Evolutionary Sequence of Spacetime and Intrinsic Spacetime and Associated Sequence of Geometries in Metric Force Fields IV

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ABSTRACT

The flat two-dimensional relative proper intrinsic metric spacetime ($\emptyset\rho', \emptyset c_s\emptyset t'$) underlying the flat four-dimensional relative proper metric spacetime ($I E^3, c, t$), which emerges at the first stage of evolution of metric spacetime and intrinsic metric spacetime in long-range metric force fields, isolated in the first three parts of this paper, endures for no moment before transforming into a curved two-dimensional relative proper intrinsic metric spacetime with pseudo-orthogonal curvilinear intrinsic dimensions, $\emptyset\rho'$ and $\emptyset c_s\emptyset t'$, on the vertical intrinsic metric spacetime hyperplane, on the larger spacetime and intrinsic spacetime of combined positive (or our) universe and the negative universe. It therefore possesses intrinsic Lorentzian metric tensor at every point. It projects an underlying flat relativistic intrinsic metric spacetime ($\emptyset\rho, \emptyset c_s\emptyset t$), which is made manifested outwardly in a flat four-dimensional relativistic metric spacetime ($I E^3, c, t$), at the second (and final) stage of evolution of metric spacetime and intrinsic metric spacetime in long-range metric force fields. The conclusion that the four-dimensional metric spacetime is everywhere flat in every long-range metric force field is reached.
The curved ‘two-dimensional’ absolute intrinsic metric spacetime \((\varphi_{\mu\nu}, \varphi_{\epsilon}, \varphi_{t})\) with absolute intrinsic sub-Riemannian metric tensor \(\varphi_{\mu\nu}\), which evolves at the first stage is brought forward to the second stage. The basic aspects of the theory of relativity on the flat relativistic metric spacetime, intrinsic theory of relativity on the underlying flat relativistic intrinsic metric spacetime and absolute intrinsic metric theory on the curved absolute intrinsic metric spacetime, associated with the presence of a metric force field in spacetime and intrinsic metric force field in intrinsic spacetime, are developed in terms of certain derived geometrical parameters, referred to as relative proper static flow speed, relative proper intrinsic static flow speed and absolute intrinsic static flow speed respectively. Particularization to the gravitational field will be a straightforward process, while using the results of this paper as template.

Keywords: Long-range metric force fields; second stage of evolution of spacetime and intrinsic spacetime; curved proper intrinsic metric spacetime; projective flat relativistic intrinsic metric spacetime; outward manifestation flat relativistic metric spacetime; static flow-speed.

1 INTRODUCTION

This fourth and last part of this paper is devoted to the second stage of evolution of metric spacetime and intrinsic metric spacetime in long-range metric force fields, having concluded the first stage in the preceding parts one, two and three [1–3]. The absolute intrinsic Riemannian spacetime geometry developed in the first three parts, which supports absolute intrinsic theory and absolute theory of metric force fields and the extension to the geometry of relative intrinsic metric spacetime and relative metric spacetime, which supports the theory of intrinsic relativity and theory of relativity in relative intrinsic metric force fields and relative metric force fields, in this fourth part, are progressive developments by the author. No related work in physics or mathematics exists in the open literature, as far as can be found. This thereby limits the references in this paper to the previous papers by the author, upon which this fourth part of this paper is based essentially.

The flat four-dimensional relative proper metric spacetime, denoted by \((\mathbb{E}^4, c, t')\) for convenience, in the second and third parts of this paper and this fourth part, where \(\mathbb{E}^4\) is the flat three-dimensional relative proper metric space, contains the rest masses \((m_0, \epsilon' / c^2)\) of particles and bodies, with the assumed absence of strong (or relativistic) gravitational field. With this assumption, the flat \((\mathbb{E}^4, c, t')\) supports the special theory of relativity (SR), which involves the motions of the rest masses \((m_0, \epsilon' / c^2)\) of particles and become the special-relativistic masses \((\gamma m_0, \gamma \epsilon' / c^2)\) relative to observers.

The introduction of a strong (or relativistic) gravitational field into the flat four-dimensional relative proper metric spacetime \((\mathbb{E}^4, c, t')\), will transform it into a curved four-dimensional metric spacetime \((\mathbb{M}^4, c, t)\) (usually denoted by \((x^0, x^1, x^2, x^3)\)), with Riemannian metric tensor \(g_{\mu\nu}\), in the context of the general theory of relativity (GR), as known. It is to be recalled however that, although the curvature of four-dimensional spacetime in a metric force field is a well thought-out prescription, see pages 111 – 149 of [4], which has not been falsified until now, it nevertheless remains an unproven fundamental postulate of the general theory of relativity.

As for the isolation of the first stage of evolution of spacetime and intrinsic spacetime and the associated geometry in long-range metric force fields in [1–3], on the other hand, only the ‘two-dimensional’ absolute intrinsic metric spacetime \((\varphi_{\mu\nu}, \varphi_{\epsilon}, \varphi_{t})\), isolated in those articles and illustrated in Fig. 11 of [3], reproduced as Fig. 1 of this article, is curved with absolute intrinsic sub-Riemannian metric tensor \(\varphi_{\mu\nu}\), while the four-dimensional relative proper metric spacetime \((\mathbb{E}^4, c, t')\) is flat in long-range metric force fields at the first stage of evolution spacetime and intrinsic spacetime, as Fig. 1 shows.
The developments in [1–3] that leads to the geometry of Fig. 11 of [3], reproduced as Fig. 1 of this article, is preceded by the isolation of co-existing four symmetrical universes in separate spacetimes with event horizon separations, referred to as four-world picture in [5–8]. The four universes constitute four-world background for the special theory of relativity (SR) on flat relative proper spacetime in each universe, as developed in those articles.

By starting with the flat four-dimensional relative proper metric spacetimes, \((IE^3, c, t')\) of our universe in Fig. 1 and \((-IE^3, -c, t'^{**})\) of the negative universe (not shown in Fig. 1), as the spacetimes of the special theory of relativity, with the inherent assumption of the absence of strong (or relativistic) gravitational field in the respective universes in [5], the flat relative proper intrinsic metric spacetime \((\varnothing p', \varnothing c, \varnothing t')\) that underlies \((IE^3, c, t')\) in our universe and \((-\varnothing p'^{**}, -\varnothing c, \varnothing t'^{**})\) that underlies \((-IE^3, -c, t'^{**})\) in the negative universe, were introduced as ansatz in section 4 of that article.

A new set of affine spacetime/intrinsic affine spacetime diagrams involving the rotations of straight line primed intrinsic affine spacetime coordinates, denoted by, \(\varnothing x'\) and \(\varnothing c t'\), (of the particle’s primed intrinsic affine frame), relative to their projective straight line unprimed intrinsic affine coordinates, \(\varnothing x\) and \(\varnothing c t\) (of the particle’s unprimed intrinsic affine frame), in the positive (or our) universe, and the simultaneous rotations of the extended straight line primed intrinsic affine coordinates, \(-\varnothing x'^{**}\) and \(-\varnothing c t'^{**}\), of the symmetry-partner particle’s primed intrinsic affine frame relative to the extended straight line unprimed intrinsic affine coordinates, \(-\varnothing x^*\) and \(-\varnothing c t^*\), of the symmetry-partner particle’s unprimed intrinsic affine frame in the negative universe, shown as Figs. 8a and 8b and their inverses as Figs. 9a and 9b of [5], were derived.

Intrinsic Lorentz transformation \((\varnothing LT)\) and its inverse in terms of extended straight line primed intrinsic affine coordinates, \(\varnothing x'\) and \(\varnothing c t'\), of the particle’s primed intrinsic affine frame and extended straight line unprimed intrinsic affine coordinates, \(\varnothing x\) and \(\varnothing c t\), of the particle’s unprimed intrinsic affine frame, were derived from the new set of diagrams (Figs. 8a, 8b, 9a and 9b of [5]), and intrinsic Lorentz invariance \((\varnothing LI)\) was validated from these, in the context of the two-dimensional intrinsic special theory of relativity \((\varnothing SR)\), which involves intrinsic affine spacetime coordinates embedded in the flat two-dimensional proper intrinsic metric spacetime.

Fig. 1. The flat four-dimensional relative proper and flat ‘two-dimensional’ absolute proper metric spacetimes and hierarchy of two-dimensional intrinsic metric spacetimes that evolve at the first stage of evolution of metric spacetimes and hierarchy intrinsic spacetimes in long-range metric force fields in our universe; (Fig. 11 of [3])
(\varphi_p', \varphi_s, \varphi_t')", with the inherent assumption of the absence of strong gravitational field in [5].

Lorentz transformation (LT) and its inverse in terms of extended straight line primed affine spacetime coordinates, \( \tilde{x}', \tilde{y}', \tilde{z}' \) and \( \tilde{c}' \), of the particle's primed affine frame and extended straight line unprimed affine spacetime coordinates, \( x, y, z \) and \( c \) of the particle's unprimed affine frame in the context of SR, were then written directly from the intrinsic Lorentz transformation (LT) and its inverse in the context of SR; SR involving four-dimensional affine spacetime coordinates embedded on the flat four-dimensional relative proper metric spacetime (\( \mathbb{I}^{\alpha}, c, t' \)), being mere outward manifestation of SR involving two-dimensional intrinsic affine spacetime coordinates embedded in the flat two-dimensional relative proper intrinsic metric spacetime (\( \varphi_p', \varphi_s, \varphi_t' \)), with the inherent assumption of the absence of strong gravitational field.

Eventually the origin of the flat two-dimensional relative proper intrinsic metric spacetime (\( \varphi_p', \varphi_s, \varphi_t' \)) underlying the flat 4-dimensional relative proper metric spacetime (\( \mathbb{I}^{\alpha}, c, t' \)) in our universe (and indeed in every one of the other three universes of the four-world picture isolated in [5–8]), was derived formally in section 1 of [8], thereby demystifying the (non-observable or hidden) intrinsic metric dimensions, \( \varphi_p' \) and \( \varphi_s, \varphi_t' \), and validating their actual presence in nature.

The special theory of relativity (SR) cannot alter the extended flat 4-dimensional relative proper metric spacetime (\( \mathbb{I}^{\alpha}, c, t' \)) on which it operates, with the assumed absence of strong (or relativistic) gravitational field. The intrinsic special theory of relativity (\( \omega \)SR) can likewise not alter the extended flat two-dimensional proper intrinsic metric spacetime (\( \varphi_p', \varphi_s, \varphi_t' \)) on which it operates, with the assumed absence of relativistic gravitational field. These, as explained under the Summary and Conclusion section of [8], is due to the fact that the spacetime/intrinsic spacetime coordinates (or spacetime/intrinsic spacetime geometry) associated with SR/\( \omega \)SR are affine space-time/intrinsic affine spacetime coordinates (or affine spacetime/intrinsic affine spacetime geometry) with no metric quality.

It is by introducing the source of a long-range relativistic metric force-field (such as the source of a relativistic gravitational field), at a point on the flat 3-dimensional relative proper metric space \( \mathbb{I}^{\alpha} \) and, consequently, the source of a long-range relativistic intrinsic metric force-field (such as the source of a relativistic intrinsic gravitational field), at the same point in the straight line relative proper intrinsic metric space \( \varphi_p' \) in Fig. 11 of [3], reproduced as Fig. 1 of this article, that the extended flat relative proper metric spacetime (\( \mathbb{I}^{\alpha}, c, t' \)) and its underlying flat relative proper intrinsic metric spacetime (\( \varphi_p', \varphi_s, \varphi_t' \)) can be made to transform into four-dimensional relativistic metric spacetime (\( \Sigma, c, t \)), which is underlay by two-dimensional relativistic intrinsic metric spacetime (\( \varphi_p, \varphi_s, \varphi_t \)) in all finite neighborhood of the source of the long-range metric force field. The geometry associated with this at the second stage of evolution of spacetime/intrinsic spacetime in long range relativistic metric force-fields shall be developed in the rest of this article.

