Physical Science International Journal

24(12): 10-38, 2020; Article no.PSIJ.63757

ISSN: 2348-0130

Re-interpretation of the Two-World Background of Special Relativity as Four-World Background

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/PSIJ/2020/v24i1230229

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Complete Peer review History: http://www.sdiarticle4.com/review-history/63757

Received 20 October 2020

Accepted 25 December 2020

Published 31 December 2020

Original Research Article

ABSTRACT

The appropriate placements of the four-dimensional spacetimes of different universes make their coexistence possible, such that corresponding points in spacetimes within the universes are not separated in space or time. The corresponding points do not touch, because they are points in separate spacetimes. The different universes are described heuristically as existing in separate spacetime 'compartments'. This new conception of many worlds (or universes) is therefore entitled compartment worlds (or universes) in this article. Compartment universes is a potential platform for many-world interpretations and uniform formulation of the natural laws. The two-world background of the special theory of relativity (SR) (involving two compartment universes), demonstrated elsewhere, is re-interpreted as four-world background (involving four compartment universes) in this article.

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Keywords: Compartment universes; four-world picture; positive and negative universes; positive and negative time-universes; origin of intrinsic spacetime; origin of intrinsic mass.

1 INTRODUCTION

A new concept of many worlds (or universes) in which different four-dimensional spacetimes of other universes coexist with the four-dimensional spacetime of our universe, started with a pair of such universes in [1, 2], is further extended in this paper. The appropriate relative placements of the four-dimensional spacetimes of different universes make their coexistence at the same point possible. This means that corresponding (or symmetry-partner) points in the different spacetimes of the universes are effectively not separated in space or time, but they do not touch, because they are points in different spacetimes. Coexisting universes in separate four-dimensional spacetimes (or separate spacetime 'compartments') is entitled compartment universes in this paper.

The problem of placing the four-dimensional spacetimes of immense extents of coexisting different universes must have made the conception of compartment universes impossible until now. Moreover a theory that could furnish the four-dimensional spacetimes of coexisting universes and describe their relative placements has eluded investigation in physics until now.

The pair of compartments universes, referred to as our (or positive) universe and negative universe, shown to constitute two-world background for the special theory of relativity (SR) in each universe in previous papers [1, 2], have coexisting four-dimensional spacetimes of equal extents, which are four-dimensional inversions of each other and are separated by event horizon. Particles and bodies are symmetrically distributed in the two universes and the two universes exhibit perfect symmetry of natural laws, as demonstrated in [2].

The multiverse of inflationary cosmology, Linde and Vachurin [3]; Buosso and Susskind [4]; Deutsche [5]; Aguirre and Tegmark [6] and others, can have dimensions of different extents and accommodate different laws. They are not compartment universes. The parallel branes of the string theory can have different number of dimensions of different extents and accommodate different laws, Maartens and Koyama [7]. They are not compartment universes either. The many worlds of many-world interpretation of quantum mechanics, Everett [8]; Wheeler [9]; DeWitt [10, 11]; Kent [12] and others.

The two-world background of SR demonstrated by reformulating SR on the spacetime hyperplane of combined flat spacetimes of our (or positive) universe and negative universe, in each of the two universes in [1, 2], is re-interpreted as four-world background in this paper. A new pair of four-dimensional spacetimes that lie 'orthogonal' to the spacetimes of our (or positive) universe and the negative universe, is derived by a simple and brief geometrical procedure. The universes associated with the new pair of spacetimes are appropriately referred to as positive time-universe and negative time-universe.

The isolated four coexisting universes in separate spacetimes in this paper and the previous papers [1, 2] namely, our (or positive) universe, negative universe, positive time-universe and negative time-universe, have four-dimensional spacetimes of equal extents. Material particles and bodies are symmetrically distributed in them, as demonstrated in this paper. Thus the number of compartments universes has been increased to four in this paper.

The two-dimensional intrinsic spacetime containing intrinsic masses of particles and bodies, which underlies (or is embedded in) the four-dimensional spacetime containing the masses of particles and bodies, introduced (as *ansatz*) in the two-world picture in [1], is derived in the larger four-world picture in this paper. As the special theory of relativity (SR) with Lorentz transformation (LT) and its inverse, operates on flat four-dimensional spacetime, the intrinsic special theory of relativity (∅SR) with intrinsic Lorentz transformation (∅LT) and its inverse, operates on flat two-dimensional intrinsic spacetime in each universe, as developed in [1].

The new spacetime/intrinsic spacetime geometrical representation of the Lorentz transformation and intrinsic Lorentz transformation, developed in the two-world picture in [1], is shown to be rooted in the four-world picture in this paper. Two outstanding issues about the new geometry in the two-world picture are resolved in the four-world picture in this paper. The definite four-world background of special relativity (or four-world interpretation of the theory) is established in this paper. A less-developed form of a part of this paper has appeared in [13].

2 ISOLATING ANOTHER SPACETIME THAT LIES 'ORTHOGONAL' TO OUR SPACETIME

Let us start with an attempt to compose a pair of three-dimensional Euclidean spaces into one compound flat six-dimensional space with a proviso that the six dimensions of the resulting compound space are mutually orthogonal. Thus let a three-dimensional Euclidean space (Euclidean 3-space) Σ' with mutually orthogonal straight line dimensions, $x^{1\prime}$, $x^{2\prime}$ and $x^{3\prime}$, lie along the horizontal as a hyper-surface and another Euclidean 3-space $\Sigma^{0\prime}$ with mutually orthogonal straight line dimensions, $x^{01\prime}, x^{02\prime}$ and $x^{03\prime}$, lie along the vertical as a hyper-surface, as illustrated in Fig. 1.

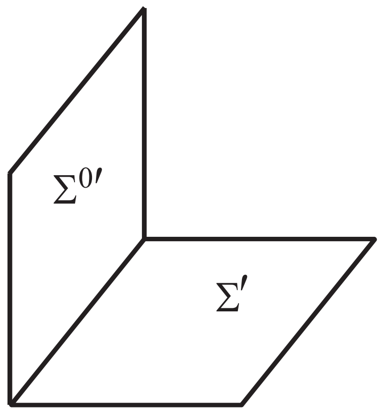

Fig. 1. Co-existing two orthogonal Euclidean 3-spaces (considered as hyper-surfaces)

The Euclidean 3-space $\Sigma^{0\prime}$ shall be described as 'orthogonal' to the Euclidean 3-space Σ'. The union of the two 'orthogonal' Euclidean 3-spaces yields a compound six-dimensional Euclidean space $(\Sigma^{0\prime}, \Sigma')$ with mutually orthogonal straight line dimensions, $x^{01\prime}$, $x^{02\prime}$, $x^{03\prime}$, $x^{1\prime}$, $x^{2\prime}$ and $x^{3\prime}$. The mutual orthogonality of the six dimensions of the two 'orthogonal' Euclidean 3-spaces is provided by the requirement that each dimension $x^{0j\prime}$ of $\Sigma^{0\prime}$; $j = 1, 2, 3$, is orthogonal to every dimension $x^{i\prime}$; $i = 1, 2, 3$ of Σ'. Or $x^{0j\prime} \perp x^{i\prime}$; $i, j = 1, 2, 3$, at every point of the Euclidean 6-space generated.

Now, corresponding to the $x'y'-$ plane of the horizontal Euclidean 3-space Σ' in Fig. 1 is the $x^{0\prime}y^{0\prime}-$plane of the vertical Euclidean 3-space $\Sigma^{0\prime}$. The dimensions, $x^{0\prime}$ and $y^{0\prime}$, of the $x^{0\prime}y^{0\prime}-$plane of $\Sigma^{0\prime}$are both perpendicular to each of the dimensions, x' and y', of Σ', from the condition of the mutual orthogonality of the dimensions of the compound Euclidean 6-spaces above. Hence $x^{0\prime}$ and $y^{0\prime}$ are effectively parallel dimensions, which are normal to the $x'y'-$plane of Σ', with respect to observers in Σ'. (Note that the possibility of either dimension $x^{0\prime}$ or $y^{0\prime}$ lying along the dimension z' of Σ' is ruled out by the condition of the orthogonality of the Euclidean spaces.) This is stated symbolically as

$$x^{0\prime} \perp x' \text{ and } y^{0\prime} \perp x' \; ; \; x^{0\prime} \perp y' \text{ and } y^{0\prime} \perp y' \; \Rightarrow x^{0\prime} || y^{0\prime} \, . \tag{1}$$

Likewise, corresponding to the $x'z'-$plane of Σ' is the $x^{0'}z^{0'}-$plane of $\Sigma^{0'}$. Again the dimensions, $x^{0'}$ and $z^{0'}$, of the $x^{0'}z^{0'}-$plane of $\Sigma^{0'}$ are both perpendicular to each of the dimensions, x' and z', of the $x'z'-$plane of Σ'. Hence $x^{0'}$ and $y^{0'}$ are effectively parallel dimensions, which are normal to the $x'z'-$plane of Σ', with respect to observers in Σ'. That is,

$$x^{0'} \perp x' \text{ and } z^{0'} \perp x' \; ; \; x^{0'} \perp z' \text{ and } z^{0'} \perp z' \;\Rightarrow x^{0'}||z^{0'} . \quad (2)$$

Finally, corresponding to the $y'z'-$plane of Σ' is the $y^{0'}z^{0'}-$plane of $\Sigma^{0'}$. Again the dimensions, $y^{0'}$ and $z^{0'}$, of the $x^{0'}z^{0'}-$plane of $\Sigma^{0'}$are both perpendicular to each of the dimensions, y' and z', of the $y'z'-$ plane of Σ'. Hence $y^{0'}$ and $z^{0'}$ are effectively parallel dimensions, which are normal to the $y'z'-$plane of Σ', with respect to observers in Σ'. That is,

$$y^{0'} \perp y' \text{ and } z^{0'} \perp y' \; ; \; y^{0'} \perp z' \text{ and } z^{0'} \perp z' \;\Rightarrow y^{0'}||z^{0'} . \quad (3)$$

The combination of statements (1), (2) and (3) gives $x^{0'}||y^{0'}||z^{0'}$ with respect to observers in Σ'. This says that the mutually perpendicular dimensions, $x^{0'}$, $y^{0'}$ and $z^{0'}$, of the vertical Euclidean 3-space $\Sigma^{0'}$, with respect to observers in $\Sigma^{0'}$, are parallel dimensions with respect to observers in the horizontal Euclidean 3-space Σ' in Fig. 1.

The parallel dimensions, $x^{0'}$, $y^{0'}$ and $z^{0'}$, constituted by the Euclidean 3-space $\Sigma^{0'}$ with respect to observers in Σ', are collinear along a singular fourth dimension to the Euclidean 3-space Σ'. They thereby constitute a one-dimensional space along the fourth dimensions to the 3-space Σ', to be denoted by $\rho^{0'}$, with respect to observers in Σ'.

Conversely, the mutually perpendicular dimensions, x', y' and z', of Σ', with respect to observers in Σ', are parallel dimensions with respect to observers in $\Sigma^{0'}$. They are collinear along the fourth dimension to the Euclidean 3-space $\Sigma^{0'}$ and thereby constitute a one-dimensional space along the fourth dimensions to the 3-space $\Sigma^{0'}$, to be denoted by ρ', with respect to observers in $\Sigma^{0'}$.

Thus Fig. 1 naturally transforms into the flat four-dimensional space $(\rho^{0'}, \Sigma')$ with respect to observers in Σ', depicted in Fig. 2a and to the flat four-dimensional space $(\rho', \Sigma^{0'})$ with respect to observers in $\Sigma^{0'}$, depicted in Fig. 2b. Representations of the Euclidean 3-spaces Σ' and $\Sigma^{0'}$ (considered as hyper-surfaces) by plane surfaces in Fig. 1, have been changed to representations by lines in Figs. 2a and 2b. This is in line with the practice in the Minkowski diagrams, as shall become obvious in the next diagrams.

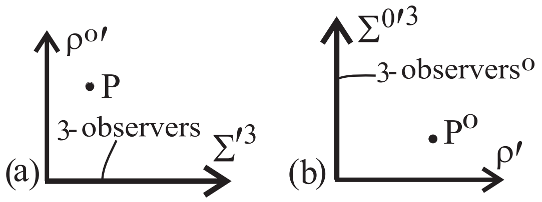

Fig. 2. The vertical and horizontal Euclidean 3-spaces in Fig. 1 are one-dimensional spaces relative to 3-observers in the horizontal Euclidean 3-space and 3-observers in the vertical Euclidean 3-space respectively

The one-dimensional space $\rho^{0'}$ in Fig. 2a has no unique orientation in the Euclidean 3-space $\Sigma^{0'}$ that contracts to it. It therefore has no unique unit vector (or basis) in $\Sigma^{0'}$. It is consequently a scalar one-dimensional space. The one-dimensional space ρ' in Fig. 2b is likewise a scalar one-dimensional space.

Point P in Fig. 2a possesses coordinate $(x^{0'}, x^{1'}, x^{2'}, x^{3'})$; $x^{0'}$ being the coordinate along the one-dimensional scalar space $\rho^{0'}$. The corresponding point P^0 in Fig. 2b possesses coordinate $(x', x^{01'}, x^{02'}, x^{03'})$; x' being the coordinate along the one-dimensional scalar space ρ'.

Now x^0 in the familiar spacetime coordinate notation $(x^{0\prime}, x^{1\prime}, x^{2\prime}, x^{3\prime})$ in the theories of relativity in Fig. 2a is the time coordinate, that is, $x^{0\prime} = ct'$, as known. This means that the scalar one-dimensional space $\rho^{0\prime}$ is the time-dimension ct' relative to observers in the Euclidean 3-space Σ'. The x' in the corresponding coordinate notation $(x', x^{01\prime}, x^{02\prime}, x^{03\prime})$ in Fig. 2b is likewise time coordinate, that is, $x' = ct^{0\prime}$, relative to observers in the Euclidean 3-space $\Sigma^{0\prime}$. Thus the one-dimensional scalar spaces, $\rho^{0\prime}$ and ρ', shall be replaced with the time dimensions ct' and $ct^{0\prime}$ respectively in Figs. 2a and 2b to have the final Figs. 3a and 3b.

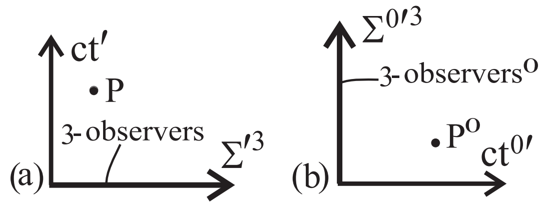

Fig. 3. (a) The scalar one dimensional spaces along the fourth dimensions along the vertical in Fig. 2a and along the horizontal in Fig. 2b are time dimensions relative to the 3-observers in the respective 3-spaces

The flat four-dimensional spacetime in Fig. 3a is our Minkowdki space, as known. Our vast universe is located in this flat spacetime (from the point of view of the special theory of relativity). The flat four-dimensional spacetime in Fig. 3b is the Minkowski space of another universe. The other universe cannot be perceived better than the time dimension ct' of our universe by observers in the three-dimensional Euclidean space Σ' of our universe, as shall be elucidated further later in this paper. It shall be referred to as time-universe in this paper. The curved spacetime of GR is possible within the time-universe as well, like within our universe.

The arbitrary origins in Figs. 3a and 3b are not separated unlike as illustrated. The corresponding points P and P^0 and every other pair of corresponding points in spacetimes of the two universes, which can be arbitrary origins as well, are not separated. Corresponding points do not touch, because they exist in different spacetimes. The issues of non-separation and the non-touching of corresponding points in the two spacetimes shall be further elucidated and made more convincing later in this article.

