the mediator between the reference frames and the mediator between the quantized units that build each one of reference frames. The quantized local units of space are probably not a cube, but rather a symmetric spherical shaped space, floating, rotating, vibrating and moving around in the surrounding grid dimension. The existence of the non-local grid dimension can be measured indirectly by the measurements of non-local quantum phenomena's like the "spooky action at a distance" of quantum entanglement [3] or by the Casimir effect [٤] due to virtual particles that pop in and out of existence from the grid dimension. If the grid dimension is the Higgs field than the Higgs boson is a direct measured evidence to this extra non local grid dimension. The extra grid dimension (or dimensions) can be also the source for the mysterious dark matter and dark energy.

In figure 2, Observer A at reference frame A is standing still while observer B at reference frame A is moving one step of Planck length downwards in the figure. The opposite symmetrical mirror effect happens at reference frame B where observer B is standing still while observer A at reference frame B is moving one step of Planck length upwards in the figure.

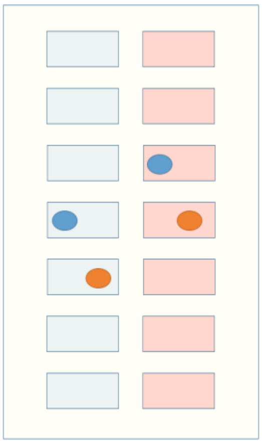

Figure 2. at $\boldsymbol{t_1}$ **,** after a discrete number of Planck time pulses, observers A & B are moving relative to each other.

In figure 3, the fact that observer A and observer B are standing still in their original reference frame means that there is no acceleration force applied and they did not leave their original reference frame during the entire time sequence from t_0 till $\boldsymbol{t_2}$**.**

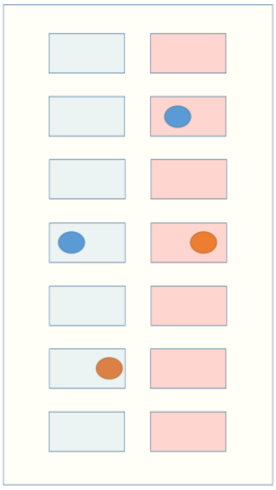

Figure 3. at $\boldsymbol{t_2}$ after another discrete number of Planck time units A & B are moving relative to each other one more step of Planck length as described in figure 2.

II. Explaining Gravity Through the Reference Frame Field Model

Einstein's special relativity theory is based on the fact that each observer has his own reference frame in which he is not moving, with his own proper time relevant to his reference frame. In order to move from one reference frame to the next the observer needs to accelerate. Einstein's general relativity theory defines an equivalence principle between acceleration and gravity. This equivalence principal leads to a model in which gravity is a curvature in the arrow of time direction (the field of time lines), through the staggered field of reference frames. At empty space without any gravitational effect or acceleration, the arrow of time (field of time lines)will lead the observer to stay always in his own reference frame for every pulse of the Planck time (figure 4),which means that the field of time lines is parallel to the field of reference frames.

In figure 4, the time line field illustrated by the gray arrows of time, stays parallel to the field of reference frames illustrated by the blue vertical lines. Each observer stays in its own frame of reference (reference frame), as the arrow of time advances through space time (a parallel structure). If they will not apply force and accelerate, Alice will stay at reference frame A and Bob will stay at reference frame E through their entire journey through space and time. The grid dimension is illustrated as the bright yellow colored space between the one dimensional reference frame field lines and the field of time lines (arrows of time). The grid non local dimension separates between the reference frames and serves as a mediator between them. This illustration of a symmetrical staggered field of reference frames can be achieved due to the assumption that space-time is quantized and there is unlimited, non-local new grid like space between the quantized space units. This paper refers to the non-local space as the grid dimension. Although the arrow of time is illustrated as a continuous line it is quantized into units in the size of Planck time.

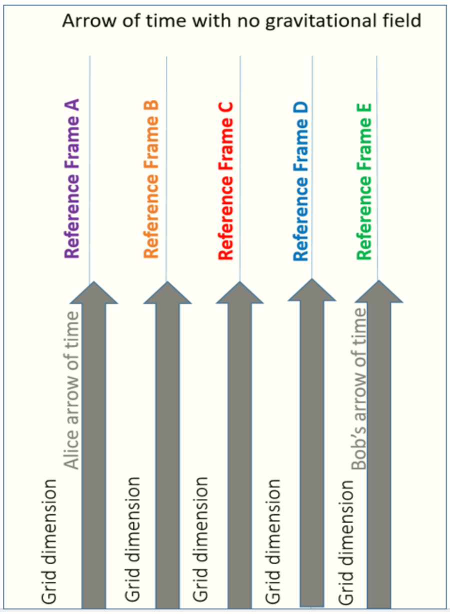

Figure 4. This illustration represents one dimensional staggered field of reference frames (A to E) in empty space with no gravitational effect and no acceleration.