2 GEOMETRICAL BACKGROUND IN THE FOUR-WORLD PICTURE FOR A NEW FLAT SPACETIME THEORY OF RELATIVITY ASSOCIATED WITH THE PRESENCE OF A LONG-RANGE METRIC FORCE FIELD

There are the theory of relativity and theory of intrinsic relativity, which are associated with the presence of a long-range relativistic metric force field in the four-dimensional metric spacetime and its underlying long-range relativistic intrinsic metric force field in the two-dimensional relative intrinsic metric spacetime. These will convert the extended flat four-dimensional relative proper metric spacetime (\( \mathbb{I}^{\alpha}, c, t' \)) and its underlying flat two-dimensional relative proper intrinsic metric spacetime (\( \varphi_p', \varphi_s, \varphi_t' \)) to extended four-dimensional relativistic metric spacetime.
The Global Curved Relative Proper Intrinsic Metric Spacetime Projects Underlying Flat Relativistic Intrinsic Metric Spacetime that is Made Manifested Outwardly in Flat Relativistic Metric Spacetime in a Metric Force Field

As follows from the preceding two paragraphs, let us introduce non-uniform relative proper intrinsic static flow speed \( \varphi V_m \) along the straight line relative proper intrinsic metric space \( \varphi p' \) and the straight line relative proper intrinsic metric.

2.1 The Global Curved Relative Proper Intrinsic Metric Spacetime

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time dimension $\varphi_{c_s t'}$ in Fig. 1 that evolves at the first stage of evolution of metric spacetime and intrinsic metric spacetimes, such that $\mathcal{V}_{m_{ab}}'$ has its largest magnitude at a point $(S, S')$ in $(\varphi', \varphi_{c_s t'})$ and decreases continuously until it vanishes virtually at point O in $(\varphi', \varphi_{c_s t'})$, which is far removed from point $(S, S')$. These will be made manifested outwardly in non-uniform relative proper static flow speed $\mathcal{V}_{m_{ab}}'$ in the relative proper metric Euclidean 3-space $\mathbb{E}^{3}$ and along the relative proper metric time dimension $c_s t'$, such that $\mathcal{V}_{m_{ab}}'$ has its largest magnitude at the corresponding point $(S, S')$ in $(\mathbb{E}^{3}, c_s t')$ and decreases in magnitude continuously until it vanishes virtually at point O in $(\mathbb{E}^{3}, c_s t')$, which is far removed from point $(S, S')$ in that figure.

The foregoing is quite apart from the non-uniform absolute proper intrinsic static flow speed $\varphi_{m_{ab}}'$ constituted along the straight line relative proper intrinsic metric space $\varphi'$ and the straight line relative proper intrinsic metric time dimension $c_s t'$ by the non-uniform $\varphi_{m_{ab}}'$ projected along the projective absolute proper intrinsic metric dimensions, $\varphi_{m_{ab}}'$ and $\varphi_{c_s t'}$, embedded in $\varphi'$ and $\varphi_{c_s t'}$ respectively, and the outward manifestations of these namely, the non-uniform absolute proper static flow speed $\mathcal{V}_{m_{ab}}'$ in $\mathbb{E}^{3}$ and along $c_s t'$ in Fig. 1.

However the presence of non-uniform absolute proper intrinsic static flow speed $\varphi_{m_{ab}}'$ along the relative proper intrinsic metric space $\varphi'$ and relative proper intrinsic metric time dimension $\varphi_{c_s t'}$, cannot cause the curvatures of $\varphi_{c_s t'}$ and $\varphi'$, or produce any other effect on them. The presence of absolute proper static flow speed $\mathcal{V}_{m_{ab}}'$ in the relative proper metric space $\mathbb{E}^{3}$ and relative proper metric time dimension $c_s t'$ can likewise produce no detectable effect on $\mathbb{E}^{3}$ and $c_s t'$, as mentioned earlier.

Let us recall the evolution of Fig. 11 of [3], reproduced as Fig. 1 of this article, from Fig. 6 of [3], reproduced as Fig. 2 of this article. The introduction of non-uniform absolute intrinsic static flow speed $\varphi_{m}$ along the initial straight line absolute intrinsic metric space $\varphi$ and along the initial straight line absolute intrinsic metric time ‘dimension’ $\varphi_{c_s t}$ in Fig. 2, causes the straight line $\varphi$ to evolve into curved absolute intrinsic metric space $\varphi$, where $\varphi$ will have largest curvature at the point $(S, S')$ where $\varphi_{m}$ is largest and virtually zero curvature at point O, which is far removed from point $(S, S')$.

On the other hand, the absolute intrinsic metric time ‘dimension’ $\varphi_{c_s t}$ and absolute metric time dimension $c_s t$ along the vertical are invariant (or remain unaffected) in the context of the absolute intrinsic metric phenomenon that causes the curvature of the absolute intrinsic metric spacetime ‘dimensions’, with respect to ‘3-observers’ in the absolute space $\mathbb{E}^{3}$ in Fig. 2.

Graphically, this implies that the straight line absolute intrinsic metric time ‘dimension’ $\varphi_{c_s t}$ along the vertical in that figure will remain not curved from its vertical position, thereby yielding the half-geometry of Fig. 1 of [3], reproduced as Fig. 3 of this article, which is valid with respect to 3-observers in the relative proper Euclidean 3-space $\mathbb{E}^{3}$ in that figure.

The initial straight line absolute intrinsic metric time ‘dimension’ $\varphi_{c_s t}$ in Fig. 2 remains not curved from the vertical, while the initial straight line absolute intrinsic metric space $\varphi$ in that figure becomes curved absolute intrinsic metric space $\varphi$ in Fig. 3, because the absolute metric time ‘dimension’ $c_s t$ and the absolute intrinsic metric time ‘dimension’ $\varphi_{c_s t}$ are invariant (or unaffected), that is, do not evolve into the absolute proper metric time dimensions $c_{s t}$ and absolute proper intrinsic metric time dimension $\varphi_{c_s t'}$, with respect to 3-observers in the relative proper Euclidean 3-space $\mathbb{E}^{3}$ along the horizontal in that figure, in the contexts of absolute physics and absolute intrinsic physics associated with the presence of absolute metric force field and absolute intrinsic metric force field.

Since there is a perfect symmetry of state between the positive (or our) universe and the positive time-universe, the half-geometry of Fig. 2 of [3], reproduced as Fig. 4 of this article, will evolve with respect to 3-observers in the relative proper Euclidean 3-space $\mathbb{E}^{3}$, within the symmetry-partner region of spacetime in the positive time-universe, simultaneously with the half-geometry of Fig. 1 of [3], reproduced as Fig. 3 of this article, in our universe.

The union of Figs. 1 and 2 of [3], which are Figs. 3 and 4 of this article, then gives the full geometry.
of Fig. 3 of [3], which is equivalent to the full geometry of Fig. 4 or Fig. 11 of that article, reproduced as Fig. 1 of this article, containing the spacetime/intrinsic spacetime dimensions of our universe solely. This and the foregoing paragraphs are mere repetitions of what have been discussed in the process of developing the geometry of Fig. 4 (or Fig. 11) of [3], reproduced as Fig. 1 of this article, repeated here to serve as a reminder.

In the contexts of the theory of relativity and intrinsic theory of relativity associated with the presence of a long-range relative proper metric force-field in the relative proper metric spacetime $(\mathbb{E}^{3}, c, t')$ and a long-range relative proper intrinsic metric force-field in the relative proper intrinsic metric spacetime $(\emptyset \rho', \emptyset c, \emptyset t')$, with the associated non-uniform relative proper static flow-speed $V'_m$ in the relative proper metric Euclidean 3-space $\mathbb{E}^{3}$ and along the relative

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Fig. 2. Flat ‘four-dimensional’ absolute metric spacetime and its underlying flat ‘two-dimensional’ absolute intrinsic metric spacetime with assumed absence of a long-range metric force field (or absence of absolute intrinsic Riemannian spacetime geometry); (Fig. 6 of [3])

Fig. 3. A curved ‘one-dimensional’ absolute intrinsic metric space $\emptyset \rho$, curving toward the absolute time/absolute intrinsic time ‘dimensions’ along the vertical, projects a straight line one-dimensional isotropic absolute proper intrinsic metric space $\emptyset \rho'_0$, along the horizontal, which is made manifested in straight line absolute proper metric space $\rho'_0$, and, a straight line relative proper intrinsic metric space $\emptyset \rho'$ appears, which is made manifested in flat three-dimensional relative metric space $\mathbb{E}^{3}$ (as a hyper-surface) along the horizontal, with respect to 3-observers in $\mathbb{E}^{3}$ in our (or positive) universe; (Fig. 1 of [3])
proper metric time dimension $c_s t'$ and non-uniform relative proper intrinsic static flow speed $\varphi V$, along the relative proper intrinsic metric space $\varphi_p$ and relative proper intrinsic metric time dimension $\varphi_{c_s} t'$, on the other hand, the relative proper metric coordinates $x^\rho$, $x^\rho$, and relative proper intrinsic metric space $\varphi_{c_s}$, and relative proper intrinsic metric time dimension $\varphi_{c_s} t'$, are all relative simultaneously (or are ‘co-relative’), with respect to 3-observers in the relativistic metric time dimension $c_s t$, in the contexts of the theory of relativity and intrinsic theory of relativity associated with the presence of a long-range relative proper metric force field in relative proper metric spacetime and long-range relative proper intrinsic metric force field in relative proper intrinsic metric spacetime.

An implication of the preceding paragraph is that all the four relative proper metric coordinates, $x^0, x^1, x^2$, and $x^3; x^0 = c_s t'$, of the flat relative proper metric spacetime ($\mathbb{E}^{3}$, $c_s t'$), will simultaneously transform into relativistic metric coordinates, $x^\rho, x^\rho$, and relative proper intrinsic metric coordinates, $\varphi_{c_s} t, \varphi_{c_s} t$, of relativistic metric spacetime ($\mathbb{E}^{3}$, $c_s t$), with respect to 3-observers in the relativistic metric Euclidean 3-space $\mathbb{E}^{3}$ and 1-observers in the relativistic metric time dimension $c_s t$. The relative proper intrinsic coordinates, $\varphi_{c_s} t'$ and $\varphi_{c_s} t'$, of the relative proper intrinsic metric spacetime ($\varphi_{c_s} t, \varphi_{c_s} t'$), will likewise simultaneously transform into relativistic intrinsic metric coordinates, $\varphi x$ and $\varphi_{c_s} \varphi t$, of the two-dimensional relativistic intrinsic metric spacetime ($\varphi_p, \varphi_{c_s} \varphi t$), with respect to 3-observers in the relativistic metric Euclidean 3-space $\mathbb{E}^{3}$ and 1-observers in the newly formed relativistic metric time dimension $c_s t$, in the contexts of the theory of relativity and intrinsic theory of relativity associated with the presence of a long-range relative proper metric force field in relative proper metric spacetime and long-range relative proper intrinsic metric field-in field in relative proper intrinsic metric spacetime.