2.1 Incorporating the Concepts of Static Geodetic Flow Speed and Static Time Dimension

An implication of the natural contraction of the three mutually perpendicular dimensions, $x^{01\prime}, x^{02\prime}$ and $x^{03\prime}$, of the vertical proper Euclidean 3-space $\Sigma^{0\prime}$ of the time-universe in Fig. 1, to a one-dimensional scalar space $\rho^{0\prime}$ relative to 3-observers in the horizontal proper Euclidean 3-space Σ' of our universe in Fig. 2a is that, a three-dimensional particle or object of rest mass m_0^0 in $\Sigma^{0\prime}$, with respect to a 3-observer in $\Sigma^{0\prime}$, is naturally contracted to a one-dimensional particle or object of equal rest mass m_0^0 in the one-dimensional scalar proper space $\rho^{0\prime}$, relative to the 3-observer in our Euclidean 3-space Σ'. This is then further transformed to a one dimensional particle or object of eqtal rest mass m_0^0 in the time dimension ct' of our universe relative to these observers, as a consequence of the natural transformation of Fig. 2a to Fig. 3a relative to 3-observers in Σ'.

Now the one-dimensional scalar proper space $\rho^{0\prime}$ is an isotropic dimension (with no unique orientation) in the proper Euclidean 3-space $\Sigma^{0\prime}$ that contracts to it. An implication of this fact is that, in deriving the contraction of a three-dimensional object of rest mass m_0^0 of any shape in $\Sigma^{0\prime}$, to a one-dimensional object in $\rho^{0\prime}$, relative to the 3-observer in Σ', the object must be replaced with an equivalent spherical object of equal rest mass m_0^0 and equal volume (with a radius $r^{0\prime}$) in $\Sigma^{0\prime}$. It must then be allowed to contract to a one-dimensional object of equal rest mass m_0^0 and a unique length $r^{0\prime}$ along $\rho^{0\prime}$, which further transforms to one-dimensional object of equal rest mass m_0^0 and length $c\Delta t'\,(= r^{0\prime})$ of the proper time dimension ct' of our universe, relative to the 3-observers in the proper Euclidean 3-space $\Sigma'$of our universe.

For example, a box of rest mass m_0^0 and dimensions $\Delta x^{0\prime}$, $\Delta y^{0\prime}$ and $\Delta z^{0\prime}$ in $\Sigma^{0\prime}$, must be replaced with an equivalent spherical box of equal rest mass m_0^0 and radius, $r^{0\prime} = (3\Delta x^{0\prime}\Delta y^{0\prime}\Delta z^{0\prime}/4\pi)^{1/3}$, in $\Sigma^{0\prime}$. This must then be allowed to contract to a one-dimensional box of equal rest mass m_0^0 and length $c\Delta t'\,(= r^{0\prime})$ of the time dimension ct', relative to 3-observers in Σ'. An object of irregular shape of rest mass m_0^0 and volume $V^{0\prime}$ in $\Sigma^{0\prime}$, must be replaced with an equivalent spherical object of equal rest mass and equal volume in $\Sigma^{0\prime}$.

The one-dimensional scalar proper space $\rho^{0\prime}$ is the natural geodesic of the four dimensions $x^{1\prime}$, $x^{2\prime}$, $x^{3\prime}$ and $\rho^{0\prime}$, just as the time dimension ct' is the natural geodesic of the four dimensions $x^{1\prime}$, $x^{2\prime}$, $x^{3\prime}$ and ct', as known. Every point along $\rho^{0\prime}$ possesses speed c of static geodetic flow along its positive axis, relative to all 3-observers in Σ', where "static geodetic flow" means not made manifested in detectable (or actual) geodetic flow. The geodetic flow of $\rho^{0\prime}$ is certainly static (or not actual), because $\rho^{0\prime}$ is a space dimension like $x^{1\prime}, x^{2\prime}$ and $x^{3\prime}$ of Σ'. Moreover the vertical Euclidean 3-space $\Sigma^{0\prime}$ (that contracts to $\rho^{0\prime}$) is not propagating (or flowing) relative to the horizontal Euclidean 3-space Σ' in Fig. 1 we started with.

The speed c of static geodetic flow of every point along $\rho^{0\prime}$ appears at every point along the proper time dimension ct', and it is the same speed c (not made manifest in geodetic flow) that appears in the notation ct' of the time dimension in Fig. 3a. Thus the proper time dimension ct' to which the vertical proper Euclidean 3- space $\Sigma^{0\prime}$ in Fig. 1 transforms, as derived earlier in this section, possesses speed c of static geodetic flow at every point along its length, but which is not made manifested in actual geodetic flow of ct'. The ct' is therefore to be referred to as static (i.e. non-flowing) time dimension.

It is appropriate to differentiate the static geodetic flow speed from the speed of light c, which material particles and bodies cannot attain in relative motion. Thus let us denote the static geodetic flow speed by c_s (with subscript "s" denoting static), while the speed of light shall remain as c. (It is the non-attainable speed of light c by material particles that appears in the factor γ as, $\gamma = (1 - v^2/c^2)^{-1/2}$, in SR and not the static geodetic flow speed c_s.) The proper static time dimension shall be re-denoted by c_st', since it is the static geodetic flow speed c_s of every point along its length that appears in its notation, as mentioned in the preceding paragraph.

The proper static time dimension c_st' is the usual proper time dimension denoted by ct' (and sometimes by $c\tau$). The need for qualification by static is to give room for the possibility of non-static time dimension with natural geodetic flow. Nevertheless the static qualification shall often be omitted for brevity, while the notation c_st' shall be sticked to henceforth in this paper.

The rest mass m_0^0 of an object located at any point along $\rho^{0\prime}$ acquires the speed c_s of the static geodetic flow of that point. This is not made manifested in translation of m_0^0 at speed c_s along $\rho^{0\prime}$, since the geodetic flow of $\rho^{0\prime}$ at speed c_s is a static (or non-actual) flow. The rest mass m_0^0 of an object at rest at its position along $\rho^{0\prime}$ relative to the 3-observers in Σ', possesses non-detectable rest energy $m^0c_s^2$ naturally. It is non-detectable since the static geodetic flow speed c_s is not a detectable speed. Thus m_0^0 that possesses only the static geodetic speed c_s in $\rho^{0\prime}$ must be considered as a state of rest energy $E^{0\prime}\,(= m_0^0c_s^2)$, instead of a state of rest mass m_0^0 at its position along $\rho^{0\prime}$, relative to 3-observers in Σ'.

When the scalar one-dimensional proper space $\rho^{0\prime}$ transforms into the proper static time dimension c_st', as happens between Fig. 2a and Fig. 3a, the rest energy $E^{0\prime}\,(= m_0^0c_s^2)$ at a point along $\rho^{0\prime}$, transforms into rest energy $E'\,(= m_0c_s^2)$ at the corresponding point along c_st', relative to 3-observers in Σ'. Note that the notations for rest energy E' and rest mass m_0 (without superscript "0") in our universe, appear in $E'\,(= m_0c_s^2)$ along our time dimension c_st'.

Thus in writing the 'four-dimensional' rest mass of a particle or object in the four-dimensional proper spacetime $(c_s t', \Sigma')$ (or $(c_s t', x^{1'}, x^{2'}, x^{3'})$), we must, for dimensional consistency, divide the rest energy $E' (= m_0 c_s^2)$ of the particle or object along $c_s t'$ by c_s^2 to have one-dimensional rest mass $E'/c_s^2 (= m_0)$ of the particle or object in ct' and add this to its three-dimensional rest mass m_0 in the proper Euclidean 3-space Σ' to obtain the four-dimensional rest mass $(E'/c_s^2, m_0)$ of the particle or object in $(c_s t', \Sigma')$ (or $(c_s t', x^{1'}, x^{2'}, x^{3'})$).

Since the speed c_s in the non-detectable rest energy $E' (= m_0 c_s^2)$ of a particle or object in the time dimension $c_s t'$ is not made manifested in translation at speed c_s along $c_s t'$, E' is not an immaterial energy with zero material attribute. Rather the one-dimensional rest mass E'/c_s^2 of a particle or object in $c_s t'$ retains the material attributes of the rest mass m_0 in Σ'. It can therefore appear in the special theory of relativity and relativistic mechanics at equal footing with the three-dimensional rest mass m_0 of the particle or object in Σ'. It is for this reason that E'/c_s^2 in $c_s t'$ shall be referred to as rest mass on equal footing with m_0 in Σ'.

The terms, "three-dimensional mass", "four-dimensional mass" and "one-dimensional mass", shall be used freely in this paper to mean mass in three-dimensional space, mass in four-dimensional spacetime and mass in time dimension respectively.

Illustrated in Fig. 4a are the three-dimensional rest mass m_0 of a particle or object at a point of straight line distance d' from a point of reference or origin in our proper Euclidean 3-space Σ' and the symmetry-partner one-dimensional mass E'/c_s^2 at the symmetry-partner point of distance $\mathrm{d}^{0'}$ along our proper static time dimension $c_s t'$ from the point of reference or origin, where the distances d' and $\mathrm{d}^{0'}$ are equal.

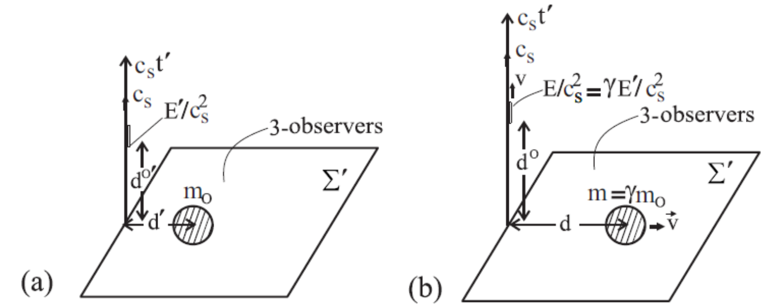

Fig. 4. The three-dimensional rest mass of an object at a position in the proper Euclidean 3-space and its one-dimensional rest mass at the symmetry-partner position in the proper time dimension in the situations where, (a) the object is stationary relative to the observer and (b) the object is in motion relative to the observer

Fig. 4a pertains to a situation where the three-dimensional rest mass m_0 of the particle or object is at rest relative to the 3-observer in the proper Euclidean 3-space Σ' and, consequently, its one-dimensional rest mass E'/c_s^2 is at rest in the proper time dimension $c_s t'$ relative to the 3-observer in Σ'. On the other hand, Fig. 4b pertains to a situation where the three-dimensional rest mass m_0 of the particle or object is in motion at a velocity $\vec{v}$ relative to this observer, thereby becoming the special-relativistic three-dimensional mass γm_0 in Σ', relative to this 3-observer in Σ' and, consequently, the one- dimensional rest mass E'/c_s^2 of the particle or object is in motion at speed, $v = |\vec{v}|$, along the proper time dimension $c_s t'$, thereby becoming the special-relativistic one-dimensional mass $\gamma E'/c_s^2$ in $c_s t'$, relative to the 3- observer in Σ'.

The one-dimensional rest mass E'/c_s^2 of length $c_s\Delta t' (= r^{0\prime})$, located at rest at a point in the time dimension c_st' in Fig. 4a, acquires the speed c_s of static (or non-actual) geodetic flow of c_st', which is not made manifested in translation of E'/c_s^2 along c_st' with respect to the 3-observer in Σ', as mentioned earlier. Moreover E'/c_s^2 possesses zero speed, $(v = 0)$, of motion along c_st' relative to the 3-observer in Σ', just as the three-dimensional rest mass m_0 possesses zero speed of motion in the Euclidean 3-space Σ' relative to the 3-observer in Σ'. Consequently m_0 and E'/c_s^2 remain stationary at their symmetry-partner locations in Σ' and c_st' respectively, relative to the 3-observer in Σ', as being assumed in Fig. 4a.

In a situation where the three-dimensional rest mass m_0 of the particle or object is in motion at a velocity $\vec{v}$ in the Euclidean 3-space Σ' and its one-dimensional rest mass E'/c_s^2 is in motion at speed, $v = |\vec{v}|$, along the time dimension, relative to the 3-observer in Σ' in Fig. 4b, on the other hand, the special-relativistic one-dimensional mass $\gamma E'/c_s^2$, acquires the speed c_s of static geodetic flow of the time dimension c_st', which is not made manifested in translation of $\gamma E'/c_s^2$ along c_st', and as well possesses speed v of translation along c_st', relative to the 3-observer in Σ'. In composing the resultant of speeds c_s and v that must appear in SR relative to the observer, the speed c_s must be set to zero.

Now during a given period of time, the special-relativistic one-dimensional mass $\gamma E'/c_s^2$ has translated at constant speed v from an initial position P_1^0 to another position P_2^0 along the time dimension c_st', while covering an interval $P_1^0P_2^0$ of c_st'. During the same period of time, the special-relativistic three-dimensional mass γm_0, has translated at equal constant speed $v = |\vec{v}|$ from an initial position P_1 to another position P_2 in the Euclidean 3-space Σ', while covering a straight line distance P_1P_2 in Σ', where the interval $P_1^0P_2^0$ covered along c_st' by $\gamma E'/c_s^2$ is equal to the straight line distance P_1P_2 covered in Σ' by γm_0, and the positions P_1 and P_2 in Σ' are symmetry-partner positions to the positions P_1^0 and P_2^0 respectively along c_st'. Consequently γm_0 and $\gamma E'/c_s^2$ are always located at symmetry-partner positions in Σ' and c_st' in the situation where they are in motion at any speed v in their respective domains, relative to the 3-observer in Σ' in Fig. 4b.

It shall be reiterated for the sake of emphasis that the one-dimensional rest mass E'/c_s^2 or special-relativistic mass $\gamma E'/c_s^2$ in our proper time dimension c_st', with respect to 3-observers in our proper Euclidean 3-space Σ', of a particle, object or observer in Figs. 4a and 4b, is actually the three-dimensional rest mass m_0^0 or three-dimensional special-relativistic mass γm_0^0 of the identical symmetry-partner particle, object or observer in the Euclidean 3-space $\Sigma^{0\prime}$ of the time-universe, with respect to 3-observers in $\Sigma^{0\prime}$. This is the origin of the one-dimensional particles, objects and observers (or 1-particles, 1-objects and 1-observers) in the time dimension to the 3-dimensional particles, objects and observers (or 3-particles, 3-objects and 3-observers) in 3-space and, consequently, the origin of 4-particles, 4-objects and 4-observers in spacetime in our universe.

The equality of rest masses, m_0 and m_0^0, of symmetry-partner particles or bodies in our universe and the time-universe follows from the equality $E'/c_s^2 = E^{0\prime}/c_s^2$, as $E^{0\prime}/c_s^2$ along the one-dimensional scalar space $\rho^{0\prime}$ (not shown) in Fig. 2a, transforms into E'/c_s^2 along the time dimension c_st' (not shown) in Fig. 3a, alongside the equalities, $E'/c_s^2 = m_0$ and $E^{0\prime}/c_s^2 = m_0^0$. This shall be elaborated further elsewhere.

The motion at speed v along the proper time dimension c_st' of the one-dimensional rest mass E'/c_s^2 of a particle or object, relative to the 3-observer in the Euclidean 3-space Σ' of our universe in Fig. 4b, is actually the motion at velocity $\vec{v}$ of the three-dimensional rest mass m_0^0 of the identical symmetry-partner particle or object in the Euclidean 3-space $\Sigma^{0\prime}$ of the time-universe, relative to the identical symmetry-partner 3-observer in $\Sigma^{0\prime}$ in that universe. Thus the three-dimensional rest mass m_0 of a particle or object in our universe and the three-dimensional rest mass m_0^0 of the identical symmetry-partner particle or object in the time-universe, are involved in simultaneous identical relative motions always in their respective universes. This also shall be elaborated elsewhere.