When gravity is applied, the field of time lines (arrows of time) will seize to be parallel to the field of reference frames and the observer will start travelling as time elapses, from one reference frame to the next (figure 5) without applying any force. This tilt in the arrow of time from the parallel direction is the curvature of space time in General Relativity and it can be measured through the gravitational time dilation.

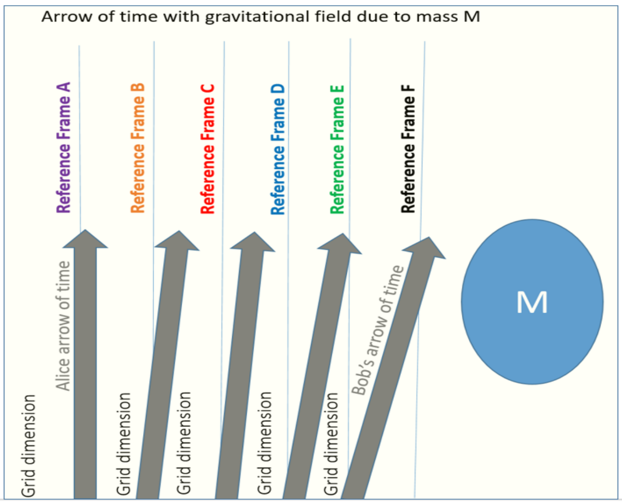

Figure 5. The same illustration of the one dimensional reference frame field, as in figure 4, but now with the gravitational effect, due to mass M, the arrow of time field loses its parallel behavior (becomes a non-parallel structure).

In figure 5, as the gravitational field increases the non-parallel behavior increases and the observer moves in an increasing rate from one reference frame to the next as the arrow of time advances through space time .The movement from one reference frame to the next as the arrow of time advances is the equivalent behavior of acceleration (the Einstein equivalence principle).Since Bob is closer to mass M than Alice, he experiences a stronger tilt from the parallel structure in the direction of the arrow of time (curvature in space-time) and he experiences a stronger time dilation effect and will seem to accelerate and age slower when observed from Alice point of view.

III. Conclusion

Albert Einstein's special theory of relativity requires that light will travel at the same constant speed for all observers, even if they are in different frames of reference, relative to one another. Due to this constant speed of light requirement, each observer has his own proper time. There is no proper universal symmetrical visualization representing the point of view of all the possible frames of reference in one four dimensional (4D) symmetrical space time image. Any standard 4D image will represent always the point of view of only one specific frame of reference and will lose its symmetrical approach. This paper suggests that space time should be visualized in a new approach, as a symmetrical quantized mosaic structure of multiple reference frames (dimensions), staggered one next to the other (the reference frame field) adding an extra non-local (not quantized) four dimensional (space-time) grid dimension in the space-time region between them. With no gravity, the time line field (the arrow of time) will be in a parallel direction with the field of reference frames, to keep the observer within his reference frame (within his own space –time dimension) throughout his journey through time in the reference frame field. When gravity is applied due to matter, energy, momentum or pressure, the arrow of time is tilted from its parallel condition towards the gravitational source leading the observer from one reference frame to the next as time elapses (curvature of space – time). As the observer's distance from the gravitational source decreases the angle of the tilt in the arrow of time increases. As the angle of the tilt in the arrow of time increases the time dilation increases (time runs slower).The Einstein field equations describe how matter energy, momentum and pressure tilt (or in another words, curve) the arrow of time field relative to the reference frame field. The tilt (or in another words, curvature) in the arrow of time relative to the field of reference frames, tell matter how to move from one reference frame to the next. Since applying an accelerating force also changes the reference frame as time elapses we can apply Einstein's equivalence principle between gravity and acceleration. This new concept, connecting the Planck length to gravity, and adding an extra non local grid like dimension (or dimensions) enables a symmetrical visualization of the special and general theory of relativity. The non - local grid dimension can explain the non - local behavior of quantum mechanics like quantum entanglement, quantum tunneling, the Pauli Exclusion Principle and the Schrodinger's wave function instantaneous collapse when measurements are applied. The local (in space and time) four dimensions of quantized space – time units and the non-local (in space and time) grid dimension [5] can be the five dimensions in the Kaluza-Klein theory [6], Instead of the suggested local curled Calabi Yau shaped extra dimensions [7].

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How to Cite this Article:

Sinbar, E. (2021). Gravity Visualized through the Field of Reference Frames Approach. International Journal of Science and Engineering Investigations (IJSEI), 10(113), 30-33. http://www.ijsei.com/papers/ijsei-1011321-05.pdf