As mentioned in section 4 of [5], affine spacetime coordinates and intrinsic affine spacetime coordinates that appear in SR/$\tilde{SR}$ shall have over-head tilde label as, $\hat{x}, \hat{y}, \hat{z}, \hat{c_s} t, \varphi \hat{x}$ and $\varphi_{c_s} \varphi t$, while the metric spacetime coordinates and intrinsic metric spacetime coordinates that appear in the theory of relativity and intrinsic theory of relativity associated with the presence of metric force field in metric spacetime and intrinsic metric force field in intrinsic metric spacetime, shall have no over-head tilde label, appearing as, $x^0, x^1, x^2, x^3, \varphi x$ and $\varphi_{c_s} \varphi t$.

Fig. 4. A curved ‘one-dimensional’ absolute intrinsic metric space $\varphi_p^\rho$, curving toward the absolute time/absolute intrinsic time ‘dimensions’ along the horizontal, projects a straight line one-dimensional isotropic absolute proper intrinsic metric space $\varphi_p^\rho$, along the vertical, which is made manifested in straight line absolute proper metric space $\varphi_p^\rho$, and, a straight line relative proper intrinsic metric space $\varphi_p^\rho$, appears, which is made manifested in flat three-dimensional relative metric space $\mathbb{E}^{3}$ (as a hyper-surface) along the vertical, with respect to 3-observers in $\mathbb{E}^{3}$ in the positive time-universe; (Fig. 2 of [3])
An implication of the penultimate paragraph is that the introduction of non-uniform relative proper intrinsic static flow speeds \( \mathbf{V}_{mn} \) and \( \mathbf{V}_{mab} \), along the straight line relative proper intrinsic metric space \( \varrho p' \) and along the straight line relative proper intrinsic metric time dimension \( \varrho c, \varrho t' \) in Fig. 1 of this article, will cause both \( \varrho p' \) and \( \varrho c, \varrho t' \) to be identically curved anticlockwise simultaneously relative to the horizontal and vertical respectively, such that the curved \( \varrho p' \) lying in the first quadrant and the curved \( \varrho c, \varrho t' \) lying in the second quadrant on the larger spacetime hyperplane of combined positive and negative universes, constitute pseudo-orthogonal curvilinear intrinsic metric dimensions, with respect to 3-observers in the relativistic metric Euclidean 3-space \( \mathbb{E}^3 \) in our (or positive) universe. It is to be remembered, as mentioned earlier that, the projective non-uniform absolute proper intrinsic static flow speed \( \varrho V_{mab} \) along \( \varrho p' \) and \( \varrho c, \varrho t' \) in Fig. 1 at the first stage of evolution of spacetime and intrinsic spacetime in a long-range metric force field cannot cause the curvature of \( \varrho p' \) and \( \varrho c, \varrho t' \).

In symmetry, the relative proper intrinsic metric space \( -\varrho p'' \) and the relative proper intrinsic metric time dimension \( -\varrho c, \varrho t'' \) of the negative universe are identically curved anticlockwise simultaneously relative to the horizontal and vertical respectively, such that the curved \( -\varrho p'' \) lying in the third quadrant and the curved \( -\varrho c, \varrho t'' \) lying in the fourth quadrant, constitute pseudo-orthogonal curvilinear intrinsic metric dimensions with respect to 3-observers in the relativistic metric Euclidean 3-space \( -\mathbb{E}^3 \) in the negative universe. These curvatures of relative proper intrinsic metric spacetime dimensions and those of the preceding paragraph will take place simultaneously within symmetry-partner long-range relativistic metric force fields and their underlying long-range relativistic intrinsic metric force fields in the positive (or our) universe and the negative universe, at the second stage of evolution of spacetime and intrinsic spacetime within symmetry-partner long-range relativistic metric force fields in the positive and negative universes.

A consequence of the foregoing is that the geometry of Fig. 5 will evolve with respect to 3-observers in the relativistic metric Euclidean 3-spaces, \( \mathbb{E}^3 \) and \( -\mathbb{E}^3 \), of the positive and negative universes, as indicated, at the second stage of evolution of spacetime/intrinsic spacetime within symmetry-partner long-range relativistic metric force fields in the positive and negative universes. The non-uniform relative proper intrinsic static flow speed \( \varrho V_{mn} \) introduced along the straight line relative proper intrinsic metric space \( \varrho p' \) and straight line relative proper intrinsic metric time dimension \( \varrho c, \varrho t' \) in Fig. 1, have largest magnitude at a point \( (S, S^d) \) on \( (\varrho p', \varrho c, \varrho t') \), due to the sources of relative proper intrinsic metric force field located at that point (not shown) in Fig. 5, and decrease in magnitude continuously until it vanishes virtually at point O in \( (\varrho p', \varrho c, \varrho t') \), which is far removed from the point \( (S, S^d) \) in that figure.

Fig. 5 has evolved from Fig. 1 upon introducing non-uniform relative proper intrinsic static flow speed along the straight line relative proper intrinsic metric space \( \varrho p' \) and straight line relative proper intrinsic metric time dimension \( \varrho c, \varrho t' \) in our universe in that figure, and their counterparts, \( -\varrho p'' \) and \( -\varrho c, \varrho t'' \), in the negative universe (not shown in Fig. 1). Hence the curved ‘two-dimensional’ absolute intrinsic metric spacetime \( (\varrho \hat{p}, \varrho \hat{c}, \varrho \hat{t}) \) in our universe in that figure and the corresponding curved ‘two-dimensional’ absolute intrinsic metric spacetime \( (\varrho \hat{p}, -\varrho \hat{c}, \varrho \hat{t'}) \) in the negative universe (not shown in that figure), have remained in Fig. 5.

A relative proper static flow speed \( V_m' \) is relativistic for, \( V_m' / c_m > 0 \) relative to all observers, since \( V_m' \) is the same relative to all observers. A relativistic metric force field is one within which \( V_m' / c_m > 0 \). Thus relativistic as being used to qualify metric force fields and metric spacetime within a relativistic metric force field, does not connote the presence of the special theory of relativity (SR), in the context of which “relativistic” has usually appeared.

It is to be noted that the straight line absolute proper intrinsic metric spacetime ‘dimensions’, \( \varrho c, \varrho t' \) and \( \varrho p' \), which are embedded in the straight line relative proper intrinsic metric spacetime dimensions, \( \varrho p' \) and \( \varrho c, \varrho t' \), in Fig. 5, are curved along with \( \varrho p' \) and \( \varrho c, \varrho t' \) in that figure. They project ‘absolute relativistic’ intrinsic metric spacetime ‘dimensions’, \( \varrho p_{ab} \) and
Fig. 5. The global metric spacetime/intrinsic metric spacetime diagram with respect to 3-observers in the relativistic metric Euclidean 3-spaces of our universe and the negative universe, at the second stage of evolution of spacetimes and intrinsic spacetimes within symmetry-partner long-range relativistic metric force fields in the two universes.

All of the curved relative proper intrinsic metric spacetimes, \( (\rho'_p, c_{st}t') \) and \( (-\rho'_p, -c_{st}t'^* \) ), the projective flat relativistic intrinsic metric spacetimes, \( (\rho^c_p, c_{st}t) \) and \( (-\rho^c_p, -c_{st}t^* \) ), and the flat four-dimensional relativistic metric spacetimes, \( (E^3, c_t) \) and \( (-E^3, -c_t^* \) ), along with the curved absolute proper intrinsic metric spacetimes, \( (\rho'_{ab}, c_{st}t'_{ab}) \) and \( (-\rho'_{ab}, -c_{st}t'^*_{ab} \) ), the projective flat ‘absolute relativistic’ intrinsic metric spacetimes, \( (\rho_{ab}, c_{st}t_{ab}) \) and \( (-\rho_{ab}, -c_{st}t^*_{ab} \) ), and the flat ‘absolute relativistic’ metric spacetimes, \( (\rho_{ab}, c_{st}t_{ab}) \) and \( (-\rho_{ab}, -c_{st}t^*_{ab} \) ), imperceptibly embedded in them, shall be found of important relevance in determining the hierarchy of intrinsic theories and theories of a metric force field and intrinsic metric force field later in this article and elsewhere.

However the main interest in this article is in the formulation of the intrinsic theory of relativity and theory of relativity associated with the presence of a long-range metric force field in metric spacetime and its underlying long-range intrinsic metric force field in intrinsic metric spacetime.

It is the curved relative proper intrinsic metric spacetimes \( (\rho'_p, c_{st}t') \) and \( (-\rho'_p, -c_{st}t'^* \) ), their projective flat relativistic intrinsic metric spacetimes \( (\rho^c_p, c_{st}t) \) and \( (-\rho^c_p, -c_{st}t^* \) ) and the outward manifestations flat relativistic metric spacetimes \( (E^3, c_t) \) and \( (-E^3, -c_t^* \) ) that are relevant for doing this.
Now the curved relative proper intrinsic metric space $\varnothing p'$ in the first quadrant and the curved relative proper intrinsic metric time dimension $\varnothing c,\varnothing t'$ in the second quadrant in Fig. 5, evolve simultaneously with respect to 3-observers in the relativistic Euclidean 3-space $\mathbb{R}^3$ in the first quadrant (or in the positive universe), and the curved relative proper intrinsic metric space $\varnothing p'^*$ in the third quadrant and the curved relative proper intrinsic metric time dimension $\varnothing c,\varnothing t'^*$ in the fourth quadrant, evolve simultaneously with respect to 3-observers$^*$ in the relativistic metric Euclidean 3-space $-\mathbb{R}^3$ in the third quadrant (or in the negative universe) in that figure.

The curved relative proper intrinsic metric space $\varnothing p'$ in the first quadrant projects a straight line relativistic intrinsic metric space $\varnothing p$ along the horizontal, which is made manifested outwardly in the relativistic metric Euclidean 3-space $\mathbb{R}^3$ in which 3-observers are now located, as indicated. The curved relative proper intrinsic metric time dimension $\varnothing c,\varnothing t'$ in the second quadrant, likewise projects straight line relativistic intrinsic metric time dimension $\varnothing c,\varnothing t$ along the vertical, which is made manifested outwardly in the relativistic metric time dimension $c, t$, in which 1-observers in the time dimension are now located in our universe.

The curved relative proper intrinsic metric space $\varnothing p'^*$ in the third quadrant projects relativistic intrinsic metric space $\varnothing p'^*$ along the horizontal, which is made manifested outwardly in the relativistic Euclidean 3-space $-\mathbb{R}^3$ in which 3-observers$^*$ are now located in the negative universe, as indicated, and the curved relative proper intrinsic metric time dimension $\varnothing c,\varnothing t'^*$ in the fourth quadrant projects relativistic intrinsic metric time dimension $\varnothing c,\varnothing t'^*$ along the vertical, which is made manifested outwardly in the relativistic metric time dimension $-c, t'^*$ in which 1-observers$^*$ in time dimension are now located in the negative universe.

However 1-observers are not indicated to exist in the relativistic time dimensions, $c, t$ and $-c, t'^*$, in Fig. 5, because the geometry of Fig. 5 is valid with respect to 3-observers in the Euclidean 3-spaces, $\mathbb{R}^3$ and $-\mathbb{R}^3$, solely, as indicated. Recall from section 4 of [7] that the anti-clockwise sense of inclination (or rotation) by positive angle of the curved relative proper intrinsic metric spacetimes dimensions relative to their projective flat relativistic intrinsic metric spacetimes by varying positive intrinsic angles, is valid with respect to 3-observers in the relativistic metric Euclidean 3-spaces in Fig. 5. It is in the complementary diagram to Fig. 5, to be developed shortly, which is valid with respect to 1-observers in the relativistic time dimensions that 1-observers in $c, t$ and $-c, t'^*$, in which the 1-observers will be indicated along $c, t$ and $-c, t'^*$.