It shall be concluded from the discussions to the preceding two paragraphs that our universe and the time-universe are identically populated by symmetry-partner moons, planets (including the earths and objects on earth), stars (including the Suns), galaxies, clusters of galaxies and freely floating objects in space. A body in our universe and its symmetry-partner in the time-universe have identical magnitudes of masses. They are in identical relative motions relative to identical symmetry-partner observers or frames of reference, within symmetry-partner regions of spacetimes in the two universes at all times. These issues shall be elaborated elsewhere. The identical sizes and shapes, or otherwise, of the rest masses m_0 and m_0^0 of symmetry-partner particles and objects in our universe and the time-universe shall be investigated elsewhere.

2.2 Origin of Four-Vectors on Flat Spacetime in our Universe

Now every parameter in the Euclidean 3-space has its counterpart (or symmetry-partner) in the time dimension. We have seen the case of the three-dimensional rest mass m_0 in the proper Euclidean 3-space Σ' and its symmetry-partner one-dimensional rest mass E'/c_s^2 in the proper time dimension c_st', as developed in this section and illustrated in Figs. 4a and 4b.

A three-vector quantity $\vec{R}$ in the Euclidean 3-space Σ' has its symmetry-partner scalar quantity R^0 in the scalar static time dimension c_st'. The composition of the two yields four-vector quantity $R_\lambda = (R^0, \vec{R})$ (or $R_\lambda = (R^0, R_1, R_2, R_3)$). We now know that the scalar components R^0 in the time dimension c_st' of four-vector quantities in our universe, are themselves three-vector quantities $\vec{R}^0$ in the Euclidean 3-space $\Sigma^{0\prime}$ of the time-universe, with respect to 3-observers in $\Sigma^{0\prime}$. The three-vector quantities $\vec{R}^0$ in $\Sigma^{0\prime}$ (which are identical symmetry-partners to the three-vector quantities $\vec{R}$ in our Euclidean 3-space Σ', become contracted to one-dimensional scalar quantities, $R^0 = |\vec{R}^0|$, in the time dimension c_st', relative to 3-observers in Σ', even as the Euclidean 3-space $\Sigma^{0\prime}$ containing $\vec{R}^0$ becomes contracted to the scalar time dimension c_st' relative to 3-observers in Σ'.

The appropriate notation for the scalar component R^0 in c_st' of every three-vector $\vec{R}$ in Σ' must be determined. For instance, R^0 is the static geodetic flow speed c_s in c_st' and $\vec{R}$ is the velocity $\vec{v}$ in Σ', in the case of velocity four-vector; $R^0 = m_0c_s$ and $\vec{R} = m_0\vec{v}$, in the case of momentum four-vector; and $R^0 = c_st'$ and $\vec{R} = \vec{r}$, where $\vec{r}$ is coordinate vector in Σ', in the case of coordinate four-vector.

What can be concluded from the above is that, particles and bodies and four-vectors, including velocity four-vector (or motions of material particles and bodies), are symmetrically located in our universe and the time-universe. More formal evidences for the symmetrical distribution of material particles and bodies and of the symmetry of their motions between the two universes shall emerge with further development of this paper and elsewhere. The coexistence of our universe and the time-universe shall be concluded from the derivations up to this point in this paper.

3 POSITIVE TIME-UNIVERSE AND NEGATIVE TIME-UNIVERSE

A veritable conclusion of two previous papers [1, 2] is that universes come in symmetrical pairs (a positive universe and a negative counterpart). There are two symmetrical time-universes, to be referred to as positive time-universe and negative time-universe. The derived time-universe up to the end of the preceding section, with its spacetime illustrated in Fig. 3b, is the positive time-universe.

In Fig. 5a is re-illustrated the combined flat spacetimes of our (or positive) universe and the negative universe (presented as Fig. 5 of [1]), while the combined flat spacetimes of the positive time-universe and the negative time-universe is illustrated in Fig. 5b.

There are four symmetrical universes in Figs. 5a and 5b namely, our (or positive) universe and negative universe (in Fig. 5a) and the positive time-universe and negative time-universe (in Fig. 5b).

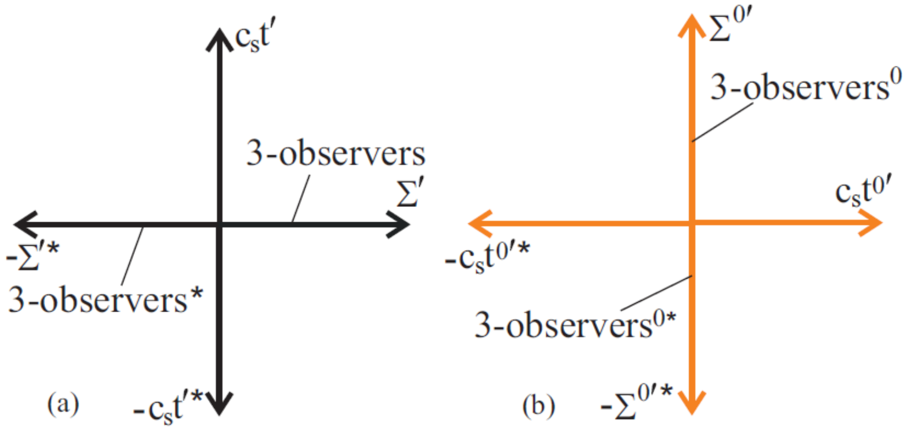

Fig. 5. Combined spacetimes of (a) our (or positive) universe and negative universe and (b) positive time-universe and negative-time universe

Figs 5a and 5b are actually not separated unlike as shown. Rather they must be brought together as Fig. 6a with respect to 3-observers in the Euclidean 3-spaces Σ' and $-\Sigma'^{*}$ of our universe and the negative universe and as Fig.6b with respect to 3-observers^0 in the Euclidean 3-spaces $\Sigma^{0\prime}$ and $-\Sigma^{0\prime*}$ of the positive time-universe and the negative time-universe.

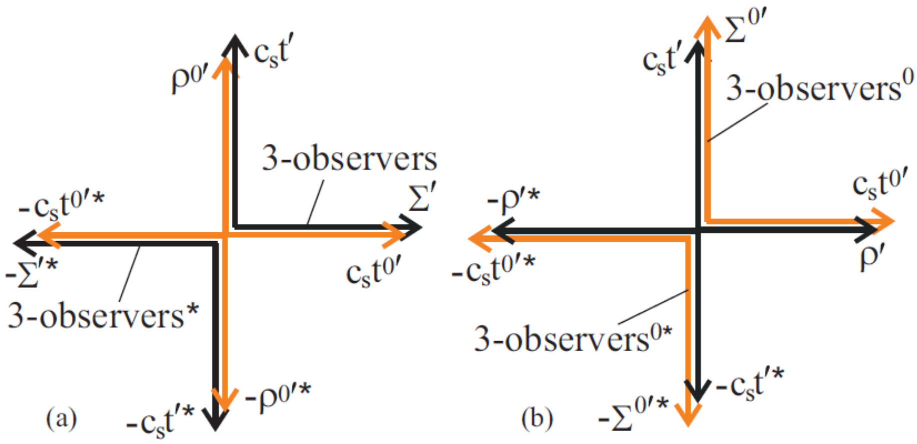

Fig. 6. Combined spacetimes of four symmetrical universes (a) with respect to 3-observers in the Euclidean 3-spaces of our universe and negative universe and (b) with respect to 3-observers^0 in the Euclidean 3-spaces of the positive time-universe and the negative time-universe

It is to be observed, as demonstrated earlier in this article that, the flat four-dimensional spacetimes $(\Sigma^{0\prime}, c_s t^{0\prime})$ and $(-\Sigma^{0\prime*}, -c_s t^{0\prime*})$ of the positive time-universe and the negative time-universe, with respect to 3-observers^0 in the Euclidean 3-spaces $\Sigma^{0\prime}$ and $-\Sigma^{0\prime*}$ of those universes in Figs. 5b, naturally contract to flat two-dimensional spacetimes $(\rho^{0\prime}, c_s t^{0\prime})$ and $(-\rho^{0\prime*}, -c_s t^{0\prime*})$ with respect to 3-observers in the Euclidean 3-spaces Σ' and $-\Sigma'^{*}$ of our universe and negative universe in Fig. 6a.

Likewise, the flat four-dimensional spacetimes $(\Sigma', c_s t')$ and $(-\Sigma'^*, -c_s t'^*)$ of our (or positive) universe and the negative universe, with respect to 3-observers in the Euclidean 3-spaces Σ' and $-\Sigma'^*$ of our universe and negative universe in Figs. 5a, are naturally contracted to flat two-dimensional spacetimes, $(\rho', c_s t')$ and $(-\rho'^*, -c_s t'^*)$, with respect to 3-observers^0 in the Euclidean 3-spaces $\Sigma^{0\prime}$ and $\Sigma^{0\prime *}$ of the positive time-universe and the negative time-universe in Fig. 6b. This, again, follows from the explained contraction of Σ' to ρ' between Fig. 1 and Fig. 2b, with respect to 3-observers in $\Sigma^{0\prime}$ derived early in the preceding section.

As mentioned earlier and illustrated between Figs. 2a and 3a, the one-dimensional positive scalar space $\rho^{0\prime}$ in Fig. 6a (to which the Euclidean 3-space $\Sigma^{0\prime}$ of the positive time-universe, contracts relative to 3-observers in our Euclidean 3-space Σ'), further transforms into the positive static time dimension $c_s t'$ of our universe relative to 3-observers in Σ' in that diagram. The one-dimensional negative scalar space $-\rho^{0\prime *}$ (to which the Euclidean 3-space $\Sigma^{0\prime *}$ of the negative time-universe, contracts relative to 3-observers in $-\Sigma'^*$ of the negative universe in Fig. 6a), likewise further transforms into the negative static time dimension $c_s t'^*$ of the negative universe, relative to 3-observers in $-\Sigma'^*$.

Although Fig. 6a exists in nature, the 3-observers in the Euclidean 3-space Σ' of our universe can perceive the flat four-dimensional spacetime $(\Sigma', c_s t')$ of our universe only; the flat two-dimensional spacetime $(\rho^{0\prime}, c_s t^{0\prime})$ to which the flat four-dimensional spacetime $(\Sigma^{0\prime}, c_s t^{0\prime})$ of the positive time-universe contracts with respect to these 3-observers in Σ', being completely hidden to them, just as $(\Sigma^{0\prime}, c_s t^{0\prime})$ is hidden to them.

Likewise, the 3-observers in the Euclidean 3-space $-\Sigma'^*$ of the negative universe can perceive the flat four-dimensional spacetime $(-\Sigma'^*, -c_s t'^*)$ of the negative universe only in Fig. 6a, the flat two-dimensional spacetime $(-\rho^{0\prime *}, -c_s t^{0\prime *})$ to which the flat four-dimensional spacetime $(-\Sigma^{0\prime *}, -c_s t^{0\prime *})$ of the negative time-universe contracts relative to 3-observers in $-\Sigma'^*$ of the negative universe, being completely hidden to these 3-observers, just as $(-\Sigma^{0\prime *}, -c_s t^{0\prime *})$ is hidden to them.

In symmetry, although Fig. 6b exists in nature, the 3-observers^0 in the Euclidean 3-space $\Sigma^{0\prime}$ of the positive time-universe can perceive the flat four-dimensional spacetime $(\Sigma^{0\prime}, c_s t^{0\prime})$ of the positive time-universe only; the flat two-dimensional spacetime $(\rho', c_s t')$ to which the flat four-dimensional spacetime $(\Sigma', c_s t')$ of our (or positive) universe contracts with respect to these 3-observers^0 in $\Sigma^{0\prime}$, being completely hidden to them, just as $(\Sigma', c_s t')$ is hidden to them.

Likewise, the 3-observers^0 in the Euclidean 3-space $-\Sigma^{0\prime *}$ of the negative time-universe can perceive the flat four-dimensional spacetime $(-\Sigma^{0\prime *}, -c_s t^{0\prime *})$ of the negative time-universe only in Fig. 6b; the flat two-dimensional spacetime $(-\rho'^*, -c_s t'^*)$ to which the flat four-dimensional spacetime $(-\Sigma'^*, -c_s t'^*)$ of the negative universe contracts relative to 3-observers^{0*} in $-\Sigma^{0\prime *}$ of the negative time-universe, being completely hidden to these 3-observers^{0*}, just as $(-\Sigma'^*, -c_s t'^*)$ is hidden to them.

3.1 Origin of the Two-dimensional Intrinsic Spacetime Containing Two-dimensional Intrinsic Masses of Particles and Bodies

It is to be recalled that the two-dimensional proper intrinsic metric spacetime denoted by $(\varnothing\rho', \varnothing c_s \varnothing t')$ that underlies (or embeds) the flat four-dimensional proper metric spacetime $(\Sigma', c_s t')$ of our (or positive) universe and $(-\varnothing\rho'^*, \varnothing c_s \varnothing t^*)$ that underlies (or embeds) the flat four-dimensional proper metric spacetime $(-\Sigma'^*, -c_s t'^*)$ of the negative universe, are introduced without deriving them (or as *ansatz*) in the two-world picture in sub-section 4.3 of [1]. Their introduction has proved profitable and, indeed, unavoidable in the subsequent developments in both [1] and [2]. The origins of intrinsic spacetimes in our (or positive) universe and negative universe, as well as positive time-universe and negative time-universe, and the origins of the intrinsic rest masses contained in them, shall be derived within the larger four-world picture in this sub-section.

Although the two-dimensional spacetime $(\rho^{0\prime}, c_s t^{0\prime})$ to which the four-dimensional spacetime $(\Sigma^{0\prime}, c_s t^{0\prime})$ of the positive time-universe contracts with respect to 3-observers in the Euclidean 3-space Σ' of our universe in Fig. 6a, is hidden to these 3-observers in Σ', as mentioned above, Fig. 6a exists in nature and the straight line one-dimensional scalar space $\rho^{0\prime}$ of the positive time-universe along the vertical has a projection—a 'shadow'—in our Euclidean 3-space Σ' (as a hyper-surface) along the horizontal in Fig. 6a. The one-dimensional rest masses m_0^0 in $\rho^{0\prime}$ (to which the three-dimensional rest masses m_0^0 of particles and bodies in the Euclidean 3-space $\Sigma^{0\prime}$ contract, as $\Sigma^{0\prime}$ contracts to $\rho^{0\prime}$ relative to 3-observers in Σ'), likewise 'casts a shadow' in our three-dimensional Euclidean space Σ' in Fig. 6a. The 'shadows' of spacetime and masses are derived below.

3.1.1 Origins of the Two-dimensional Intrinsic Spacetimes in the Four Universes

Let us for the purpose of the derivations to be done hereunder, consider just the first quadrants of Fig. 6a and and 6b and present them as Figs. 7a and 7b. Now the one-dimensional scalar proper metric space $\rho^{0\prime}$ is naturally inclined at zero angle, $\psi_0 = 0$, to the vertical, or at an angle, $\eta_0 = \pi/2$, to the proper Euclidean 3-space Σ' of our universe, considered as a hyper-surface (represented by a line — a 'hyper-line'), along the horizontal in Fig. 7a. Although $\rho^{0\prime}$ is hidden to the 3-observers in Σ', however since it exists along the vertical, it projects a component—a 'shadow'—into Σ' along the horizontal, as mentioned above.

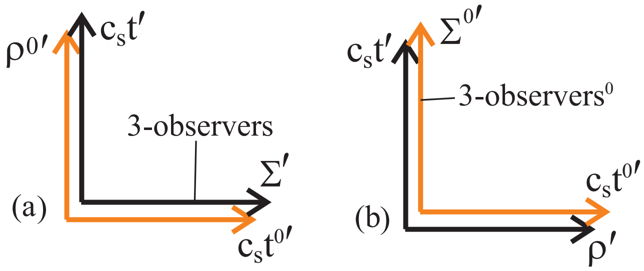

Fig. 7. The four-dimensional proper metric spacetimes of our (or positive) universe and the positive time-universe with respect to: (a) 3-observers in the proper Euclidean 3-space of our universe and (b) 3-observers^0 in the proper Euclidean 3-space of the positive time-universe

Let us start by artificially considering $\rho^{0\prime}$ to be inclined clockwise by a non-zero angle ψ_0 to the vertical, or anti-clockwise by angle, $\eta_0 = \pi/2 - \psi_0$, to the horizontal in Fig. 7a. The projection of $\rho^{0\prime}$ into Σ' along the horizontal in its artificially inclined position, to be denoted by $\rho_{\rm h}^{0\prime}$, is

$$\rho_{\rm h}^{0\prime} = \rho^{0\prime} \cos \eta_0 \ . \tag{1}$$

One important result of the reformulation SR on a two-world background in [1] is the fact that the "hyperbolic projections" of spacetime coordinates (in terms of $\cosh \alpha$ and $\sinh \alpha$), on the flat four-dimensional spacetime hyperplane, in the Minkowski geometry in the one-world background of SR, is replaced by their trigonometric counterparts (in terms of $\cos \psi$ and $\sin \psi$) in the context of the two-world background of SR in that article. This leads to length contraction in the form, $l = l' \cos \psi;\ \cos \psi = (1 - v^2/c^2)^{1/2}$, for instance. The trigonometric projection of coordinates on spacetime hyperplane idea is applied in Eq. (1).

Now the extended straight line dimension $\rho^{0\prime}$ is naturally inclined at an angle, $\eta_0 = \pi/2$, relative to the horizontal in Fig. 7a, not in the context of SR, but due to the fact that $\rho^{0\prime}$ possesses the maximum static geodetic flow speed, $V_0 = c_s$, at every point along its length. In the artificially inclined condition of $\rho^{0\prime}$ for which Eq. (1) is written, V_0 has a constant value that is smaller than c_s at every point along the inclined $\rho^{0\prime}$. Unlike the relative speed v of SR, which varies with observer or frame of reference, the static geodetic flow speed V_0 is the same relative to all observers or frames of reference. Hence V_0 is an absolute speed. Since $\rho^{0\prime}$ is naturally along the vertical, the angle η_0 shall be set to $\pi/2$ in Eq. (1) giving

$$\rho_{\rm h}^{0\prime} = \rho^{0\prime}\cos\eta_0 = \rho^{0\prime}\cos\frac{\pi}{2} = 0 \ . \tag{2}$$

Equation (2) states that the scalar one-dimensional proper metric space $\rho^{0\prime}$ along the vertical, projects zero component (or nothing) into the proper Euclidean 3-space Σ' (as a hyper-surface) along the horizontal. However we shall not ascribe absolute nothingness to the projection of the one-dimensional proper metric space $\rho^{0\prime}$ along the vertical into the Euclidean 3-space Σ' along the horizontal in Fig. 7a. The one-dimensional space $\rho^{0\prime}$ certainly 'casts a shadow' in Σ', as mentioned earlier.

Actually, it is the factor $\cos\pi/2$ that vanishes in Eq. (2) and not $\rho^{0\prime}$ multiplying it. Thus let us re-write Eq. (2) as

$$\rho_{\rm h}^{0\prime} = \rho^{0\prime}\cos\frac{\pi}{2} = 0\times\rho^{0\prime} \equiv \varnothing\rho' \ , \tag{3}$$

where the projective $\varnothing\rho'$ is without the dummy superscript "0" label used to differentiate the coordinates and parameters of the positive time-universe from those of our universe, because it lies (or is embedded) in our Euclidean 3-space Σ' along the horizontal, thereby being an entity of our universe (without superscript "0" label).

Thus instead of associating absolute nothingness to the projection of $\rho^{0\prime}$ that lies along the vertical into the Euclidean 3-space Σ' as a hyper-surface along the horizontal, as done in Eq. (2), a dimension denoted by $\varnothing\rho'$ has been associated with it in Eq. (3). Any interval of the $\varnothing\rho'$ is equivalent to zero interval of the one-dimensional scalar space $\rho^{0\prime}$ that projects it, as follows from, $\varnothing\rho' \equiv 0\times\rho^{0\prime}$, in Eq. (3). It then follows that any interval of $\varnothing\rho'$ is equivalent to zero interval of the proper Euclidean 3-space Σ' it underlies (or in which it is embedded). Or any interval of $\varnothing\rho'$ is no interval of space Σ'. The name nospace shall be coined for $\varnothing\rho'$ from the preceding statement, where $\varnothing\rho'$ is the proper (or classical) nospace by virtue of the prime label on it. Nospace is non-observable and non-detectable to observers in the metric space Σ', since any interval of it is zero interval of space.

An alternative name of intrinsic space shall be given to nospace, where intrinsic means non-observable and non-detectable to observers in the metric space Σ'. The $\varnothing\rho'$ is the proper (or classical) intrinsic space by virtue of the prime label on it.

As mentioned in section 2 at the neighborhood of Figs. 2a and 2b of this paper, the one-dimensional proper metric space $\rho^{0\prime}$ can be considered to be along any direction of the Euclidean 3-space $\Sigma^{0\prime}$ of the positive time-universe that contracts to it, with respect to 3-observers in our Euclidean Σ'. Thus $\rho^{0\prime}$ is an isotropic scalar one-dimensional space with no unique orientation (or basis) in the Euclidean 3-space $\Sigma^{0\prime}$ that contracts to it. The one-dimensional intrinsic space (or one-dimensional nospace) $\varnothing\rho'$, which $\rho^{0\prime}$ projects into our Euclidean 3-space Σ', is likewise an isotropic scalar intrinsic space dimension with no unique orientation in Σ' with respect to 3-observers in Σ'. An alternative conceptual explanation of the isotropy of $\varnothing\rho'$ in Σ' is given in paragraphs under Figs. 6a and 6b of [1].

The proper metric static time dimension $c_st^{0\prime}$ of the positive time-universe is naturally along the horizontal in Fig. 7a. Its projection into the static proper metric time dimension c_st' of our universe along the vertical, to be denoted by $c_st_{\rm v}^{0\prime}$, is likewise given like Eq. (2) as

$$c_st_{\rm v}^{0\prime} = c_st^{0\prime}\cos\frac{\pi}{2} = 0 \ . \tag{4}$$

Equation (4) states that the proper metric time dimension $c_st^{0\prime}$ of the positive time-universe that lies along the horizontal naturally, projects zero component (or nothing) into the proper time dimension c_st' of our universe along the vertical in Fig. 7a. However we shall not ascribe absolute nothingness to the projection of the proper metric time dimension $c_st^{0\prime}$ along the horizontal into c_st' along the vertical. It certainly 'casts a shadow' in c_st'.

Actually, it is the factor $\cos\pi/2$ that vanishes and not $c_st^{0\prime}$ multiplying it in Eq. (4). Thus let us rewrite Eq. (4) as

$$c_st_{\rm v}^{0\prime} = c_st^{0\prime}\cos\frac{\pi}{2} = 0\times c_st^{0\prime} \equiv \varnothing c_s\varnothing t' \ , \tag{5}$$

where the projective $\varnothing c_s \varnothing t'$ is without the superscript "0" label, because it lies (or is embedded) in our proper time dimension $c_s t'$, thereby being an entity of our universe (without superscript "0" label).

Thus instead of associating absolute nothingness to the projection of $c_s t^{0\prime}$ that lies along the horizontal into the proper time dimension $c_s t'$ along the vertical, as done in Eq. (4), a dimension $\varnothing c_s \varnothing t'$ has been associated with it in Eq. (5). Any interval of the one-dimensional $\varnothing c_s \varnothing t'$ is equivalent to zero interval of the time dimension $c_s t^{0\prime}$ that projects it, as follows from, $\varnothing c_s \varnothing t' \equiv 0 \times c_s t^{0\prime}$, in Eq. (5). It then follows that any interval of $\varnothing c_s \varnothing t'$ is equivalent to zero interval of our proper time dimension $c_s t'$ in which it is embedded. Or any interval of $\varnothing c_s \varnothing t'$ is no interval of time dimension. The name notime dimension shall be coined for $\varnothing c_s \varnothing t'$ from the preceding statement, where $\varnothing c_s \varnothing t'$ is the proper (or classical) notime dimension by virtue of the prime label on it. The notime dimension is non-observable and non-detectable to 1-observers in $c_s t'$, since any interval of it is zero interval of time dimension $c_s t'$.

An alternative name of intrinsic time dimension shall be given to $\varnothing c_s \varnothing t'$, where intrinsic means non-observable and non-detectable. The $\varnothing c_s \varnothing t'$ is the proper (or classical) intrinsic time dimension by virtue of the prime label on it.

The projection of the proper intrinsic metric scalar space $\varnothing \rho'$ into the metric Euclidean 3-space Σ' of our universe by the one-dimensional scalar proper metric space $\rho^{0\prime}$ of the positive time-universe in Fig. 7a, expressed by Eq. (3), and the projection of the proper intrinsic metric static time dimension $\varnothing c_s \varnothing t'$ into the proper metric static time dimension $c_s t'$ of our universe along the vertical, by the proper metric static time dimension $c_s t^{0\prime}$ of the positive time-universe along the horizontal in Fig. 7a, expressed by Eq. (5), are illustrated in Fig. 8a.

The derivations from Eq. (1) through Eq. (5) that lead to Fig. 8a in our universe, have been based on Fig. 7a. It is straight forward to do the same derivations with Fig. 7b and arrive at the corresponding Fig. 8b in the positive time-universe.

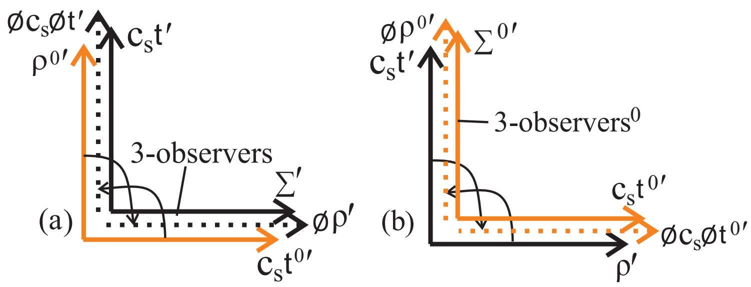

Fig. 8. (a) The flat two-dimensional proper metric spacetime of the positive time-universe with respect to 3-observers in our proper Euclidean 3-space, projects two-dimensional proper intrinsic metric spacetime into the flat four-dimensional proper metric spacetime of our universe. (b) The flat two-dimensional proper metric spacetime of our universe with respect to 3-observers^0 in the proper Euclidean 3-space of the positive time-universe, projects two-dimensional proper intrinsic metric spacetime into the flat four-dimensional proper metric spacetime of the positive time-universe

Now the scalar proper space and the proper time dimension, $\rho^{0\prime}$ and $c_s t^{0\prime}$, of the positive time-universe in Fig. 8a, cannot appear in physics in our universe. Whereas the proper intrinsic space and proper intrinsic time dimension, $\varnothing \rho'$ and $\varnothing c_s \varnothing t'$, which they project into the four-dimensional proper spacetime of our universe can appear in intrinsic physics in our universe. Likewise the scalar proper space and proper time dimension, ρ' and $c_s t'$, of the our universe in Fig. 8b, cannot appear in physics in the positive time-universe. Whereas the proper intrinsic space and proper intrinsic time dimension, $\varnothing\rho^{0\prime}$ and $\varnothing c_s \varnothing t^{0\prime}$, which they project into the four-dimensional proper metric spacetime of the positive time-universe, can appear in intrinsic physics in the positive time-universe.

The dimensions, $\rho^{0\prime}$ and $c_s t^{0\prime}$, shall be removed from Fig. 8a yielding the spacetime and intrinsic spacetime of our universe, which shall be added to the symmetry-partner spacetime and intrinsic spacetime of the negative universe to have Fig. 9a. The dimensions ρ' and $c_s t'$ shall likewise be removed from Fig. 8b yielding the spacetime and intrinsic spacetime of the positive time-universe, which shall be added to the symmetry-partner spacetime and intrinsic spacetime of the negative time-universe to have Fig. 9b.

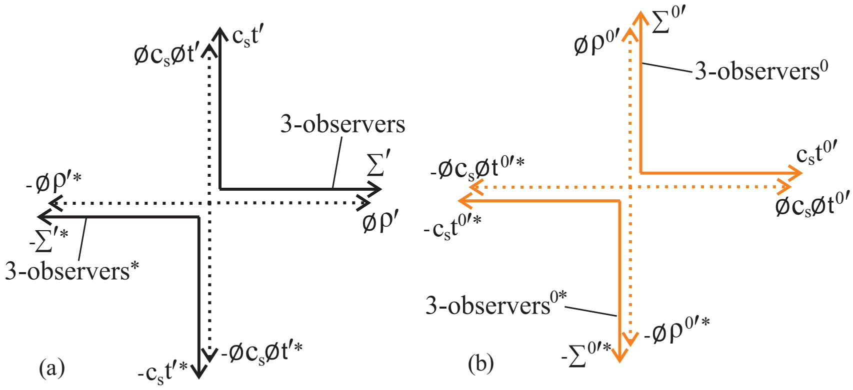

Fig. 9. (a) Figure 8a with the one-dimensional proper scalar space and proper time dimension of the positive time-universe removed, yielding the flat proper four-dimensional spacetime and the underlying flat two-dimensional proper intrinsic spacetime of our universe combined with those of the negative universe. (b) Figure 8b with the one-dimensional scalar proper space and proper time dimension of our universe removed, yielding the flat four-dimensional proper spacetime and the underlying flat two-dimensional proper intrinsic spacetime of the positive time-universe combined with those of the negative time-universe

The singular isotropic proper intrinsic space (or proper nospace) $\varnothing\rho'$ of our universe is effectively orientated along all directions of the proper metric Euclidean 3-space Σ' of our universe in which it is embedded and the singular isotropic proper intrinsic space (or proper nospace) $-\varnothing\rho'^{*}$ of the negative universe is effectively orientated along all directions of the proper Euclidean 3-space $-\Sigma'^{*}$ of the negative universe in which it is embedded in Fig. 9a.

The singular isotropic proper intrinsic space (or proper nospace) $\varnothing\rho^{0\prime}$ of the positive time-universe is effectively orientated alone all directions of the proper Euclidean 3-space $\Sigma^{0\prime}$ of the positive time-universe in which it is embedded and the singular isotropic proper intrinsic space (or proper nospace) $-\varnothing\rho^{0\prime *}$ of the negative time-universe is effectively orientated alone all directions of the proper Euclidean 3-space $\Sigma^{0\prime\prime *}$ of the negative time-universe in which it is embedded in Fig. 9b.

Figure 9a of our universe and the negative universe is Fig. 7 of [1], introduced as *ansatz* in the two-world picture of that paper, which has now been derived within the larger four-world picture. The counterpart Fig. 9b of the positive time-universe and the negative time-universe is new.

As is clear from the above, the flat two-dimensional proper metric spacetime $(\rho^{0\prime}, c_s t^{0\prime})$ of the positive time-universe projects the flat two-dimensional proper intrinsic metric spacetime $(\varnothing\rho', \varnothing c_s \varnothing t')$ of our universe. However the two-dimensional $(\rho^{0\prime}, c_s t^{0\prime})$ with respect to 3-observers in the proper Euclidean 3-space Σ' of our universe in Fig. 8a is the flat four-dimensional proper metric spacetime $(\Sigma^{0\prime}, c_s t^{0\prime})$ of the positive time-universe, with respect to 3-observers^0 in $\Sigma^{0\prime\prime}$ of that universe. It must thus be said that the proper intrinsic metric spacetime $(\varnothing\rho', \varnothing c_s \varnothing t')$ of our universe is the projection (or 'shadow') of the four-dimensional proper metric spacetime $(\Sigma^{0\prime\prime}, c_s t^{0\prime})$ of the positive time-universe. As the converse, the proper intrinsic metric spacetime $(\varnothing\rho^{0\prime}, \varnothing c_s \varnothing t^{0\prime})$ of the positive time-universe is the projection (or 'shadow') of the four-dimensional proper metric spacetime $(\Sigma', c_s t')$ of our universe.