Thus the flat four-dimensional relative proper metric spacetime $(\mathbb{R}^3, c, t'^*)$ and its underlying flat two-dimensional relative proper intrinsic metric spacetime $(\varnothing p, \varnothing c, \varnothing c, \varnothing t)$, which appear within a long-range metric force field at the first stage of evolution of spacetime/intrinsic spacetime in our universe in Fig. 11 of [3], reproduced as Fig. 1 of this article, evolve into flat four-dimensional relativistic metric spacetime $(\mathbb{E}^3, c, t)$ and its underlying flat two-dimensional relativistic intrinsic metric spacetime $(\varnothing p, \varnothing c, \varnothing c, \varnothing t)$ in Fig. 5, at the second stage of evolution of spacetime/intrinsic spacetime in the long-range metric force-field.

The flat 4-dimensional relative proper metric spacetime $(\mathbb{R}^3, c, t'^*)$ and its underlying flat relative proper intrinsic metric spacetime $(-\mathbb{R}^3, -c, t'^*)$, which appear within the symmetry-partner long-range metric force field in the negative universe (not shown in Fig. 1), at the first stage of evolution of spacetime/intrinsic spacetime, likewise evolve into flat four-dimensional relativistic metric spacetime $(-\mathbb{E}^3, -c, t'^*)$ and its underlying flat two-dimensional relativistic intrinsic metric spacetime $(-\varnothing p', -\varnothing c, \varnothing c, \varnothing t'^*)$ in Fig. 5, at the second stage of evolution of spacetime/intrinsic spacetime within the symmetry-partner long-range metric force-field. There are some other features of Fig. 5 that are important for remark. First, the absolute intrinsic metric space $\varnothing \hat{p}$ and the relative proper intrinsic metric space $\varnothing p'$, are shown to be identically curved relative to the relativistic intrinsic metric space $\varnothing p$ along the horizontal. Indeed the curved $\varnothing p'$ should fall along the curved $\varnothing \hat{p}$ in Fig. 5. This means that the point P along the curved $\varnothing \hat{p}$ in Fig. 1 is the same as point P along the curved $\varnothing p'$ in Fig. 5. Consequently the absolute
intrinsic angle $\varphi_{m,P}$ of inclination of the curved $\varphi$ to the horizontal at point P along $\varphi$ in Fig. 1 and the relative proper intrinsic angle $\varphi_{m,P}$ of inclination of the curved $\varphi'$ to the horizontal at point P along the curved $\varphi'$ in Fig. 5, are equal in magnitude. It then follows that the absolute intrinsic static flow speed $\varphi_{m,P}$ at point P along the curved $\varphi'$ in Fig. 1 and the relative proper intrinsic static flow speed $\varphi'_{m,P}$ at point P along $\varphi'$ in Fig. 5 are equal in magnitude. That is,

$$\sin |\varphi_{m,P}| = \sin |\varphi_{m,P}|$$  \hspace{1cm} (1a)$$

or

$$|\varphi_{m,P}| = |\varphi'_{m,P}|$$  \hspace{1cm} (1b)$$

In order for relations (1a) and (1b) to hold, it must be that the source of absolute intrinsic metric force field located at the point S along the curved absolute intrinsic metric space $\varphi$ in Fig. 1, which establishes non-uniform absolute intrinsic static flow speed $\varphi_{m,P}$ between points S and O along the curved $\varphi$ in that figure, is ‘projected’ as a source of absolute proper intrinsic metric force field of identical magnitude, into the corresponding point S along the projective absolute proper intrinsic metric space $\varphi_{m,P}$.

A source of relative proper intrinsic metric force field of identical magnitude then appears automatically at the corresponding point S along the straight line relative proper intrinsic metric space $\varphi'$, which appears along the horizontal automatically along with the projection of $\varphi_{m,P}$ along the horizontal in Fig. 1. The source of relative proper intrinsic metric force field that appears automatically thereby establishes non-uniform relative proper intrinsic static flow speed $\varphi_{m,P}$ (of identical magnitudes as the projective non-uniform absolute proper intrinsic static flow speed $\varphi_{m,P}$) along the straight line $\varphi'$ in Fig. 1 and, consequently, along the curved $\varphi'$ in Fig. 5.

The point P along the curved relative proper intrinsic metric time dimension $\varphi_{c,t}$ in the second quadrant is the symmetry-partner to point P along the curved relative proper intrinsic metric space $\varphi'$ in the first quadrant in Fig. 2. Consequently the relative intrinsic angle $\varphi_{P}$ of inclination of the curved $\varphi_{P}$ to the vertical at point P along the curved $\varphi_{P}$ and the relative intrinsic angle $\varphi_{P}$ of inclination of the curved $\varphi'$ to the horizontal at point P along the curved $\varphi'$, are equal in magnitude. It then follows that the non-uniform relative proper intrinsic static flow speeds, $\varphi'_{m,P}$ and $\varphi'_{m,P}$, are equal in magnitude. That is,

$$\sin |\varphi_{m,P}| = \sin |\varphi_{m,P}|$$  \hspace{1cm} (2a)$$

or

$$|\varphi_{m,P}| = |\varphi'_{m,P}|$$  \hspace{1cm} (2b)$$

Finally, the relative proper intrinsic static flow speed $\varphi'_{m,P}$ of point P along the curved relative proper intrinsic metric space $\varphi'$ is shown to be invariantly projected as relative proper intrinsic static flow speed $\varphi'_{m,P}$ into the relativistic intrinsic metric space $\varphi$ along the horizontal, and this is made manifested in relative proper static flow speed $\varphi'_{m,P}$ in the relativistic metric Euclidean 3-space $\mathbb{E}_3$ in Fig. 5. The relative proper intrinsic static flow speed $\varphi'_{m,P}$ of point P along the curved relative proper intrinsic metric time dimension $\varphi_{c,t}$ is likewise shown to be invariantly projected as relative proper intrinsic static flow speed $\varphi'_{m,P}$ into the relativistic intrinsic metric time dimension $\varphi_{c,t}$, which is made manifested in relative proper static flow speed $\varphi'_{m,P}$ along the relativistic metric time dimension $\varphi_{c,t}$ along the vertical in Fig. 5.

On the other hand, one expects that the non-uniform relative proper intrinsic static flow speed $\varphi'_{m,P}$ along the curved relative proper intrinsic metric space $\varphi'$ should be projected as non-uniform relativistic intrinsic static flow speed $\varphi'_{m,P}$ (without prime label) into the projective relativistic intrinsic metric space $\varphi$ along the horizontal and that the non-uniform relative proper intrinsic static flow speed $\varphi'_{m,P}$ along the curved relative proper intrinsic metric time dimension $\varphi_{c,t}$ should be projected as non-uniform relativistic intrinsic static flow speed $\varphi'_{m,P}$ into the projective relativistic intrinsic metric time dimension $\varphi_{c,t}$ along the vertical in Fig. 5.

The fact that the non-uniform relative proper intrinsic static flow speed $\varphi'_{m,P}$ along the curved relative proper intrinsic metric space $\varphi'$ is invariantly projected as relative proper intrinsic static flow speed $\varphi'_{m,P}$ into the relativistic intrinsic metric space $\varphi$ along the horizontal and $\varphi_{c,t}$ along the vertical respectively in Fig. 5, is a graphical interpretation.
of the invariance of intrinsic static flow speed in the context of the intrinsic theory of relativity associated with the presence of a long-range relativistic intrinsic metric force field in intrinsic metric space. This invariance is stated as

$$\varnothing V_m = \varnothing V'_m,$$

hence,

$$V_m = V'_m,$$

where Eqs. (3a) and (3b) have been written at an arbitrary pair of symmetry-partner points along the curved $\varnothing \rho'$ and $\varnothing c_\rho t'$. The invariance of relative proper intrinsic static flow speed and relative proper intrinsic proper flow speed (3a) and (3b), in the context of the theory of relativity and theory of intrinsic relativity associated with the presence of a relative proper metric force field in relative proper metric spacetime and relative proper intrinsic metric spacetime, which involve relative proper static flow speed and relative proper intrinsic static flow speed respectively, established in spacetime and intrinsic spacetime by the source of a long-range relative proper metric force field, at the second stage of evolution of spacetimes and intrinsic spacetimes within the metric force field, shall be given formal proof elsewhere, upon particularizing to the gravitational field.

The corresponding invariance of absolute intrinsic static flow speed and absolute static flow speed,

$$\varnothing V'_{m ab} = \hat{V} m and V'_{m ab} = \hat{V}_m,$$

deduced and presented as Eqs. (83a) and (83b) of [3], in the context of absolute intrinsic metric theory of physics and absolute metric theory of physics, involving absolute intrinsic static flow speeds and absolute static flow speed respectively, established in absolute spacetime and absolute intrinsic spacetime by the source of a long-range absolute metric force-field, at the first stage of evolution of spacetime/intrinsic spacetime within the metric force field, shall likewise be given formal proofs elsewhere upon particularizing to the gravitational field.

Now the perfect symmetry of state among the four universes namely, positive (or our) universe, negative universe, positive time-universe and negative time-universe, isolated in [5–8], implies that, as the geometry of Fig. 5 evolves with respect to 3-observers in the relativistic Euclidean 3-spaces, $\mathbb{E}^3$ and $-\mathbb{E}^3$, in our universe and the negative universe, at the second stage of evolution of spacetime/intrinsic spacetime, within symmetry-partner long-range metric force fields in our universe and the negative universe, the geometry of Fig. 3 evolves simultaneously with respect to 3-observers in the relativistic Euclidean 3-spaces $\mathbb{E}^{13}$ and $-\mathbb{E}^{13}$ in the positive time-universe and the negative time-universe, at the second stage of evolution of spacetime/intrinsic spacetime within the symmetry-partner long-range metric force fields in the positive time-universe and the negative time-universe.

Fig. 6 in the positive time-universe and the negative time-universe co-exists with Fig. 5 in the positive (or our) universe and the negative universe. It should serve as a complementary diagram to Fig. 5 toward formulating the theory of relativity associated with the presence of symmetry-partner relative proper metric force fields in the relative proper spacetimes in our universe and the negative universe. However Fig. 6 in its present form cannot serve as a complementary diagram to Fig. 5. This is so, because the spacetime and intrinsic spacetime dimensions of the positive time-universe and the negative time-universe in Fig. 6 are elusive to observers in our universe and the negative universe and cannot appear in physics in our universe and the negative universe.

In order to make Fig. 6 a valid complementary diagram to Fig. 5, the spacetime and intrinsic spacetime dimensions of the positive time-universe and the negative time-universe in it must be transformed to those of our universe and the negative universe, as developed in [8] (see system (15) of that article). This means that the following transformations of spacetime/intrinsic spacetime dimensions must be performed on Fig. 6, thereby transforming Fig. 6 to Fig. 7.
Fig. 6. The symmetrical global metric spacetime/intrinsic metric spacetime diagram in the positive time-universe and the negative time-universe, which evolve simultaneously with Fig. 5 in our universe and the negative universe, at the second stage of evolution of spacetimes/intrinsic spacetimes within symmetry-partner long-range metric force fields in the positive time-universe and the negative time-universe, with respect to 3-observers in the relativistic metric Euclidean 3-spaces in those universes.