It also follows that the proper intrinsic metric spacetime $(-\varnothing\rho'^{*}, -\varnothing c_s \varnothing t'^{*})$ of the negative universe is the projection (or 'shadow') of the four-dimensional proper metric spacetime $(-\Sigma^{0\prime *}, -c_s t^{0\prime *})$ of the negative time-universe and the proper intrinsic metric spacetime $(-\varnothing\rho^{0\prime *}, -\varnothing c_s \varnothing t^{0\prime *})$ of the negative time-universe is the projection (or 'shadow') of the four-dimensional proper metric spacetime $(-\Sigma'^{*}, -c_s t'^{*})$ of the negative universe.

3.1.2 Origin of Two-Dimensional Intrinsic Rest Mass in the Two-Dimensional Proper Intrinsic Spacetime Underlying Four-Dimensional Rest Mass in the Four-Dimensional Proper Spacetime

Let us locate the four-dimensional rest mass $(m_0, \varepsilon'/c_s^2)$ of a particle at a point on the flat four-dimensional proper metric spacetime $(\Sigma', c_s t')$ of our universe. The identical four-dimensional rest mass $(m_0^0, \varepsilon^{0\prime}/c_s^2)$ of the symmetry-partner particle in the positive time-universe will be automatically located at the symmetry-partner point on the flat four-dimensional proper metric spacetime $(\Sigma^{0\prime}, c_s t^{0\prime})$ of that universe. This happens by virtue of the perfect symmetry of state among the four universes, which shall be prescribed at this point, but shall be established elsewhere.

However the four-dimensional rest mass $(m_0^0, \varepsilon^{0\prime}/c_s^2)$ in $(\Sigma^{0\prime}, c_s t^{0\prime})$, with respect to 3-observers^0 in the proper Euclidean 3-space $\Sigma^{0\prime}$ of the positive time-universe is naturally contracted to two-dimensional rest mass $(m_0^0, \varepsilon^{0\prime}/c_s^2)$ in two-dimensional proper metric spacetime $(\rho^{0\prime}, c_s t^{0\prime})$, with respect to 3-observers in the proper Euclidean 3-space Σ' of our universe, where the three-dimensional rest mass m_0^0 in $\Sigma^{0\prime}$ is equal to the one-dimensional rest mass m_0^0 in $\rho^{0\prime}$ in magnitude.

Thus the location of the rest masses, $(m_0, \varepsilon'/c_s^2)$ and $(m_0^0, \varepsilon^{0\prime}/c_s^2)$, of symmetry-partner particles at symmetry-partner points on the flat metric spacetimes $(\Sigma', c_s t')$ of our universe and $(\Sigma^{0\prime}, c_s t^{0\prime})$ of the positive time-universe, will cause Figs. 7a and 7b to be modified as Fig. 10a and 10b respectively.

The one-dimensional isotopic scalar proper metric space $\rho^{0\prime}$ along the vertical, being pseudo-orthogonal to the proper Euclidean 3-space Σ' (as a hyper-surface) along the horizontal, possesses static geodetic flow speed, $V_0 = c_s$, at every point along its length, with respect to 3-observers in Σ', as mentioned earlier. Consequently, the line of rest mass m_0^0 of a particle or object in $\rho^{0\prime}$ acquires the static geodetic flow speed c_s of $\rho^{0\prime}$, but it is not in motion at this speed along $\rho^{0\prime}$. The possession of the static geodetic flow speed c_s alone by m_0^0 along $\rho^{0\prime}$ is consequently a state of rest energy $m_0^0 c_s^2$, with respect to 3-observers in Σ', as illustrated in Figs. 10a.

The one-dimensional isotopic scalar proper metric space $\rho^{0\prime}$ transforms into the proper metric static time dimension $c_s t'$ and the rest energy $m_0^0 c_s^2$ in $\rho^{0\prime}$ transforms into rest energy $\varepsilon' (= m_0 c_s^2)$ in $c_s t'$ along the vertical, relative to 3-observers in Σ' in Fig. 10a. Like $\rho^{0\prime}$ that transforms into $c_s t'$, every point along $c_s t'$ possesses the static geodetic flow speed c_s relative to 3-observers in Σ'. Hence the rest energy $\varepsilon' (= m_0 c_s^2)$ in $c_s t'$, acquires the static geodetic flow speed c_s of $c_s t'$, but it is not in motion at this speed along $c_s t'$, relative to the 3-observer in Σ'.

The discussions in the preceding two paragraphs on Fig. 10a have their counterparts on Fig. 10b. The one-dimensional isotopic scalar proper metric space ρ' along the horizontal, being pseudo-orthogonal to the proper Euclidean 3-space $\Sigma^{0\prime}$ (as a hyper-surface) along the vertical, possesses static geodetic flow speed, $V_0 = c_s$, at every point along its length, with respect to

3-observers^0 in $\Sigma^{0\prime}$ in Fig. 10b. Consequently, the line of rest mass m_0 of a particle or object in ρ' acquires the static geodetic flow speed c_s of ρ', but it is not in motion at this speed along ρ'. The possession of speed c_s alone by m_0 along ρ' is consequently a state of rest energy $m_0c_s^2$, with respect to 3-observers in $\Sigma^{0\prime}$, as illustrated in Figs. 10b.

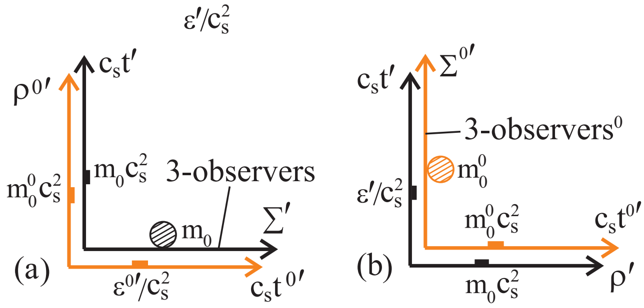

Fig. 10. Identical four-dimensional rest masses of symmetry-partner particles at symmetry-partner points on the flat four-dimensional proper spacetimes of our universe and the positive time-universe with respect to (a) 3-observers in the proper Euclidean 3-space of our universe and, (b) 3-observers^0 in the proper Euclidean 3-space of the positive time-universe

The one-dimensional isotopic scalar proper metric space ρ' transforms into the proper metric static time dimension $c_st^{0\prime}$ and the rest energy $m_0c_s^2$ in ρ' transforms into rest energy $\varepsilon^{0\prime}\,(= m_0^0c_s^2)$ in $c_st^{0\prime}$, along the horizontal relative to 3-observers^0 in $\Sigma^{0\prime}$ in Fig. 10b. Like ρ' that transforms into $c_st^{0\prime}$, every point along $c_st^{0\prime}$ possesses the static geodetic flow speed c_s. Hence the rest energy $\varepsilon^{0\prime}\,(= m_0^0c_s^2)$ in $c_st^{0\prime}$, acquires the static geodetic flow speed c_s of $c_st^{0\prime}$, but it is not in motion at speed c_s along $c_st^{0\prime}$, relative to any 3-observer^0 in $\Sigma^{0\prime}$.

On the other hand, every point in the proper Euclidean 3-spaces, Σ' and $\Sigma^{0\prime}$, possesses zero static geodetic flow speed, $V_0 = 0$, relative to 3-observers in the respective 3-spaces. Consequently the rest mass m_0 in Σ' is a state of rest mass with respect to 3-observers in Σ' and m_0^0 in $\Sigma^{0\prime}$ is a state of rest mass with respect to 3-observers^0 in $\Sigma^{0\prime}$, as illustrated in Figs. 10a and 10b.

The one-dimensional rest energy $m_0^0c_s^2$ in the one-dimensional scalar proper metric space $\rho^{0\prime}$ along the vertical in Figs. 10a can be said to be in non-detectable motion at constant speed, $V_0 = c_s$, along the positive axis of $\rho^{0\prime}$, relative to all 3-observers in the proper Euclidean 3-space Σ' in that figure. It is consequently in non-detectable absolute motion at speed c_s along $\rho^{0\prime}$. There is a mass relation in the context of absolute motion that can be applied for the non-detectable absolute motion at static geodetic flow speed, $V_0 = c_s$, of m_0^0 along $\rho^{0\prime}$, which is derived below.

Unlike the one-dimensional scalar proper metric space $\rho^{0\prime}$ that is artificially considered to be inclined at an angle $\eta_0 < \pi/2$ to the horizontal, which projects a component $\rho_{\rm h}^{0\prime}$ into the proper Euclidean 3-space Σ' (as a hyper-surface) along the horizontal in Eq. (1), the rest energy, $\varepsilon^{0\prime} = m_0^0c_s^2$, in $\rho^{0\prime}$ is neither a dimension nor the scalar fourth component of a four-vector. Hence it cannot be said that $m_0^0c_s^2$ in $\rho^{0\prime}$ that is artificially considered to be inclined at an angle, $\eta_0 < \pi/2$, to the horizontal, projects a component into Σ' along the horizontal.

However a scalar 'rest momentum', $p^{0\prime} = m_0^0c_s$, is associated with the rest energy, $\varepsilon^{0\prime} = m_0^0c_s^2$, as $\varepsilon^{0\prime} = p^{0\prime}c_s$ or $m_0^0c_s^2 = (m_0^0c_s)c_s$. The 'rest momentum' $p^{0\prime}$ in $\rho^{0\prime}$ is the scalar fourth component $p^{0\prime}$ of momentum four-vector $(p^{0\prime}, m_0\vec{v})$ in (c_st', Σ'). The $p^{0\prime}$ in $\rho^{0\prime}$ that is artificially considered to be inclined at an angle, $\eta_0 < \pi/2$, to the horizontal, projects a component $p_{\rm h}^{0\prime}$ into Σ' (as a hyper-surface) along the horizontal namely,

$$p_{\rm h}^{0\prime} = p^{0\prime}\cos\eta_0 \qquad (6a)$$

or

$$m_0^0 v_0 = m_0^0 c_s \cos\eta_0\ . \qquad (6b)$$

As stated by Eq. (6b), it is the static geodetic flow speed factor c_s in, $p^{0\prime} = m_0^0 c_s$, along the artificially inclined $\rho^{0\prime}$ that projects a component of static geodetic flow speed v_0 into Σ', while the rest mass m_0^0 remains unchanged in the projected component $p_{\rm h}^{0\prime} = m_0^0 v_0$. Thus canceling m_0^0 in Eq. (6b) gives

$$v_0 = c_s \cos\eta_0\ . \qquad (7)$$

The static geodetic flow speed c_s of every point of the artificially inclined $\rho^{0\prime}$, as the scalar fourth component of the velocity four-vector, projects a component v_0 into Σ' (as a hyper-surface) along the horizontal, as stated by Eq. (7).

Multiplication of Eq. (6a) or (6b) by v_0 gives the rest energy formed in (or effectively 'projected' into) Σ' by $m_0^0 c_s^2$ in the artificially inclined $\rho^{0\prime}$ as

$$\varepsilon_{\rm h}^{0\prime} = m_0^0 v_0^2 = m_0^0 c_s^2 \cos^2\eta_0\ . \qquad (8)$$

Let us write the rest energy, $\varepsilon_{\rm h}^{0\prime} = m_0^0 v_0^2$, as a rest energy in terms of c_s^2 by introducing another rest mass $m_{0\rm h}^0$ as

$$\varepsilon_{\rm h}^{0\prime} = m_{0\rm h}^0 c_s^2 = m_0^0 c_s^2 \cos^2\eta_0\ , \qquad (9a)$$

hence,

$$m_{0\rm h}^0 = m_0^0 \cos^2\eta_0\ . \qquad (9b)$$

Equation (9b) is the desired effective mass 'projection' expression. It states that the rest mass m_0^0 in the rest energy $m_0^0 c_s^2$ in $\rho^{0\prime}$ that is artificially considered to be inclined at an angle $\eta_0 < \pi/2$ to the horizontal, forms rest mass factor $m_{0\rm h}^0$ in the rest energy $m_{0\rm h}^0 c_s^2\ (= m_0^0 v_0^2)$ formed in (or effectively 'projected' into) Σ'.

Now $\rho^{0\prime}$ containing $m_0^0 c_s^2$ is naturally along the vertical as illustrated in Fig. 10a. We must therefore let $\psi_0 = \pi/2$ for the natural situation in Eq. (9b) to have

$$m_{0\rm h}^0 = m_0^0 \cos^2\frac{\pi}{2} = 0\ . \qquad (10)$$

Equation (10) states that m_0^0 (as a factor in $m_0^0 c_s^2$) in $\rho^{0\prime}$ along the vertical forms absolute nothing in Σ' (as a hyper-surface) along the horizontal. However m_0^0 in $\rho^{0\prime}$ definitely 'casts a shadow' in Σ'.

Actually, it is the factor $\cos^2\pi/2$ that vanishes and not m_0^0 multiplying it in Eq. (10). Thus let us re-write Eq. (10) as

$$m_{0\rm h}^0 = m_0^0 \cos^2\frac{\pi}{2} = 0 \times m_0^0 \equiv \varnothing m_0\ . \qquad (11)$$

Instead of saying that m_0^0 in $\rho^{0\prime}$ forms (or effectively 'projects') absolute nothing into Σ', as stated by Eq. (10), an entity $\varnothing m_0$ is associated with the 'shadow' of m_0^0 in Σ' in Eq. (11). The entity $\varnothing m_0$ is without the dummy superscript "0" label, used to differentiate the coordinates and parameters of the time-universes from those of our universe and the negative universe, because it is an entity formed in our proper Euclidean 3-space Σ', thereby being an entity of our universe.

Now any quantity of $\varnothing m_0$ is equivalent to zero quantity of m_0^0 that forms it, as follows from, $\varnothing m_0 = 0 \times m_0^0$, in Eq. (11). It then follows that any quantity of $\varnothing m_0$ is equivalent to zero quantity of the rest mass m_0 in our Euclidean 3-space Σ', since m_0 and m_0^0 are equal in magnitude, as deduced earlier. In other words, any quantity of $\varnothing m_0$ is no quantity of mass. The name nomass shall be coined for $\varnothing m_0$ from the preceding statement. The $\varnothing m_0$ is the proper (or classical) nomass by virtue of the subscript "0" on it. The nomass $\varnothing m_0$ is non-observable and non-detectable to 3-observers in Σ', since it is equivalent to zero rest mass.

An alternative name of intrinsic mass shall be given to nomass, where intrinsic has the meaning of non-observable and non-detectable. The $\varnothing m_0$ is the intrinsic rest mass by virtue of the subscript "0" on it. The proper (or classical) nomass (or the intrinsic rest mass) $\varnothing m_0$ is formed in the proper nospace (or proper intrinsic space) $\varnothing\rho'$ projected into Σ' by $\rho^{0\prime}$ in Eq. (3).

Just as the rest mass m_0^0 in $\rho^{0\prime}$ of the positive time-universe along the vertical forms (or effectively 'projects') a 'shadow' of classical nomass (or intrinsic rest mass) $\varnothing m_0$ in the proper Euclidean 3-space Σ' of our universe along the horizontal, as derived above, the rest mass $\varepsilon^{0\prime}/c_s^2 (= m_0^0)$ in the proper metric time dimension $c_s t^{0\prime}$ of the positive time-universe along the horizontal in Fig. 10a, 'casts a shadow' in the proper metric time dimension $c_s t'$ of our universe along the vertical in that figure.

We must simply replace $m_{0\mathrm{h}}^0$ by $\varepsilon_{\mathrm{v}}^{0\prime}/c_s^2$ and m_0^0 by $\varepsilon^{0\prime}/c_s^2$ in Eq. (9b) to have the 'shadow' (or effective 'projection') of $\varepsilon^{0\prime}/c_s^2$ in $c_s t'$ along the vertical as

$$\varepsilon_{\mathrm{v}}^{0\prime}/c_s^2 = (\varepsilon^{0\prime}/c_s^2)\cos^2\eta_0 \ . \tag{12}$$

Equation (12) expresses the effective 'projection' into $c_s t'$ along the vertical of $\varepsilon^{0\prime}/c_s^2$ in $c_s t^{0\prime}$ that is artificially considered to be inclined at an angle $\eta_0 < \pi/2$ to the vertical. However $c_s t^{0\prime}$ is naturally along the horizontal as illustrated in Fig. 10a, or $\eta_0 = \pi/2$ naturally in Eq. (12). Thus letting $\psi_0 = \pi/2$ in Eq. (12) for the natural situation gives

$$\varepsilon_{\mathrm{v}}^{0\prime}/c_s^2 = (\varepsilon^{0\prime}/c_s^2)\cos^2\frac{\pi}{2} = 0 \ . \tag{13}$$

Equation (13) states that $\varepsilon^{0\prime}/c_s^2$ in $c_s t^{0\prime}$ along the horizontal forms (or effectively 'projects') absolute nothing into $c_s t'$ along the verrical in Fig. 10a. However $\varepsilon^{0\prime}/c_s^2$ in $c_s t^{0\prime}$ certainly 'casts a shadow' in $c_s t'$. Actually it is the factor $\cos^2\pi/2$ that vanishes and not $\varepsilon^{0\prime}/c_s^2$ multiplying it in Eq. (13). Thus let us re-write Eq. (13) as

$$\varepsilon_{\mathrm{v}}^{0\prime}/c_s^2 = (\varepsilon^{0\prime}/c_s^2)\cos^2\frac{\pi}{2} = 0\times\varepsilon^{0\prime}/c_s^2 \equiv \varnothing\varepsilon'/\varnothing c_s^2 \ . \tag{14}$$

While Eq. (13) says that $\varepsilon^{0\prime}/c_s^2$ in $c_s t^{0\prime}$ along the horizontal forms absolute nothing in $c_s t'$ along the vertical in Fig. 10a, an entity $\varnothing\varepsilon'/\varnothing c_s^2$ is associated with the 'shadow' of $\varepsilon^{0\prime}/c_s^2$ in $c_s t'$ in Eq. (14). The $\varnothing\varepsilon'/\varnothing c_s^2$ is without the dummy superscript "0" label, because it is an entity formed in the time dimension $c_s t'$ of our universe, thereby being an entity of our universe without superscript "0" label.

Now any quantity of $\varnothing\varepsilon'/\varnothing c_s^2$ is equivalent to zero quantity of the rest mass $\varepsilon^{0\prime}/c_s^2$ that forms it, as follows from, $\varnothing\varepsilon'/\varnothing c_s^2 = 0\times\varepsilon^{0\prime}/c_s^2$ in Eq. (14). Hence any quantity of $\varnothing\varepsilon'/\varnothing c_s^2$ is equivalent to zero quantity of rest mass ε'/c_s^2 in our time dimension $c_s t'$, since $\varepsilon^{0\prime}/c_s^2$ and ε'/c_s^2 are equal in magnitude. In other words, any quantity of $\varnothing\varepsilon'/\varnothing c_s^2$ is no quantity of mass. The name nomass shall be coined for $\varnothing\varepsilon'/\varnothing c_s^2$ from the preceding statement. The $\varnothing\varepsilon'/\varnothing c_s^2$ is the proper (or classical) nomass by virtue of the prime label on it. The nomass $\varnothing\varepsilon'/\varnothing c_s^2$ is non-observable and non-detectable to 1-observers in $c_s t'$, since it is equivalent to zero rest mass.

An alternative name of intrinsic mass shall be given to $\varnothing\varepsilon'/\varnothing c_s^2$, where $\varnothing\varepsilon'/\varnothing c_s^2$ is the intrinsic rest mass by virtue of the prime label on it. The proper (or classical) nomass (or intrinsic rest mass) $\varnothing\varepsilon'/\varnothing c_s^2$ is resident in the proper notime (or proper intrinsic time) dimensions $\varnothing c_s\varnothing t'$ projected into $c_s t'$ along the vertical by $c_s t^{0\prime}$ along the horizontal in Eq. (5).

Graphically let us incorporate $\varnothing m_0$ formed in $\varnothing\rho'$ along the horizontal and $\varnothing\varepsilon'/\varnothing c_s^2$ formed in $\varnothing c_s\varnothing t'$ along the vertical into Fig. 10a to have Fig. 11a. It is straight forward to repeat the derivations from Eqs. (6a) and (6b) through Eq. (14), based on Fig. 10a, which lead to Fig. 11a, for Fig. 10b. The derivations based on Fig. 10b shall not be done to save space, but Fig. 11b they lead to shall be presented as counterpart in the positive time-universe of Fig. 11a in our universe.

It is clear from Fig. 11a that the flat two-dimensional proper metric spacetime $(\rho^{0\prime}, c_s t^{0\prime})$ containing two-dimensional rest mass $(m_0^0, \varepsilon^{0\prime}/c_s^2)$ of the positive time- universe, with respect to 3-observers in the proper Euclidean 3-space Σ' of our universe, forms (or projects) flat two-dimensional proper intrinsic metric spacetime $(\varnothing\rho', \varnothing c_s\varnothing t')$ containing two-dimensional intrinsic rest mass $(\varnothing m_0, \varepsilon'/\varnothing c_s^2)$ into (or 'underneath') the flat four-dimensional proper metric spacetime $(\Sigma', c_s t')$ containing the four-dimensional rest mass $(m_0, \varepsilon'/c_s^2)$ of the symmetry-partner particle of our universe.

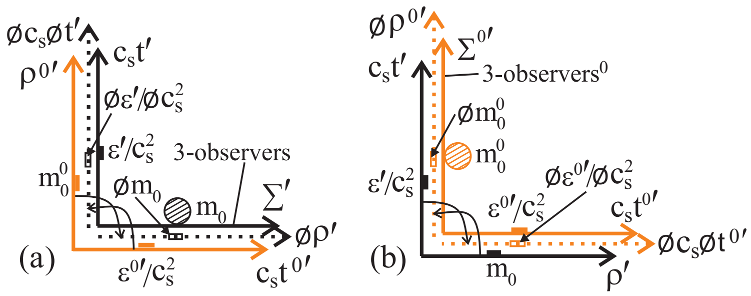

Fig. 11. (a) Two-dimensional rest mass of a particle on the flat two-dimensional proper metric spacetime of the positive time-universe, with respect to 3-observers in the proper Euclidean 3-space of our universe, 'projects' two-dimensional intrinsic rest mass into projective two-dimensional proper intrinsic metric spacetime underneath (or embedded in) the flat four-dimensional rest mass of the symmetry-partner particle in the flat four-dimensional proper metric spacetime in our universe and, (b) conversely

Conversely, the flat two-dimensional proper metric spacetime $(\rho', c_s t')$ containing two-dimensional rest mass $(m_0, \varepsilon'/c_s^2)$ of our universe, with respect to 3-observers^0 in the proper Euclidean 3-space $\Sigma^{0\prime}$ of the positive time-universe in Fig. 11b, forms (or projects) flat two-dimensional proper intrinsic metric spacetime $(\varnothing\rho^{0\prime}, \varnothing c_s \varnothing t^{0\prime})$ containing two-dimensional intrinsic rest mass $(\varnothing m_0^0, \varepsilon^{0\prime}/\varnothing c_s^2)$ into (or 'underneath') the flat four-dimensional proper metric spacetime $(\Sigma^{0\prime}, c_s t^{0\prime})$ containing the four-dimensional rest mass $(m_0^0, \varepsilon^{0\prime}/c_s^2)$ of the symmetry-partner particle of the positive time-universe.

However the flat two-dimensional proper metric spacetime $(\rho^{0\prime}, c_s t^{0\prime})$ containing two-dimensional rest mass $(m_0^0, \varepsilon^{0\prime}/c_s^2)$ of a particle of the positive time-universe, with respect to 3-observers in the proper Euclidean 3-space Σ' of our universe in Fig. 11a, is actually a flat four-dimensional proper metric spacetime $(\Sigma^{0\prime}, c_s t^{0\prime})$ containing four-dimensional rest mass $(m_0^0, \varepsilon^{0\prime}/c_s^2)$ of the particle with respect to 3-observers^0 in the proper Euclidean 3-space $\Sigma^{0\prime}$ of the positive time-universe.

Likewise the flat two-dimensional proper metric spacetime $(\rho', c_s t')$ containing two-dimensional rest mass $(m_0, \varepsilon'/c_s^2)$ of the symmetry-partner particle of our universe, with respect to 3-observers in the proper Euclidean 3-space $\Sigma^{0\prime}$ of the positive time-universe in Fig. 11b, is actually a flat four-dimensional proper metric spacetime $(\Sigma', c_s t')$ containing four-dimensional rest mass $(m_0, \varepsilon'/c_s^2)$ of the symmetry-partner particle, with respect to 3-observers in the proper Euclidean 3-space Σ' of our universe.

What must be concluded from the foregoing four paragraphs is that, the flat four-dimensional proper metric spacetime $(\Sigma^{0\prime}, c_s t^{0\prime})$ containing the four-dimensional rest mass $(m_0^0, \varepsilon^{0\prime}/c_s^2)$ of a particle or object, of the positive time-universe, forms (or projects) flat two-dimensional proper intrinsic metric spacetime $(\varnothing\rho', \varnothing c_s \varnothing t')$ containing two-dimensional intrinsic rest mass $(\varnothing m_0, \varnothing\varepsilon'/\varnothing c_s^2)$ of the particle or object into (or 'underneath') the flat four-dimensional proper metric spacetime $(\Sigma', c_s t')$ containing the four-dimensional rest mass $(m_0, \varepsilon'/c_s^2)$ of the the symmetry-partner particle or object of our universe.

Although the two proper spacetimes containing rest masses and the proper intrinsic spacetime containing intrinsic rest mass in each of Figs. 11a and 11b exist with respect to the indicated 3-observers, let us hide the flat two-dimensional proper metric spacetime $(\rho^{0\prime}, c_s t^{0\prime})$ containing two-dimensional rest mass $(m_0^0, \varepsilon^{0\prime}/c_s^2)$ of the positive time-universe with respect to 3-observers in the Euclidean 3-space Σ' of our universe in Fig. 11a, which are hidden to observers in our universe and cannot appear in physics in our universe from that figure. On the other hand, the two-dimensional proper intrinsic metric spacetime $(\varnothing\rho', \varnothing c_s \varnothing t')$

containing intrinsic rest mass $(\varnothing m_0, \varnothing\varepsilon'/\varnothing c_s^2)$ formed in our universe by $(\rho^{0\prime}, c_s t^{0\prime})$ containing $(m_0^0, \varepsilon^{0\prime}/c_s^2)$ must be retained, since it can appear in intrinsic physics in our universe. When the resulting diagram in our (or positive) universe is combined with its symmetry-partner in the negative universe, we have Fig. 12a.

Likewise, let us hide the flat two-dimensional proper metric spacetime $(\rho', c_s t')$ containing two-dimensional rest mass $(m_0, \varepsilon'/c_s^2)$ of our universe with respect to 3-observers^0 in the Euclidean 3-space $\Sigma^{0\prime}$ of the positive time-universe in Fig. 11b, which are hidden to 3-observers^0 in the positive time-universe and cannot appear in physics in the positive time-universe from that figure. On the other hand, the two-dimensional proper intrinsic metric spacetime $(\varnothing\rho^{0\prime}, \varnothing c_s \varnothing t^{0\prime})$ containing intrinsic rest mass $(\varnothing m_0^0, \varnothing\varepsilon^{0\prime}/\varnothing c_s^2)$ formed in the positive time-universe by $(\rho', c_s t')$ containing $(m_0, \varepsilon'/c_s^2)$, must be retained, since it can appear in intrinsic physics in the positive time-universe. When the resulting diagram in the positive time-universe is combined with its symmetry-partner in the negative time-universe, we have Fig. 12b.

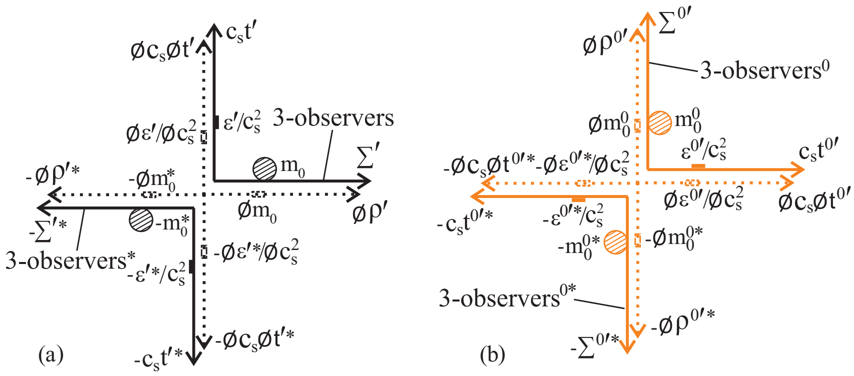

Fig. 12. Flat two-dimensional proper intrinsic metric spacetime containing two-dimensional intrinsic rest mass of a particle or object embedded in (or 'underlying') the flat four-dimensional proper metric spacetime containing the four-dimensional rest mass of the particle or object (a) in our universe and the negative universe and (b) in the positive time-universe and the negative time-universe

The quartet of four-dimensional rest masses located in the quartet of four-dimensional spacetimes in Figs. 12a and 12b, belong to a quartet of symmetry-partner particles or objects. The masses of the members of every quartet of symmetry-partner particles or bodies are symmetrically located in spacetimes in the four universes. This means that they are located at symmetry-partner points in spacetimes in the universes.

3.2 Showing that Symmetry-partner Point in Spacetimes in the Four Universes are Effectively not Separated

Let us temporarily keep the rest masses, the intrinsic spacetimes and the intrinsic rest masses away from Figs. 12a and 12b and present the resulting pairs of four-dimensional spacetimes as Figs. 13a and 13b with some further details shown.

Now the proper Euclidean 3-space $\Sigma^{0\prime}$ of the positive time-universe with respect to 3-observers^0 in it in Fig. 13b, is what appears as the proper time dimension $c_s t'$ of our universe relative to 3-observers in the Euclidean 3-space Σ' of our universe in Fig. 13a. Hence points, O^0, B^0 and B_1^0, in Fig. 13b are the same as the points, O, B and B_1, in Fig. 13a.

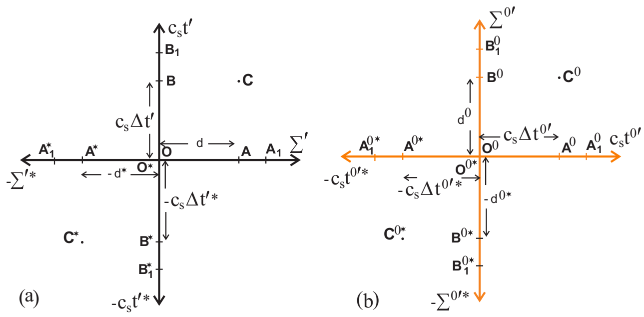

Fig. 13. Four-dimensional spacetimes of the four universes with quartets of symmetry-partner points in spacetimes shown

Likewise the proper Euclidean 3-space Σ' of our universe, with respect to 3-observers in it in Fig. 13a, is what appears as the proper time dimension $c_s t^{0\prime}$ of the positive time-universe relative to 3-observers^0 in the Euclidean 3-space $\Sigma^{0\prime}$ of the positive time-universe in Fig. 13b. Hence points, O, A and A_1, in Fig. 13a are the same as points, O^0, A^0 and A_1^0 in Fig. 13b.