Fig. 7. The global metric spacetime/intrinsic metric spacetime diagram obtained by transforming the spacetimes and intrinsic spacetimes of the positive time-universe and the negative time-universe in Fig. 6 to the spacetimes and intrinsic spacetimes of the positive (or our) universe and the negative universe; the complementary diagram to Fig. 5, which is valid with respect to 1-observers in the relativistic metric time dimensions in our universe and the negative universe.
Fig. 8a. The affine spacetime/intrinsic affine spacetime diagram of the special theory of relativity and intrinsic special theory of relativity with respect to symmetry-partner 3-observers in the metric Euclidean 3-spaces of our universe and the negative universe; (Fig. 8a of [5])

Fig. 8b. The affine spacetime/intrinsic affine spacetime diagram of the special theory of relativity and intrinsic special theory of relativity with respect to symmetry-partner 1-observers in the metric time dimensions of our universe and the negative universe; the complementary diagram to Fig. 8a; (Fig. 8b of [5])
Implementation of system (4) on Fig. 6 yields Fig. 7. The 3-observers in the relativistic Euclidean 3-spaces, $E^0_3$ and $-E^0_3$, of the positive time-universe and negative time-universe in Fig. 6, become 1-observers in the time dimensions, $c_at$ and $-c_at^*$, of our universe and negative universe in Fig. 7, due to the transformations (or contractions) of $E^0_3$ and $-E^0_3$ to $c_at$ and $-c_at^*$ in system (4).
Fig. 7 obtained by performing the transformations of system (4) on Fig. 6, is valid with respect to 1-observers in the metric time dimensions, c,t and \(-c,t\)' as indicated. Recall from section 2 of [8] that the clockwise inclination (or rotation) of the curved relative proper intrinsic metric spacetimes, \(\varphi'_p\) and \(\varphi_{c,t}'\), relative to their projective relativistic intrinsic metric spacetimes, \(\varphi_p\) and \(\varphi_{c,t}\), by varying positive intrinsic angle in Fig. 7, is valid with respect to 1-observers in the time dimensions.

Fig. 7 contains the metric spacetime and intrinsic metric spacetime dimensions of our universe and the negative universe solely. It is hence a valid complementary diagram to Fig. 5 for the purpose of formulating the theory of relativity and intrinsic theory of relativity associated with the presence of symmetry-partner relative proper metric force fields in the relative proper metric spacetimes and the underlying symmetry-partner relative proper intrinsic metric force fields in the relative proper intrinsic metric spacetimes in our universe and the negative universe.

The geometry of Fig. 5 and its complementary geometry of Fig. 7 in our universe and negative universe, in the context of the theory of relativity and intrinsic theory of relativity associated with non-uniform relative proper static flow speed and non-uniform relative proper intrinsic static flow speed, established in spacetimes and intrinsic spacetimes by symmetry-partner relative proper metric force fields and relative proper intrinsic metric force fields in our universe and the negative universe, correspond to the geometry of Fig. 8a of [5] and its complementary geometry of Fig. 8b of that article. These are the theory of relativity and intrinsic theory of relativity (SR/\(\varphi SR\)), associated with uniform relative dynamical speeds and uniform relative intrinsic dynamical speeds of the motions of symmetry-partner particles relative to symmetry-partner ‘stationary’ observers in our universe and the negative universe. Figures 8a and 8b of [5] are reproduced as Fig. 8a and Fig. 8b respectively of this article, on pages 49 at the end of this article.

Just as Fig. 8a and Fig. 8b of [5] of SR/\(\varphi SR\), reproduced as Fig. 8b and Fig. 8b of this article on page 49 at the end of this article, have Fig. 9a and Fig. 9b of [5] as their inverses, there are inverses to Fig. 5 and Fig. 7 of this article for the theory of relativity and intrinsic theory of relativity associated with the presence of symmetry-partner long-range metric force fields in our universe and negative universe. Figures 9a and 9b of [5], are reproduced as Fig. 9a and Fig. 9b of this article on page 50 at the end of this article. The derivations of the inverses to Fig. 5 and Fig. 7 of this article are done below.

Now the extended curved relative proper intrinsic metric space \(\varphi_p\) and the extended curved relative proper intrinsic metric time dimension \(\varphi_{c,t}\) possess varying positive relative proper intrinsic static flow speed \(V'_m\) along their lengths, relative to all 3-observers in the relativistic metric Euclidean 3-space \(E^3\) in Fig. 5. Consequently \(\varphi'_p\) is curved anticlockwise at varying positive relative intrinsic angles \(\varphi_p\) relative to the straight line \(\varphi_p\) along the horizontal and \(\varphi_{c,t}'\) is identically curved anticlockwise (into the second quadrant) at varying positive relative intrinsic angle \(\varphi_p\) relative to the straight line \(\varphi_{c,t}\) along the vertical in Fig. 5.

In obtaining the inverse of Fig. 5, one could, at first thought, consider the projective extended relativistic intrinsic metric space \(\varphi_p\) and extended projective straight line relativistic intrinsic metric time dimension \(\varphi_{c,t}\) to possess varying negative relative proper intrinsic static flow speed \(-V'_m\) along their lengths, relative to the curved relative proper intrinsic metric space \(\varphi'_p\) and curved relative proper intrinsic metric time dimension \(\varphi_{c,t}'\) respectively. One could then further consider the relativistic intrinsic metric space \(\varphi_p\) to be curved into the first quadrant at varying negative intrinsic angle \(-\varphi_p\) relative to straight line relative proper intrinsic metric space \(\varphi'_p\) along the horizontal and the relativistic intrinsic metric time dimension \(\varphi_{c,t}\) to be curved into the second quadrant at varying negative intrinsic angle \(-\varphi_p\) relative to straight line relative proper intrinsic metric time dimension \(\varphi_{c,t}'\) along the vertical. The straight line \(\varphi'_p\) along the horizontal and the straight line \(\varphi_{c,t}'\) along the vertical so formed, will then be made manifested outwardly in three-dimensional relative proper Euclidean space \(E^3\) as hypersurface along the horizontal and straight line relative proper metric time dimension \(c,t')\) along the vertical.
The inverse of Fig. 5 derived as explained in the preceding paragraph is invalid for two major reasons. First, it brings back the flat four-dimensional relative proper metric spacetime ($I^4 \rho, c_s t$) and its underlying flat two-dimensional relative proper intrinsic metric spacetime ($\rho', \rho c_s t'$) at the second stage of evolution of metric spacetimes and intrinsic metric spacetimes in a long range metric force field, which cannot be, since the flat relative proper metric spacetime ($I^4 \rho, c_s t$) and its underlying flat relative proper intrinsic metric spacetime ($\rho', \rho c_s t'$), have evolved into flat relativistic metric spacetime ($I^4 V_m$) and its underlying flat relativistic intrinsic metric spacetime ($\rho', \rho c_s t'$) permanently at the second stage. Secondly, projective negative non-uniform relative proper intrinsic static flow speed $-\rho V_m'$ along the length of the relativistic intrinsic metric spacetime dimensions, $\rho'$ and $\rho c_s t'$, cannot give rise to curvature of $\rho'$ and $\rho c_s t'$. Rather it is non-uniform negative relativistic intrinsic static flow speed (without prime label) $-\rho V_m$ along the lengths of the relativistic intrinsic metric dimensions, $\rho$ and $\rho c_s t$, that can give rise to their curvature relative to straight line $\rho'$ and $\rho c_s t'$. In other words, contrary to the inverse of Fig. 5 described in the penultimate paragraph, the relativistic intrinsic metric spacetime ($\rho, \rho c_s t$) cannot be curved relative to flat relative proper intrinsic metric spacetime ($\rho', \rho c_s t'$) by virtue of non-uniform negative relative proper intrinsic static flow speed $-\rho V_m'$ along the lengths of $\rho$ and $\rho c_s t$.

The curvature of the relative proper intrinsic metric spacetime ($\rho', \rho c_s t'$) relative to its projective flat relativistic intrinsic metric spacetime ($\rho, \rho c_s t$) underlying a flat relativistic metric spacetime ($I^4 \rho, c_s t$) in Fig. 5, must be retained in the inverse of Fig. 5. However the straight line relativistic intrinsic metric space $\rho$ with varying positive relative proper intrinsic static flow speeds $\rho V_m$ as its length along the horizontal in Fig. 5, must be considered to possess varying negative relative proper intrinsic static flow speed $-\rho V_m'$ along its length along the horizontal and to be inclined clockwise by varying negative intrinsic angle $-\psi$ relative to the curved $\rho'$ in the inverse diagram, where the curved $\rho'$ also possesses non-uniform relative proper intrinsic static flow speed $-\rho V_m'$ along its length.

The straight line relativistic intrinsic metric time dimension $\rho c_s t$ with varying positive relative proper intrinsic static flow $-\rho V_m$ speed along its length and to be inclined clockwise by varying relative intrinsic angle $-\psi$ relative to the curved $\rho c_s t'$ in the inverse diagram, where the curved $\rho c_s t'$ also possesses non-uniform relative proper intrinsic static flow speed $-\rho V_m'$ along its length.

The valid inverse of Fig. 5 that follows from the preceding paragraph is depicted in Fig. 10. It is to be observed that the straight line relativistic intrinsic metric space $\rho$ along the horizontal is rotated clockwise by equal negative relative intrinsic angle $-\psi_{p,o}$ relative to the tangent to the curved relative proper intrinsic metric space $\rho'$ at the point P along the curved $\rho'$ and the straight line relativistic intrinsic metric time dimension $\rho c_s t$ along the vertical is rotated clockwise by equal negative relative intrinsic angle $-\psi_{p,o}$ relative to the tangent to the curved relative proper intrinsic time dimension $\rho c_s t'$, at the symmetry-partner point $P'$ along the curved $\rho c_s t'$ in Fig. 10. The negative relative proper intrinsic static flow speed $-\rho V_m'$ and negative relative intrinsic angle $-\psi$ vary along the curved $\rho'$ and curved $\rho c_s t'$ in Fig. 10.

Now the clockwise sense of inclination of the relativistic intrinsic metric time dimension $\rho c_s t$ along the vertical relative to the curved relative proper intrinsic metric time dimension $\rho c_s t'$ in the second quadrant, by varying negative relative intrinsic angles $-\psi$ along the curved $\rho c_s t'$, due to varying negative relative proper intrinsic static flow speed $-\rho V_m'$ along $\rho c_s t'$, is valid with respect to 1-observers in the relativistic time dimensions, $c_s$ t and $-c_s t'$ of the positive and negative universes as indicated. The clockwise sense of inclination of the straight line relativistic intrinsic metric space $\rho$ along the horizontal relative to the curved relative proper intrinsic metric space $\rho'$ in the first quadrant, by varying negative intrinsic angles, $-\psi$ along the curved
\( \varphi_{\rho'} \), due to varying negative relative proper intrinsic static flow speed \(-\varphi_{V'_\rho}\) along \( \varphi_{\rho'} \) in Fig. 10, is likewise valid with respect to 1-observers in the relativistic time dimensions, \( c_s t \) and \(-c_s t^*\), of the positive and negative universes as indicated.

**Fig. 10.** The inverse of the global metric spacetime/intrinsic metric spacetime diagram of Fig. 5; is valid with respect to 1-observers in the relativistic time dimensions \( c_s \) and \(-c_s t^*\) in the positive and negative universes.