The points, O^{0*}, B^{0*} and B_1^{0*}, in Fig. 13b are the same as the points, O^*, B^* and B_1^*, in Fig. 13a and the points, O^*, A^* and A_1^*, in Fig. 13a are the same as points, O^{0*}, A^{0*} and A_1^{0*} in Fig. 13b. The point C^0 in spacetime $(\Sigma^{0\prime}, c_s t^{0\prime})$ in Fig. 13b is the same as point C in $(\Sigma', c_s t')$ in Fig. 13a and point C^* in $(-\Sigma'^*, -c_s t'^*)$ in Fig. 13a is the same as point C^{0*} in $(-\Sigma^{0'}{}^*, -c_s t^{0'}{}^*)$ in Fig. 13b.

As follows from the preceding three paragraphs, we only need to show the non-separation or otherwise of symmetry partner points in spacetime in Fig. 13a to confirm their non-separations from their corresponding symmetry-partner points in spacetime in Fig. 13b and conversely. In other words, if points A and A^* are effectively not separated, then the four points, A, A^*, A^0 and A^{0*}, are effectively not separated, for instance, since points A and A^0 are the same and points A^* and A^{0*} are the same.

Now Fig. 13a is Fig. 5 of [1]. It is shown under Fig. 5 of that paper that points A and A^* in Fig. 13a are effectively separated by zero distance, $\mathrm{d} - \mathrm{d}^* = 0$. Hence points A and A^* are effectively not separated. Points B and B^* in Fig. 13a are effectively separated by zero interval of proper time dimension, $c_s \Delta t' - c_s \Delta t'^* = 0$. Hence points B and B^8 are effectively not separated. Consequently points C and C^* are effectively not separated in Fig. 13a. Then as follows from the preceding paragraph, points A, A^*, A^0 and A^{0*} in Figs. 13a and 13b are effectively not separated; points, B, B^*, B^0 and B^{0*}, in Figs. 13a and 13b are effectively not separated and, consequently, points, C, C^*, C^0 and C^{0*}, in Figs. 13a and 13b are effectively not separated. Although every quartet of symmetry-partner points in spacetimes in the four universes are effectively not separated, they do not touch, because they are points of different spacetimes.

It is also described under Fig. 5 of [1] that, as the rest mass m_0 of a particle in Σ' moves at speed v from point A to point A_1, the rest mass $-m_0^*$ of the symmetry-partner particle in $-\Sigma'^*$ moves from point A^* to point A_1^* at identical speed v. The one-dimensional rest mass ε'/c_s^2 in $c_s t'$ moves at the speed v from point B to point B_1 and $-\varepsilon'^*/c_s^2$ in $-c_s t'^*$ moves at identical speed v from point B^* to point B_1^* in Fig. 13a. The motions at identical speed v of the rest masses, m_0, ε'/c_s^2, $-m_0^*$ and $-\varepsilon'^*/c_s^2$, occur simultaneously in their respective spaces and time dimensions in Fig. 13a. This follows from the so far prescribed perfect symmetry of state between our (or positive) universe and the negative universe.

Likewise as as m_0^0 of a particle in $\Sigma^{0\prime}$ in Fig. 13b (which is actually ε'/c_s^2 in $c_s t'$ in Fig. 13a), moves at speed v from point A^0 to point A_1^0, the rest mass $-m_0^{0*}$ of the symmetry-partner particle in $-\Sigma^{0'}{}^*$ moves from point A^{0*} to point A_1^{0*} at identical speed v. The one-dimensional rest mass $\varepsilon^{0\prime}/c_s^2$ in $c_s t^{0\prime}$ in Fig. 13b (which is actually

m_0 in Σ' in Fig. 13a), moves at equal speed v from point B^0 to point B$_1^0$ and $-\varepsilon^{0'^*}/c_s^2$ in $-c_st'^{0*}$ moves at identical speed v from point B^{0*} to point B$_1^{0*}$ in Fig. 13b. The motions at identical speed v of the rest masses, m_0^0, $\varepsilon^{0\prime}/c_s^2$, $-m_0^{0*}$ and $-\varepsilon'^{0*}/c_s^2$, occur simultaneously in their respective spaces and time dimensions in Fig. 13b. This again follows from a prescribed perfect symmetry of state between positive time-universe and the negative time-universe.

The rest masses, m_0, ε'/c_s^2, $-m_0^*$ and $-\varepsilon'^*/c_s^2$ in Fig. 13a and m_0^0, $\varepsilon^{0\prime}/c_s^2$, $-m_0^{0*}$ and $-\varepsilon'^{0*}/c_s^2$ in Figs. 13b, mentioned in the preceding two paragraphs, are symmetry-partners. They commence motions from symmetry-partner points, A, B, A*, B*, A^0, B^0, A^{0*} and B^{0*}; move at identical speed v and reach new symmetry-partner points, A$_1$, B$_1$, A$_1^*$, B$_1^*$, A$_1^0$, B$_1^0$, A$_1^{0*}$ and B$_1^{0*}$ respectively simultaneously. The new quartet of symmetry-partner points, A$_1$, A$_1^*$, A$_1^0$ and A$_1^{0*}$, are effectively not separated and the new quartet of symmetry-partner points, B$_1$, B$_1^*$, B$_1^0$ and B$_1^{0*}$, are effectively not separated.

The import of the foregoing discussions is to show that the members of every quartet of symmetry-partner particles or bodies in the four universes are effectively not separated in space or time, whether they are stationary or in motion in their respective spacetimes. However they do not touch because they exist in different spacetimes. The fact that they are in simultaneous identical (or symmetrical) motions in their respective spacetimes is implied and this shall be shown more rigorously elsewhere.

As established in previous papers [1, 2], our (or positive) universe is separated by event horizons along the time dimensions, c_st' and $-c_st'^*$, in Fig. 13a. This makes observers in our universe to be unable to observe the negative universe and the events taking place in it, vice versa. The positive time-universe is likewise separated from the negative time-universe by event horizons along the time dimensions, $c_st^{0\prime}$ and $-c_st'^{0*}$, in Fig. 13b. This likewise makes observers in the positive time-universe to be unable to observe the negative time-universe and the events taking place in it, vice versa.

On the other hand, the Euclidean 3-space $\Sigma^{0\prime}$ of the positive time-universe containing three-dimensional particles and bodies, with respect to 3-observers^0 in it in Fig. 13b, is the scalar time dimension c_st' of our universe containing one-dimensional particles and bodies, with respect to 3-observers in the Euclidean 3-space Σ' of our universe. The scalar time dimension $c_st^{0\prime}$ of the positive time-universe, containing one-dimensional particles and bodies, with respect to 3-observers in the Euclidean 3-space $\Sigma^{0\prime}$ of the positive time-universe in Fig. 13b, is the Euclidean 3-space Σ' containing three-dimensional particles and bodies of our universe, with respect to 3-observers in Σ' in Fig. 13a.

It follows from the preceding paragraph that the positive time-universe cannot be perceived better than the scalar static time dimension c_st' containing one-dimensional particles and bodies of our universe, by 3-observers in the Euclidean 3-space Σ' of our universe, and conversely. In symmetry, the negative time-universe cannot be perceived better than the scalar static time dimension $-c_st'^*$ containing one-dimensional particles and bodies of the negative universe, by 3-observers* in the Euclidean 3-space Σ'^* of the negative universe, and conversely.

4 FINAL JUSTIFICATION FOR THE NEW SPACETIME AND INTRINSIC SPACETIME GEOMETRICAL REPRESENTATIONS OF LORENTZ TRANSFORMATION AND INTRINSIC LORENTZ TRANSFORMATION AND THEIR INVERSES IN THE TWO-WORLD PICTURE

New geometrical representations of Lorentz transformation and intrinsic Lorentz transformation (LT/∅LT) and their inverses are derived and presented as Figs. 8a and 8b and Figs. 9a and 9b of [1], within the two-world picture isolated in that paper. However at least two outstanding issues about those diagrams remain to be resolved (or explained) in order to finally justify them. The first issue is the unexplained origin of Fig. 8b that must necessarily be drawn to complement Fig. 8a of [1] in deriving ∅LT and LT.

The second issue is the unspecified reason why anticlockwise relative rotations of intrinsic affine spacetime coordinates are positive rotations (involving positive intrinsic angle $\varnothing\psi$) with respect to 3-observers in the Euclidean 3-spaces Σ' and $-\Sigma'^{*}$ in Fig. 8a of [1], while, at the same time, clockwise relative rotations of intrinsic affine spacetime coordinates are positive rotations (involving positive intrinsic angle $\varnothing\psi$) with respect to 1-observers in the proper metric time dimensions, $c_s t'$ and $-c_s t'^{*}$, in Fig. 8b of that paper. These two issues shall be explained within the larger four-world picture encompassed by Figs. 12a and 12b of this paper.

Let us as done in deriving Figs. 8a and 8b and their inverses, Figs. 9a and 9b, of [1], toward the derivation of intrinsic Lorentz transformation and Lorentz transformation (∅LT/LT) and their inverses in the positive and negative universes in that paper, prescribe particle's primed and unprimed affine frames in terms of extended affine spacetime coordinates in the positive (or our) universe as, $(\tilde{x}', \tilde{y}', \tilde{z}', c_s\tilde{t}')$ and $(\tilde{x}, \tilde{y}, \tilde{z}, c_s\tilde{t}\,)$, respectively. They are underlay by particle's primed and unprimed intrinsic affine frames in terms of extended intrinsic affine coordinates, $(\varnothing\tilde{x}', \varnothing c_s\varnothing\tilde{t}')$ and $(\varnothing\tilde{x}, \varnothing c_s\varnothing\tilde{t})$, respectively.

The prescribed perfect symmetry of state between the positive universe and the negative universe in [1], implies that there exist identical symmetry-partner particle's primed affine frame and identical particle's unprimed affine frame, $(-\tilde{x}'^{*}, -\tilde{y}'^{*}, -\tilde{z}'^{*}, -c_s\tilde{t}'^{*})$ and $(-\tilde{x}^{*}, -\tilde{y}^{*}, -\tilde{z}^{*}, -c_s\tilde{t}^{*})$, respectively, as well as their underlying identical symmetry-partner particle's primed intrinsic affine frame and symmetry-partner particle's unprimed intrinsic affine frame, $(-\varnothing\tilde{x}'^{*}, -\varnothing c_s\varnothing\tilde{t}'^{*})$ and $(-\varnothing\tilde{x}^{*}, -\varnothing c_s\varnothing\tilde{t}^{*})$, respectively in the negative universe.

Let us consider the motion at a constant speed v of the rest mass m_0 of a particle along the affine space coordinate $\tilde{x}'$ of its primed affine frame and the underlying intrinsic motion at constant intrinsic speed $\varnothing v$ of the intrinsic rest mass $\varnothing m_0$ of the particle along the primed intrinsic affine space coordinate $\varnothing\tilde{x}'$ of its primed intrinsic affine frame, relative to a 'stationary' 3-observer in the proper Euclidean 3-space Σ' in the positive universe. Again the prescribed perfect symmetry of state between the positive and negative universes implies that the rest mass $-m_0^{*}$ of the symmetry-partner particle is in simultaneous motion at equal constant speed v along the $-\tilde{x}'^{*}$-axis of its primed affine frame of reference and its intrinsic rest mass $-\varnothing m_0^{*}$ is in simultaneous intrinsic motion at equal intrinsic speed $\varnothing v$ along the intrinsic affine space coordinate $-\varnothing\tilde{x}'^{*}$ of its primed intrinsic affine frame, relative to the symmetry-partner 3-observer* in the proper Euclidean 3-space $-\Sigma'^{*}$ in the negative universe.

As developed in sub-section 4.4 of [1], the simultaneous identical motions of symmetry-partner particles relative to symmetry-partner 'stationary' observers in the positive and negative universes, described in the preceding paragraph, give rise to Fig. 8a of that article with respect to 'stationary' 3-observers in the Euclidean metric 3-spaces, Σ' and $-\Sigma'^{*}$, which shall be reproduced here as Fig. 14a. The flat proper metric spacetimes, $(\Sigma', c_s t')$ and $(-\Sigma'^{*}, -c_s t'^{*})$, in which the 'stationary' observers are located and their underlying flat proper intrinsic metric spacetimes, $(\varnothing\rho', \varnothing c_s\varnothing t')$ and $(-\varnothing\rho'^{*}, -\varnothing c_s\varnothing t'^{*})$, are not shown in Fig. 14a for convenience, unlike as done in Fig. 8a of [1].

It is to be remembered that the particle's unprimed affine frame $(\tilde{x}, \tilde{y}, \tilde{z}, c_s\tilde{t}\,)$ (also denoted by $(\tilde{\Sigma}', c_s\tilde{t}')$ in Fig. 14a), is embedded in the flat proper metric spacetime $(\Sigma', c_s t')$ in the positive universe and $(-\tilde{x}^{*}, -\tilde{y}^{*}, -\tilde{z}^{*}, -c_s\tilde{t}^{*})$ (also denoted by $(-\tilde{\Sigma}'^{*}, -c_s\tilde{t}'^{*})$ in Fig. 14a), is embedded in the proper metric spacetime $(-\Sigma'^{*}, -c_s t'^{*})$ in the negative universe in Fig. 14a.

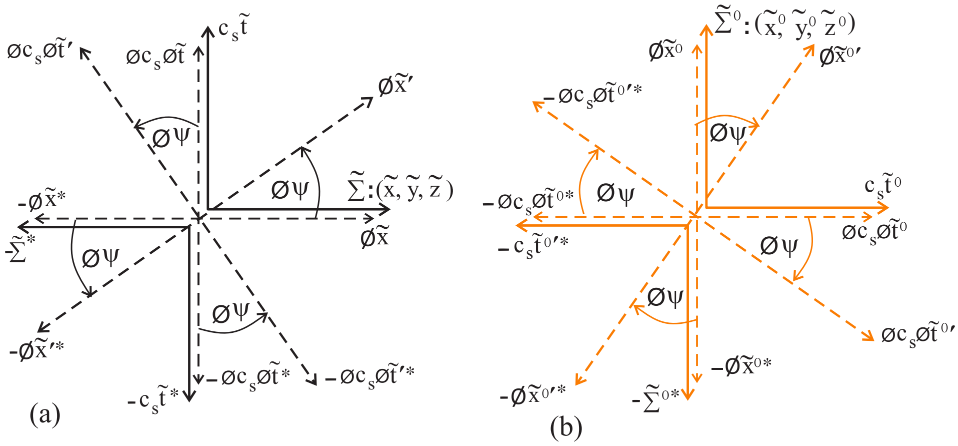

Fig. 14. Rotations of primed intrinsic affine spacetime coordinates of particles' primed intrinsic affine frames relative to the projective unprimed intrinsic affine spacetime coordinates of the particles' unprimed intrinsic affine frames that are valid relative to the 'stationary' symmetry-partner 3-observers in the proper metric Euclidean 3-spaces (not shown) in (a) the positive and negative universes and (b) the positive time-universe and the negative time-universe

The so far prescribed symmetry of state among the four universes encompassed by Figs. 12a and 12b of this paper, but which shall be validated elsewhere, implies that identical symmetry-partner particles undergo identical motions simultaneously relative to identical symmetry-partner 'stationary' observers in the four universes. It follows from this that Fig. 14b drawn upon the reference flat four-dimensional proper metric spacetimes and its underlying flat two-dimensional proper intrinsic metric spacetimes of the positive time-universe and the negative time-universe in Fig. 12b, co-exists with Fig. 14a drawn upon Fig. 12a in nature. The flat proper metric spacetimes, $(\Sigma^{0\prime}, c_s t^{0\prime})$ and $(-\Sigma^{0\prime *}, -c_s t^{0\prime *})$, in which the 'stationary' observers^0 are located and their underlying flat proper intrinsic metric spacetimes, $(\varnothing\rho^{0\prime}, \varnothing c_s \varnothing t^{0\prime})$ and $(-\varnothing\rho^{0\prime *}, -\varnothing c_s \varnothing t^{0\prime *})$, are again not shown in Figs. 14b for convenience.