**Fig. 11.** The inverse of the global metric spacetime/intrinsic metric spacetime diagram of Fig. 7; is valid with respect to 3-observers in the relativistic metric Euclidean 3-spaces \( \mathbb{E}^3 \) and \(-\mathbb{E}^3\) of the positive and negative universes.
Fig. 10 is valid with respect to 1-observers in the relativistic time dimensions, \(c,t\) and \(-c,t^*\), because the clockwise rotations (or inclinations) of the curved relative proper intrinsic metric dimensions, \(\varnothing_c,\varnothing_{t'}\) and \(\varnothing_p,\varnothing_{t'}\), relative to their projective straight line relativistic intrinsic metric dimensions, \(\varnothing_p\) and \(\varnothing_{c,t}\), respectively, by varying positive intrinsic angle \(\varnothing\) in Fig. 7, are equivalent to clockwise rotations (or inclinations) of the straight line relativistic intrinsic metric dimensions, \(\varnothing_p\) and \(\varnothing_{c,t}\), relative to the curved relative proper intrinsic metric dimensions, \(\varnothing_p^\prime\) and \(\varnothing_{c,t'}\), respectively, by varying negative relative intrinsic angle \(-\varnothing\) in Fig. 10. Consequently, the inverse of Fig. 7, which can be derived from that figure by following the derivation of Figs. 8a and 8b and their inverses, is valid with respect to 3-observers in the relativistic Euclidean 3-spaces, \(E^3\) and \(-E^3\), relative to their projective straight line relativistic intrinsic metric dimensions, \(\varnothing_c,\varnothing_{t'}\) and \(\varnothing_p,\varnothing_{t'}\), respectively, by varying positive intrinsic angle \(\varnothing\) in Fig. 10, are equivalent to anti-clockwise rotations (or inclinations) of the straight line relativistic intrinsic metric dimensions, \(\varnothing_c,\varnothing_{t'}\) and \(\varnothing_p,\varnothing_{t'}\), respectively, by varying negative relative intrinsic angle \(-\varnothing\) in Fig. 11. Consequently, Fig. 11, like Fig. 5, is valid with respect to 3-observers in \(\mathbb{E}^3\) and \(-\mathbb{E}^3\) as indicated.

Figs. 8a and 8b and their inverses, Figs. 9a and 9b, of [5], reproduced as Figs. 8a and 8b and Figs. 9a and 9b of this article, on pages 49 and 50 at the end of this article, involve inclined extended straight line pseudo-orthogonal primed (or proper) intrinsic affine spacetime coordinates, \(\varnothing\tilde{x},\varnothing\tilde{t}\) and \(\varnothing_{c},\varnothing_{t'}\), relative to their projective extended pseudo-orthogonal unprimed (or relativistic) straight line intrinsic affine coordinates, \(\varnothing x,\varnothing t\) and \(\varnothing_{c},\varnothing_{t}\). They involve constant relative positive intrinsic dynamical speed and positive dynamical speed, \(\varnothing v\) and \(v\) (in Figs. 8a and 8b on page 49) and constant relative negative intrinsic dynamical speed and negative dynamical speed, \(-\varnothing v\) and \(-v\) (in Figs. 9a and 9b on pages 50), in the context of the intrinsic special theory of relativity and special theory of relativity (\(\varnothing\text{SR/SR}\)), as developed in [5].

On the other hand, Figs. 5 and 7 and their inverses, Figs. 10 and 11, of this article, involve extended inclined curved pseudo-orthogonal curvilinear relative proper intrinsic metric spacetime dimensions, \(\varnothing p^\prime\) and \(\varnothing_{c,t'}\), which are curved relative to their projective extended straight line pseudo-orthogonal relativistic intrinsic metric spacetime dimensions, \(\varnothing p\) and \(\varnothing_{c,t}\). They involve non-uniform positive relative proper intrinsic static flow speed \(\varnothing V_m^\prime\) along the curved and straight line intrinsic metric spacetime dimensions (in Figs. 5 and 7), and non-uniform negative relative proper intrinsic static flow speed \(-\varnothing V_m^\prime\) along the curved and straight line intrinsic metric dimensions (in Figs. 10 and 11), in the context of the intrinsic theory of relativity and theory of relativity associated with the presence of symmetry-partner long-range relative proper metric force fields in metric spacetimes and symmetry-partner long-range relative proper
intrinsic metric force fields in the underlying intrinsic metric spacetimes in our universe and the negative universe.

From the point of view of the absolute intrinsic metric theory on the curved ‘two-dimensional’ absolute intrinsic metric spacetime \((\mathcal{E}, \mathcal{C}, \mathcal{E}t)\), involving non-uniform absolute intrinsic static flow speed \(\mathcal{E}V_m\) along the curve \(\mathcal{E}p\) and \(\mathcal{C}t\), developed in the preceding three parts of this paper [1–3], at the first stage of evolution of spacetime and intrinsic spacetime within a long-range metric force field, on the other hand, there is only one diagram namely, the curved absolute intrinsic spacetime \((\mathcal{E}p, \mathcal{C}t)\) relative to its projective flat absolute proper intrinsic metric spacetime \((\mathcal{E}p_{ab}, \mathcal{C}t_{ab})\) and the relative proper intrinsic metric spacetime \((\mathcal{E}p', \mathcal{C}t')\), which appears automatically alongside the projection of \((\mathcal{E}p_{ab}, \mathcal{C}t_{ab})\) along the horizontal, as well as the outward manifestation of \((\mathcal{E}p', \mathcal{C}t')\) namely, the flat four-dimensional reverse proper intrinsic metric spacetime \((\mathcal{E}3^3, c, t)\) in Fig. 1.

Inverse diagrams and inverse coordinate transformations exist in relativity only and not in the context of the absolute intrinsic metric theory. Consequently the curved \((\mathcal{E}p, \mathcal{C}t)\) in the first quadrant and the curved \((-\mathcal{E}p^*, -\mathcal{C}t^*)\) in the third quadrant in Figs. 5 and 7 are retained in the inverse diagrams of Fig. 10 and Fig. 11.

2.2 Deriving Intrinsic Local Lorentz Transformation and Local Lorentz Transformation and Their Inverses Within Long-range Metric Force Fields in Terms of Intrinsic Static Flow Speed and Static Flow Speed

Let us consider an elementary interval \(d\mathcal{E}p'\) of the curved relative proper intrinsic metric space \(\mathcal{E}p'\) about point \(P\) along the curve \(\mathcal{E}p'\) in the first quadrant in Fig. 5. The interval \(d\mathcal{E}p'\) possesses positive relative proper intrinsic static flow speed \(\mathcal{E}V_m,_{p'}\) and is inclined anticlockwise to the horizontal at intrinsic angle \(\mathcal{E}V_p\). It projects relativistic intrinsic metric space interval \(d\mathcal{E}p\) along the horizontal that also possesses relative proper intrinsic static speed \(\mathcal{E}V_m,_{p}\), with respect to all 3-observers in the relativistic Euclidean 3-space \(-\mathcal{E}3^3\) in Fig. 5.

The corresponding elementary interval \(\mathcal{C}t'\) of the curved relative proper intrinsic metric time dimension \(\mathcal{C}t\) about the symmetry-partner point \(P^0\) along the curve \(\mathcal{C}t'\) in the second quadrant in Fig. 5, possesses intrinsic static flow speed \(\mathcal{C}V_{m, p}\) and is inclined anticlockwise at intrinsic angle \(\mathcal{C}V_{p0}\) to the vertical. It projects interval \(\mathcal{C}t'\) of relativistic intrinsic metric time dimension along the vertical that also possesses proper intrinsic static flow speed \(\mathcal{C}V_{m, p}\), with respect to all 3-observers in \(-\mathcal{E}3^3\) in that figure.

The elementary interval \(-d\mathcal{E}p^*\) of the curved relative proper intrinsic metric space \(-\mathcal{E}p^*\) about the symmetry-partner point \(P^*\) along \(-\mathcal{E}p^*\) in the third quadrant in Fig. 5, possesses positive relative proper intrinsic static flow speed \(\mathcal{E}V_m,_{p}^*\) and is inclined anticlockwise at intrinsic angle \(\mathcal{E}V_{p}^*\) to the horizontal. It projects relativistic intrinsic metric space interval \(-d\mathcal{E}p^*\) along the horizontal that also possesses relative proper intrinsic static flow speed \(\mathcal{E}V_m,_{p}^*\), with respect to all 3-observers* in the relativistic Euclidean 3-space \(-\mathcal{E}3^3\) in that figure. The corresponding elementary interval \(-\mathcal{C}t^*\) of the curved relative proper intrinsic metric time dimension \(-\mathcal{C}t^*\) about the symmetry-partner point \(P^0\) along \(-\mathcal{C}t^*\) in the fourth quadrant in Fig. 5, possesses positive relative intrinsic static flow speed \(\mathcal{E}V_{m, p}^0\) and it is inclined anticlockwise at intrinsic angle \(\mathcal{E}V_{p0}^*\) to the vertical. It projects interval \(-\mathcal{C}t^*\) of relativistic intrinsic metric time dimension along the vertical that also possesses positive relative intrinsic static flow speed \(\mathcal{E}V_{m, p}^0\), with respect to all 3-observers* in \(-\mathcal{E}3^3\) in Fig. 5.

The elementary intervals of curved relative proper intrinsic metric spaces and curved relative proper intrinsic metric time dimensions, \(d\mathcal{E}p', -d\mathcal{E}p^*, \mathcal{C}t, \mathcal{C}t'\) and \(-\mathcal{C}t^*\), shall be considered to be indefinitely short so that they are short straight line segments within which relative proper intrinsic static flow speed has a constant value. Then since the points, \(P^0\) and \(P^0\), along the curve \(\mathcal{C}t'\) and \(-\mathcal{C}t^*\) and points, \(P\) and \(P^*\), along the curve \(\mathcal{E}p'\) and \(-\mathcal{E}p^*\) are symmetry-partner points in Fig. 5, the intrinsic
angle $\omega \psi_{m,p}$ of inclinations of intervals, $\omega c_d \omega t'$, and $-\omega c_d \omega t''$, to the vertical and the intrinsic angle $\omega \psi_{m,p}$ of inclinations of intervals, $d\omega p'$ and $-d\omega p''$, to the horizontal are equal, that is, $\omega \psi_{m,p} = \omega \psi_{m,p}$, in Fig. 5.

By making use of the information in the preceding two paragraphs and drawing the inclined elementary intervals, $d\omega p'$, $\omega c_d \omega t'$, $-d\omega p''$ and $-\omega c_d \omega t''$, relative to their projections, $d\omega p$, $\omega c_d \omega t$, $-d\omega p$ and $-\omega c_d \omega t$, respectively, at the symmetry-partner points, $P$ along the curved $\omega c_d \omega t'$, $P'$ along the curved $-\omega y''$ and $P''$ along the curved $-\omega c_d \omega t''$ in Fig. 5, we have Fig. 12. The local geometry of Fig. 12, derived from the global geometry of Fig. 5, is valid with respect to all 3-observers in the relativistic metric Euclidean 3-spaces, $\mathbb{E}^3$ and $-\mathbb{E}^3$, as is the case with Fig. 5.

Fig. 12 has been drawn at the symmetry-partner points $P$, $P''$, $P'$ and $P'''$ along the curved relative proper intrinsic metric dimensions $\omega y''$, $\omega c_d \omega t'$, $-\omega y''$ and $-\omega c_d \omega t''$, respectively, in Fig. 5, as mentioned above. Hence the appearance of intrinsic angle of inclination $\omega \psi_{m,p}$ (where $\omega \psi_{m,p} = \omega \psi_{m,p}$) in Fig. 7. The inclined elementary intervals of proper intrinsic metric spacetime $d\omega p'$, $\omega c_d \omega t'$, $-d\omega p''$ and $-\omega c_d \omega t''$, possess equal positive relative proper intrinsic static flow speed $\omega V_{m,p}$ and invariantly project same into their respective relativistic components $d\omega p$, $\omega c_d \omega t$, $-d\omega p$ and $-\omega c_d \omega t$. It is to be noted that the line segments $AB'$, $AC'$, $A'B''$, and $AC''$ are mere connecting lines and not intrinsic metric coordinates. The line segments $AB$, $AC$, $A'B'$ and $AC'$ are likewise mere connecting lines.

The component $d\omega p$ of interval of relativistic intrinsic metric space projected along the horizontal is made manifest outwardly in an elementary volume $d\omega V_3$ of the relativistic Euclidean 3-space $\mathbb{E}^3$ in Fig. 12. Likewise the component $\omega c_d \omega t$ of the relativistic intrinsic metric time dimension projected along the vertical is made manifest outwardly in an elementary interval $c_d t$ of the relativistic metric time dimension $c_d t$ along the vertical.

In addition, the inclined negative elementary relative proper intrinsic metric time dimension $-\omega c_d \omega t''$ from the negative universe in the fourth quadrant, projects component $-\omega c_d \omega t'' \sin \omega \psi_{m,p}$ along the horizontal in the first quadrant, which is made manifest outwardly in $-c_d t \sin \omega \psi_{m,p}$ along the horizontal in Fig. 12. The dummy star label has been removed from the projective component $-\omega c_d \omega t'' \sin \omega \psi_{m,p}$ of the inclined $-\omega c_d \omega t''$, because this projective component is now an intrinsic dimension in the positive universe. The star label on the spacetime and intrinsic spacetime and parameters and intrinsic parameters of the negative universe have been consistently used to differentiated from those of our universe in all previous articles, starting from since [5].

Derivation of partial intrinsic local Lorentz transformation from Fig. 12 follows the same procedure used to derive partial intrinsic Lorentz transformation from Fig. 8a of [5] in the context of intrinsic special theory of relativity (ωSR). The procedure is applied hereunder.

Now $d\omega p$ being the projective component along the horizontal of the inclined $d\omega p'$, then $d\omega p = d\omega p' \cos \omega \psi_{m,p}$. Hence we must express the rotated $d\omega p'$ in terms of its projection $d\omega p$ along the horizontal with respect to all $3$-observers in $\mathbb{E}^3$ and write

$$d\omega p' = d\omega p \sec \omega \psi_{m,p}.$$  

This is all the intrinsic metric spacetime interval transformation that should have been possible along the horizontal in the first quadrant, with respect to 3-observers in the relativistic Euclidean 3-space $\mathbb{E}^3$ in Fig. 12, except that the inclined interval of negative relative proper intrinsic metric time dimension $-\omega c_d \omega t''$ in the fourth quadrant also projects interval $-\omega c_d \omega t'' \sin \omega \psi_{m,p}$ (with the star label removed for the reason given above) along the horizontal, which must be added to the right-hand side of the last displayed equation to have

$$d\omega p' = d\omega p \sec \omega \psi_{m,p} - \omega c_d \omega t' \sin \omega \psi_{m,p}.$$  

But the inclined interval $\omega c_d \omega t'$ is related to its projection $\omega c_d \omega t$ along the vertical in the same Fig. 12 as, $\omega c_d \omega t = \omega c_d \omega t' \cos \omega \psi_{m,p}$, hence $\omega c_d \omega t' = \omega c_d \omega t \sec \omega \psi_{m,p}$. Using this in the last displayed equation gives

$$d\omega p' = d\omega p \sec \omega \psi_{m,p} - \omega c_d \omega t' \tan \omega \psi_{m,p}$$  

(with respect to 3 - observers in $\mathbb{E}^3$).  

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Equation (5) is the partial transformation of elementary intrinsic metric spacetime coordinate intervals in terms of the intrinsic angle $\psi_{m,P}$, which can be derived along the horizontal in the first quadrant, with respect to 3-observers in $E^3$ in Fig. 12.

The complementary diagram to Fig. 12 that can be drawn at the symmetry-partner points, $P$, $P'$, $P^*$ and $P'^*$, along the curved relative proper intrinsic metric spacetimes dimensions, $\partial p'$, $\partial c_t \partial t'$, $-\partial p^*$ and $-\partial c_t \partial t'^*$, in Fig. 7; Fig. 7 being the complementary diagram to Fig. 5, is depicted in Fig. 13. The local geometry of Fig. 13 derived from the global geometry of Fig. 7 is valid with respect to 1-observers in the relativistic metric time dimensions, $c_s t$ and $-c_s t^*$, as is the case with Fig. 7.

Now $\partial c_t \partial t'$ being the projective component along the vertical of the inclined $\partial c_t \partial t'$ in the first quadrant in Fig. 13, then $\partial c_t \partial t' = \partial c_t \partial t' \cos \psi_{m,P}$. We must express the rotated $\partial c_t \partial t'$ in terms of its projection $\partial c_t \partial t$ along the vertical with respect to 1-observers in $c_s t$ and write,

$$\partial c_t \partial t' = \partial c_t \partial t \sec \psi_{m,P}.$$ 

This is all the transformation of intrinsic metric spacetime intervals that should have been possible along the vertical in the first quadrant, with respect to 1-observers in the relativistic time dimension $c_s t$ in Fig. 13, except that the inclined negative relative proper intrinsic metric space interval $-\partial p^*$ in the second quadrant also projects component $-\partial p' \sin \psi_{m,P}$ (its star label has been removed because it is an intrinsic coordinate of our universe) along the vertical, which must be added to the right-hand side of the last displayed equation to have

$$\partial c_t \partial t' = \partial c_t \partial t \sec \psi_{m,P} - d\partial p' \sin \psi_{m,P}.$$ (with respect to 1 observers in $c_s t$).

---

**Fig. 12.** The local metric spacetime/intrinsic metric spacetime diagram drawn at symmetry-partner points in spacetimes/intrinsic spacetimes in the positive (or our) universe and the negative universe obtained from the global diagram of Fig. 5, for deriving partial transformation of elementary intrinsic metric spacetime coordinate intervals in terms of intrinsic static flow speed, with respect to 3-observers in the relativistic Euclidean 3-spaces in the positive and negative universes.
Equation (6) is the partial transformation of elementary intrinsic metric spacetime coordinate intervals in terms of the intrinsic angle $\phi_{m,P}$, which can be derived along the vertical in the first quadrant, with respect to 1-observers in $c,s,t$ in Fig. 13.

Collecting Eqs. (5) and (6) gives the full transformation of elementary intrinsic metric spacetime coordinate intervals from the local geometry of Fig. 12 and its complementary geometry of Fig. 13 as

$$
\begin{align*}
\phi_{c,s,d} &= \phi_{c,s,d} \sec \phi_{m,P} - d\phi' \tan \phi_{m,P} \quad \text{(w.r.t 1 - observers in } c,s,t) ; \\
\phi' &= \phi' \sec \phi_{m,P} - \phi_{c,s,d} \tan \phi_{m,P} \quad \text{(w.r.t 3 - observers in } \mathbb{E}^3). 
\end{align*}
$$

There is an inverse of system (7), which must be derived from the inverses to Figs. 12 and 13. Now in obtaining the inverse of the local diagrams of Figs. 12 and 13, the inclined position of the primed intrinsic local metric frame $(d\phi', \phi_{c,s,d})$ and the non-inclined position (or flatness) of the unprimed (or relativistic) intrinsic local metric frame $(d\phi, \phi_{c,s,d})$ in Figs. 12 and 13 must be retained. However the flat (or non-inclined) relativistic (or unprimed) local intrinsic metric frame $(d\phi, \phi_{c,s,d})$ must now be considered to possess negative relative proper intrinsic static flow speed $-\phi_{V_{m,P}}$ and to be inclined at negative intrinsic angle $-\phi_{m,P}$ relative to the inclined relative proper (or primed) local intrinsic metric frame $(d\phi', \phi_{c,s,d})$. The negative relative proper intrinsic static flow speed of the unprimed local intrinsic metric frame $(d\phi, \phi_{c,s,d})$ is still invariantly projected into the inclined primed local intrinsic metric frame $(d\phi', \phi_{c,s,d})$. The resulting inverse diagram to Fig. 12 is depicted in Fig. 14.

---

**Fig. 13.** The complementary diagram to Fig. 12 drawn at symmetry-partner points in spacetimes/intrinsic spacetimes in the positive and negative universes, from the global diagram of Fig. 7, for deriving partial transformation of elementary intrinsic metric spacetime coordinate intervals in terms of intrinsic static flow speed with respect to 1-observers in the relativistic metric time dimensions in the positive and negative universes.
The clockwise rotation of the relative proper (or primed) intrinsic local metric frame \((\text{c}t)\) relative to its projective relativistic (or unprimed) intrinsic local metric frame \((\text{c}t)\) by a positive intrinsic angle \(\psi_{m,p}\) in Fig. 13, is equivalent to the clockwise rotation of the relativistic (or unprimed) intrinsic local metric frame \((\text{c}t)\) relative to the relative proper (or primed) intrinsic local metric frame \((\text{c}t)\), by negative intrinsic angle \(-\psi_{m,p}\) in Fig. 14. Consequently Fig. 13 and Fig. 14 are both valid with respect to 1-observers in the relativistic time dimensions \(c_t\) and \(-c_t^*\) in our universe and the negative universe.

Fig. 14 as the inverse of Fig. 12 in a long-range metric force field and an intrinsic long-range metric force field, corresponds to Fig. 9a as the inverse of Fig. 8a [5], reproduced as Figs. 8a and 9a on pages 49 and 50 of this article in the context of SR/DSR. Consequently the procedure applied in deriving partial inverse intrinsic affine coordinate transformation from Fig. 9(a) of this article in [5] shall be applied in deriving partial inverse transformation of elementary intrinsic metric spacetime coordinate intervals from Fig. 14 here.

Now the interval of inclined relative proper intrinsic metric space \(d\psi_p\) in the first quadrant in Fig. 14 is the projection of the non-inclined interval of relativistic intrinsic metric space \(d\psi_p\) in the first quadrant in that figure. That is, 
\[d\psi_p = d\psi_p \cos(-\psi_{m,p}) = d\psi_p \cos(\psi_{m,p}).\]

The non-inclined \(d\psi_p\) must be expressed in terms of its projective \(\psi_{p}'\) with respect to 1-observers in \(c_t\) in the inverse diagram of Fig. 14 as 
\[d\psi_p = d\psi_p' \sec \psi_{m,p}.\]

This is all the elementary intrinsic metric spacetime coordinate interval transformation that should have been possible along the inclined path \(AB'\), with respect to 1-observers in the relativistic time dimension \(c_t\) in the first quadrant in Fig. 14, except that the interval \(\psi_{c,t}\) of relativistic intrinsic metric time dimension along the vertical projects a component, \(\psi_{c,t}\), of the inclined path \(AB'\), where \(\psi_{c,t} + \psi_{c,t} = \psi_{t}/2\) or \(\psi_{c,t} = \psi_{t}/2 - \psi_{c,t}\). Hence, 
\[\psi_{c,t} \sec \psi_{m,p} = \psi_{c,t} \sec \psi_{m,p}.\]

This component must be added to the right-hand side of the last displayed equation to have 
\[d\psi_p = d\psi_p' \sec \psi_{m,p} + \psi_{c,t} \sec \psi_{m,p};\]
(w.r.t. 1-observers in \(c_t\)) However,
\[ ψ_c dσt' = ψ_c dσt \cos(-ψ_m, p) = ψ_c dσt \cos ψ_m, p, \quad \text{hence, } \quad ψ_c dσt = ψ_c dσt' \sec ψ_m, p, \] along the vertical in the first quadrant in Fig. 14. Using this in the last displayed equation gives

\[ dσ_p = dσ_p' \sec ψ_m, p + ψ_c dσt' \tan ψ_m, p : (w.r.t. 1 - observers in c,t). \tag{8} \]

This is the partial inverse transformation of elementary intrinsic metric spacetime coordinate intervals that can be derived along the inclined path AB' with respect to 1-observers in the relativistic (or unprimed) frame \( (relativistic (or \: unprimed) \: intrinsic \: local \: metric) \). This is so because anti-clockwise rotation of the relativistic Euclidean 3-spaces, \( E^3 \) and \(-E^3\), is valid with respect to 3-observers in our universe and the negative universe.