It is also to be remembered that the particle's unprimed affine frame $(\tilde{x}^0, \tilde{y}^0, \tilde{z}^0, c_s\tilde{t}^0)$ (also denoted by $(\tilde{\Sigma}^{0\prime}, c_s\tilde{t}^{0\prime})$ in Fig. 14b), is embedded in the flat proper metric spacetime $(\Sigma^{0\prime}, c_s t^{0\prime})$ in the positive time-universe and $(-\tilde{x}^{\,0*}, -\tilde{y}^{\,0*}, -\tilde{z}^{\,0*}, -c_s\tilde{t}^{\,0*})$ (also denoted by $(-\tilde{\Sigma}^{0\prime *}, -c_s\tilde{t}^{0\prime *})$ in Fig. 14b), is embedded in the proper metric spacetime $(-\Sigma^{0\prime *}, -c_s t^{0\prime *})$ in the negative time-universe in Fig. 14b.

Fig. 14b is valid with respect to 3-observers in the Euclidean 3-spaces $\Sigma^{0\prime}$ of the positive time-universe and $-\Sigma^{0\prime *}$ of the negative time-universe (not shown). It is to be noted that the anti-clockwise rotations of the primed intrinsic affine spacetime coordinates $\varnothing\tilde{x}^{\,\prime}$ and $\varnothing c_s \varnothing\tilde{t}^{\,\prime}$ relative to their projective unprimed intrinsic affine coordinates $\varnothing\tilde{x}$ and $\varnothing c_s\varnothing\tilde{t}$ respectively, by positive intrinsic angle $\varnothing\psi$, with respect to 3-observers in the Euclidean 3-space $\Sigma^{\prime}$ and $-\Sigma^{\prime *}$ (along the horizontal) (not shown) in Fig. 14a, correspond to clockwise rotations of the primed intrinsic affine spacetime coordinates $\varnothing\tilde{x}^{\,0\prime}$ and $\varnothing c_s\varnothing\tilde{t}^{\,0\prime}$ relative to their projective unprimed intrinsic affine coordinates $\varnothing\tilde{x}^{\,0}$ and $\varnothing c_s\varnothing\tilde{t}^{\,0}$ respectively, by positive intrinsic angle $\varnothing\psi$, with respect to 3-observers^0 in $\Sigma^{\,0\prime}$ and $-\Sigma^{\,0\prime *}$ (along the vertical) (not shown) in Fig. 14b.

Fig. 14b co-exists with Fig. 14a in nature and must complement Fig. 14a toward the derivation of intrinsic Lorentz transformation ($\varnothing$LT) and Lorentz transformation (LT) graphically in the positive (or our) universe and the negative universe, by physicists in our universe and the negative universe. However Fig. 14b in its present form cannot serve the complementary role to Fig. 14a, because it contains the spacetime and intrinsic spacetime coordinates of the positive time-universe and the negative time-universe, which are elusive to observers in our (or positive) universe and the negative universe, or which cannot appear in physics in the positive and negative universes.

In order for Fig. 14b to be able to serve the complementary role to Fig. 14a toward deriving the $\varnothing$LT and LT in the positive and negative universes, it must be appropriately modified. As derived in section one of this paper and mentioned in the preceding section, the proper Euclidean 3-spaces, $\Sigma^{0\prime}$ and $-\Sigma^{0\prime *}$, of the positive time-universe and the negative time-universe, with respect to 3-observers in them, are the proper time dimensions, $c_s t'$ and $-c_s t'^*$, respectively, with respect to 3-observers in the proper Euclidean 3-spaces, Σ' and $-\Sigma'^*$, of our universe and the negative universe, and the proper time dimensions, $c_s t^{0\prime}$ and $-c_s t^{0\prime *}$, of the positive time-universe and the negative time-universe, with respect to 3-observers in the proper Euclidean 3-spaces, $\Sigma^{0\prime}$ and $-\Sigma^{0\prime *}$, of the positive time-universe and the negative time-universe, are the proper Euclidean 3-spaces, Σ' and $-\Sigma'^*$, of our universe and the negative universes respectively, with respect to 3-observers in Σ' and $-\Sigma'^*$.

As follows from the preceding paragraph, Fig. 14b will contain the spacetime and intrinsic spacetime coordinates of our (or positive) universe and the negative universe solely by performing the following transformations of spacetime and intrinsic spacetime coordinates on it relative to 3-observers in the Euclidean 3-spaces Σ' and $-\Sigma'^*$ of our universe and the negative universe.

$$\begin{aligned}
\tilde{\Sigma}^0 \quad &\rightarrow \quad c_s\tilde{t}\ ;\ c_s\tilde{t}^0 \rightarrow \tilde{\Sigma}\ ;\ -\tilde{\Sigma}^{0*} \rightarrow -c_s\tilde{t}^*\ ;\\
-c_s\tilde{t}^{0*} \quad &\rightarrow \quad -\tilde{\Sigma}^*\ ;\ \varnothing\tilde{x}^0 \rightarrow \varnothing c_s\varnothing\tilde{t}\ ;\varnothing c_s\varnothing\tilde{t}^0 \rightarrow \varnothing\tilde{x}\ ;\\
-\varnothing\tilde{x}^{0*} \quad &\rightarrow \quad -\varnothing c_s\varnothing\tilde{t}^*\ ;\ -\varnothing c_s\varnothing\tilde{t}^{0*} \rightarrow -\varnothing\tilde{x}^*\ ;\\
\varnothing\tilde{x}^{0\prime} \quad &\rightarrow \quad \varnothing c_s\varnothing\tilde{t}'\ ;\ \varnothing c_s\varnothing\tilde{t}^{0\prime} \rightarrow \varnothing\tilde{x}'\ ;\\
-\varnothing\tilde{x}^{0\prime *} \quad &\rightarrow \quad -\varnothing c_s\varnothing\tilde{t}'^*\ ;-\varnothing c_s\varnothing\tilde{t}^{0\prime *} \rightarrow -\varnothing\tilde{x}'^*.
\end{aligned} \tag{15}$$

System (15) expresses the transformation of the affine specetimes and intrinsic affine spacetimes of the positive time-universe and the negative time-universe into the affine spacetimes and intrinsic affine spacetimes of our universe and the negative universe. There are the corresponding transformations of the metric spacetime and intrinsic metric spacetimes between the two universes, which are given by simply removing the tilde label in system (15).

The implementation of the affine coordinate and intrinsic affine coordinate transformations of systems (15) on Fig. 14b gives Fig. 15b containing the affine spacetime coordinates and intrinsic affine spacetimes coordinates of our universe and the negative universe (shown in black color).

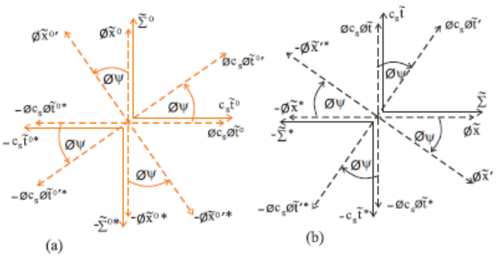

Fig. 15. (b) Complementary diagram to Fig. 14a obtained by transforming the affine spacetime and intrinsic affine spacetime coordinates of the positive time-universe and the negative time-universe in Fig. 14b into the affine spacetime and intrinsic affine spacetime coordinates of the positive (or our) universe and the negative universe; is valid with respect to the 'stationary' 1-observers in the proper metric time dimensions of our universe and the negative universe (not shown) and, (a) the complementary diagram to Fig. 14b obtained by transforming the affine spacetime and intrinsic affine spacetime coordinates of the positive (or our) universe and the negative universe in Fig. 14a into the affine spacetime and intrinsic affine spacetime coordinates of the positive time-universe and the negative time-universe; is valid with respect to the 'stationary' 1-observers[0] in the proper time dimensions of the positive time-universe and the negative time-universe (not shown)

Fig. 15a is valid with respect to 'stationary' 1-observers in the proper metric time dimensions, $c_s t'$ and $-c_s t'^*$, of our (or positive) and negative universes (not shown), where these 'stationary' 1-observers are the 'stationary' 3-observers in the proper Euclidean metric 3-spaces, $\Sigma^{0\prime}$ and $-\Sigma^{0\prime *}$, in Fig. 14b. Since Fig. 15a contains the affine spacetime/intrinsic affine spacetime coordinates of the positive (or our) universe and the negative universe solely, it can serve as a complementary diagram to Fig. 14a toward deriving ∅LT and LT in the positive (or our) universe and the negative universe. Indeed Fig. 14a and Fig. 15b are the same as the more detailed forms of Figs. 8a and 8b of [1], with which the ∅LT and LT are derived in the positive (or our) universe and the negative universe in that paper.

On the other hand, Fig. 14a will contain the spacetime and intrinsic spacetime coordinates of the positive time-universe and the negative time-universe solely, as shown in (in orange color) Fig. 15a, by performing the inverses of the transformations of affine spacetime and intrinsic affine spacetime coordinates of system (15) (that is, by reversing the directions of the arrows in system (15)) on Fig. 14a. Just as Fig. 15b must complement Fig. 14a for the purpose of deriving ∅LT and LT in the positive (or our) universe and the negative universe, as presented in sub-section 4.4 of [1], Fig. 15a must complement Fig. 14b for the purpose of deriving ∅LT and LT in the positive time-universe and the negative time-universe by physicists in those universes.

The clockwise sense of relative rotations of primed intrinsic affine spacetime coordinates by positive intrinsic angles $\varnothing\psi$ with respect to 'stationary' 1-observers in the metric time dimensions, $c_s t'$ and $-c_s t'^*$, (not shown) in Fig. 15b, follows from the validity of the clockwise sense of relative rotations of primed intrinsic affine spacetime coordinates by positive intrinsic angle $\varnothing\psi$ with respect to 'stationary' 3-observers^0 in the proper Euclidean metric 3-spaces, $\Sigma^{0\prime}$ and $-\Sigma^{0\prime *}$, in Fig. 14b. The 1-observers in $c_s t'$ and $-c_s t'^*$ in Fig. 15b are what the 3-observers^0 in Σ'^0 and $-\Sigma'^{0*}$ in Fig. 14b transform to, as noted above.

The second outstanding issue about the diagrams of Figs. 8a and 8b of [1], mentioned at the beginning of this section namely, the unexplained reason why anti-clockwise relative rotations of intrinsic affine spacetime coordinates with respect to 3-observers in the Euclidean 3-spaces, Σ' and $-\Sigma'^*$, are positive rotations involving positive intrinsic angles $\varnothing\psi$ in Fig. 8a of [1], while, at the same time, clockwise relative rotations of intrinsic affine spacetime coordinates with respect to 1-observers in the time dimensions, $c_s t'$ and $-c_s t'^*$, are positive rotations involving positive intrinsic angles $\varnothing\psi$ in Fig. 8b of [1], has thus been explained above.

Since Fig. 8b of [1] or Fig. 15b of this article has been shown to originate upon the reference metric spacetime/intrinsic metric spacetime diagram of Fig. 12b of this article, which is valid with respect to 3-observers^0 in the Euclidean 3-spaces, $\Sigma^{0\prime}$ and $-\Sigma^{0\prime *}$ of the positive and negative time-universes, the origin from the positive time-universe and negative time-universe of Fig. 8b of [1] (or Fig. 15b of this article), which must necessarily be drawn to complement Fig. 8a of [1] (or Fig. 14a of this article), in deriving ∅LT and LT in our (or positive) universe and the negative universe, has been shown. Thus the first outstanding issue about Figs. 8a and 8b of [1], which could not be explained in that article, mentioned at the beginning of this section, namely the unexplained origin of Fig. 8b that must be drawn to complement Fig. 8a of [1] in deriving the ∅LT and LT in our universe and the negative universe, has been explained within the larger four-world picture. The four-world background of Figs. 8a and its complementary diagram of Fig. 8b of [1] (or Fig. 14a and Fig. 15b of this article), has thus been established.

The new geometrical representation of Lorentz transformation and intrinsic Lorentz transformation (LT/∅LT) in our universe and the negative universe of Figs. 8a and 8b of [1] (or Fig. 14a and Fig. 15b of this article), is said to rest on a two-world background in [1] and [2], because those diagrams contain the spacetime and intrinsic spacetime dimensions of the positive (or our) universe and the negative universe solely, and also because the origin of Fig. 8b in [1] (or Fig. 15b of this article) from the diagram of Fig. 12b of of this article in the positive time-universe and the negative time-universe is unknown in [1]. The ∅LT/LT and, consequently, the intrinsic special theory of relativity and special theory of relativity (∅SR/SR), shall be said to rest on a four-world background henceforth.

It is to be noted however that, although they have their origin in the four-world picture, Fig. 14a and its complementary diagram of Fig. 15b of this article (or Figs. 8a and 8b of [1]), contain the spacetime/intrinsic spacetime coordinates of our universe and the negative universe solely, as though they are two-world diagrams. Also, although Figs. 14b and its complementary diagram of Fig. 15a have their origin in the four-world picture, they contain the spacetime/intrinsic spacetime coordinates of the positive time-universe and the negative time-universe solely, as though they are two-world diagrams.

5 CONCLUSION

This paper shall be concluded with remarks that, along with two previous papers [1, 2], a quartet of flat four-dimensional proper metric spacetimes (in assumed classical gravitational fields), containing the four-dimensional rest masses of particles and bodies and their underlying flat two-dimensional proper intrinsic metric spacetimes, containing the two-dimensional intrinsic rest masses of particles and bodies, of four universes have been derived. The quartet of four-dimensional proper spacetimes are placed relative to one another, such that corresponding (or symmetry-partner) points in them are effectively not separated in space or time, but they do not touch, because they are points in separate spacetimes. Consequently members of every quartet of symmetry-partner particles or bodies located at symmetry-partner points in the quartet of spacetimes of the universes, do not touch or interact.

A new spacetime/intrinsic spacetime geometrical representation of Lorentz transformation (LT) and intrinsic Lorentz transformation (∅LT) and their inverses, comprising of a set of four spacetime/intrinsic spacetime diagrams, developed in the ensuing four-world picture, affords the formulation of identical special theory of relativity (SR) on flat four-dimensional spacetime and identical intrinsic special theory of relativity (∅SR) on flat two-dimensional intrinsic spacetime, in each of the four universes. What is left to be done in order to have a complete description of the coexistence of four symmetrical universes in separate spacetimes in nature, is formal validations of symmetry of natural laws and symmetry of state among the four universes.

ACKNOWLEDGMENT

My gratitude goes to Professors John Wheeler at Princeton University (now of blessed memory), Jerome Friedman at MIT and Christopher Isham at Imperial College, for encouragement in words to continue with this investigation at the initial stage, and Professor A. Maduemezia at University of Ibadan, for enlightening discussions on the Lorentz group. I acknowledge with thanks financial assistance by Sir Dr. Ibukun Omotehinse, Mr. Stephen Ifayefunmi, Dr. Raphael Agboola, Mr. Cyril Ugwu, Senator Anthony Agbo and Mr. Afolabi Owolabi.

COMPETING INTERESTS

No competing interests are involved in this work.

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