Again Fig. 15 is the inverse of Fig. 13 like Fig. 9(b) is the inverse of Fig. 8(b) in [5], reproduced as Figs. 9(b) and 8(b) of this article. Consequently the procedure applied in deriving partial inverse intrinsic affine coordinate transformation from Figs. 9(b) and 8(b) of this article shall be applied in deriving partial inverse intrinsic coordinate interval transformation from Fig. 15 here.

Finally the inverse of the local geometry of Fig. 13, which can be derived from the global geometry of Fig. 11 is depicted in Fig. 15. Figure 10 is valid with respect to 3-observers in the relativistic Euclidean 3-spaces, \( E^3 \) and \(-E^3\). This is so because anti-clockwise rotation of the relativistic (or unprimed) intrinsic local metric frame \( (dσ_p, ψ_c dσt') \) relative to its projective relativistic (or unprimed) intrinsic local metric frame \( (dσ_p, ψ_c dσt) \), by a positive intrinsic angle \( ψ_m, p \) in Fig. 12, is equivalent to the anti-clockwise rotation of the relativistic (or unprimed) intrinsic local metric frame \( (dσ_p, ψ_c dσt) \) relative to the inclined relative proper intrinsic local metric frame \( (dσ_p', ψ_c dσt') \) by negative intrinsic angle \(-ψ_m, p\) in Fig. 15. Consequently Fig. 15, like Fig. 12, is valid with respect to all 3-observers in the relativistic Euclidean 3-spaces, \( E^3 \) and \(-E^3\), in our universe.

Now the interval \( ψ_c dσt' \) of the inclined relative proper intrinsic metric time dimension \( ψ_c dσt' \) along the inclined path AC' in the first quadrant in Fig. 15, is the projection of the non-inclined interval \( ψ_c dσt \) of the relativistic intrinsic metric time dimension \( ψ_c dσt \) along the horizontal in the first quadrant in that figure. That is, \( ψ_c dσt' = ψ_c dσt \cos(-ψ_m, p) = ψ_c dσt \cos(ψ_m, p) \). The interval \( ψ_c dσt \) must be expressed in terms of its projection \( ψ_c dσt' \) along the path AC' with respect of 3-observers in \( E^3 \) in Fig. 15 as

\[ ψ_c dσt = ψ_c dσt' \sec ψ_m, p. \]

**Fig. 15.** The inverse of the local diagram of Fig. 13, drawn from the global diagram of Fig. 11, for deriving partial inverse transformations of elementary intrinsic metric spacetime coordinate intervals in terms of relative proper intrinsic static flow speed with respect to 3-observers in the relativistic metric Euclidean 3-spaces in the positive and negative universes.
Dividing the second into the first equation of system (11) gives

$$\partial_c \partial t = \frac{\partial_c \partial t'}{\sin \theta_{\rho, m, p}} + d \partial \rho \sin \theta_{\rho, m, p};$$  
(w.r.t. 3 – observers in \(E^3\))

However, \(d \partial \rho' = d \partial \rho \cos(-\theta_{\rho, m, p})\), hence, \(d \partial \rho = d \partial \rho' \sec \theta_{\rho, m, p}\), along the horizontal in the first quadrant in Fig. 15. Using this in the last displayed equation gives

$$\partial_c \partial t = \frac{\partial_c \partial t'}{\sec \theta_{\rho, m, p}} + d \partial \rho' \tan \theta_{\rho, m, p};$$  
(w.r.t. 3 – observers in \(E^3\)).

This is the partial inverse transformation of elementary intrinsic metric spacetime coordinate intervals that can be derived along the inclined path \(AC'\) with respect to 3-observers in the relativistic Euclidean 3-space \(E^3\) in the first quadrant (or in our universe) in Fig. 15. Collecting Eqs. (8) and (9) gives

$$\partial_c \partial t = \frac{\partial_c \partial t'}{\sec \theta_{\rho, m, p}} + d \partial \rho' \tan \theta_{\rho, m, p};$$  
(w.r.t. 3 observers in \(E^3\))

$$d \partial \rho = d \partial \rho' \sec \theta_{\rho, m, p} + \partial_c \partial t' \tan \theta_{\rho, m, p};$$  
(w.r.t. 1 observers in \(c_s t\)).

System (10) derived from the local diagrams of Figs. 14 and 15 is the inverse of system (7) derived from the local diagrams of Figs. 12 and 13.

Let us consider an intrinsic event that involves interval \(\partial_c \partial t'\) of relative proper intrinsic metric time dimension but zero interval of relative proper intrinsic metric space \((d \partial \rho' = 0)\). This reduces system (10) as

$$\partial_c \partial t = \frac{\partial_c \partial t'}{\sec \theta_{\rho, m, p}};$$  

$$d \partial \rho = \partial_c \partial t' \tan \theta_{\rho, m, p}.$$  

(11)

Dividing the second into the first equation of system (11) gives

$$\frac{d \partial \rho}{\partial_c \partial t} = \sin \theta_{\rho, m, p}.$$  

(12)

But \(d \partial \rho/d \partial t = \theta_{\rho, m, p}^m\), is the positive relative proper intrinsic static flow speed of the primed intrinsic local metric frame \((d \partial \rho', \partial_c \partial t')\) and its projective unprimed intrinsic local metric frame \((d \partial \rho, \partial_c \partial t)\), knowing that intrinsic dynamical speed is absent, since no particle is in motion.

Let us also recall the definition of \(\sin \theta_{\rho, m, p}^m\) in Eq. (80) of the preceding third part of this paper [3] and the discussion following it. The corresponding definition of \(\sin \theta_{\rho, m, p}\) in the present context is, \(\sin \theta_{\rho, P} = \partial \rho/\partial_c \partial t = \partial \rho' \sin \theta_{\rho, m, p}/c_m\). As discussed in converting Eq. (80) to Eqs. (81) and (82) of the preceding article, the ratio, \(\sin \theta_{\rho, m, p} = \theta_{\rho, m, p}/c_m\) (where \(c_m\), with magnitude \(3 \times 10^6\) m s\(^{-1}\), is the maximum over all relative proper intrinsic static-flow speeds \(\theta_{\rho, m, p}\) that can be established in intrinsic metric spacetime), is the appropriate ratio. The ratio, \(\sin \theta_{\psi, m, p} = \theta_{\rho, m, p}/c_m\), where \(c_m\) is the maximum intrinsic static geodesic flow-speed that appears in the time dimensions, \(\partial_c \partial t\) and \(\partial_c \partial t'\) (introduced in sub-section 2.1 of [7]), is inappropriate. Indeed \(\partial_c\) is
equivalent to zero magnitude of $\varnothing V_{m}'$. The speed $V_{m}'$ and $c_{m}$ shall referred to as gravitational flow-speed and re-denoted upon particularizing the results of this paper to the gravitational field elsewhere. Then the difference between $\varnothing c_{s}$ and $\varnothing c_{m}$ shall become clarified. Hence,

$$\sin \varnothing \psi_{m, \rho} = \varnothing V_{m, \rho}/\varnothing c_{m} \equiv \varnothing \beta_{m, \rho}(\varnothing V_{m, \rho})$$  \hspace{1cm} (13a)

$$\sec \varnothing \psi_{m, \rho} = \frac{1}{\sqrt{1 - \frac{\varnothing V_{m, \rho}^{2}}{\varnothing c_{m}^{2}}}} \equiv \varnothing \gamma_{m, \rho}(\varnothing V_{m, \rho}) .$$  \hspace{1cm} (13b)

Using Eqs. (13a) and (13b) in systems (7) and (10) gives the following respectively

$$d\varnothing t' = \varnothing \gamma_{m, \rho}(\varnothing V_{m, \rho}')d\varnothing t - \frac{\varnothing V_{m, \rho}'}{\varnothing c_{m}^{2}}d\varnothing \rho ;$$  \hspace{1cm} (14)

(w.r.t. 1 - observers in $c_{s}t$);

$$d\varnothing \rho' = \varnothing \gamma_{m, \rho}(\varnothing V_{m, \rho}')d\varnothing \rho - \varnothing V_{m, \rho}d\varnothing t' ;$$  \hspace{1cm} (15)

(w.r.t. 3 - observers in $E^{3}$)

and

$$d\varnothing t = \varnothing \gamma_{m, \rho}(\varnothing V_{m, \rho}')d\varnothing t + \frac{\varnothing V_{m, \rho}'}{\varnothing c_{m}^{2}}d\varnothing \rho' ;$$

(w.r.t. 3 - observers in $E^{3}$);

$$d\varnothing \rho = \varnothing \gamma(\varnothing V_{m, \rho}')d\varnothing \rho + \varnothing V_{m, \rho}d\varnothing t' ;$$

(w.r.t. 1 - observers in $c_{s}t$).

Systems (14) and (15) in terms of intrinsic static flow speed $\varnothing V_{m, \rho}'$, take on the forms of intrinsic Lorentz transformation ($\varnothing$LT) and its inverse respectively in terms of relative intrinsic dynamical speed $\varnothing v$, in the context of intrinsic special theory of relativity ($\varnothing$SR), presented as systems (20) and (21) of [5]. Hence systems (14) and (15) shall be referred to as intrinsic local Lorentz transformation ($\varnothing$LLT) and its inverse respectively in terms of relative intrinsic static flow speed, in the context of the intrinsic theory of relativity associated with the presence of intrinsic metric force field in intrinsic metric spacetime.

Either system (10) or its inverse (7), or the explicit form in terms of relative proper intrinsic static flow speed (14) or (15), leads to intrinsic local Lorentz invariance

$$\varnothing c_{s}^{2}d\varnothing t^{2} - d\varnothing \rho^{2} = \varnothing c_{s}^{2}d\varnothing t'^{2} - d\varnothing \rho'^{2} .$$  \hspace{1cm} (16)

The intrinsic local Lorentz transformation of elementary relative proper intrinsic metric spacetime intervals, $d\varnothing \rho'$ and $\varnothing \rho_{s, \rho}d\varnothing t'$, into elementary relativistic intrinsic metric spacetime intervals, $d\varnothing \rho$ and $\varnothing \rho_{s, \rho}d\varnothing t$, of system (7) or (14) and its inverse system (10) or (15), written at symmetry-partner points P and P$'$ along the curved relative proper intrinsic metric space $\varnothing \rho'$ and curved relative proper intrinsic metric time dimension $\varnothing \rho_{s, \rho}d\varnothing t'$ in Figs. 5 and 7 and their inverses Figs. 10 and 11, can equally be written at another symmetry-partner points Q and Q$'$ along those curved relative proper intrinsic metric spaces and curved relative proper intrinsic metric time dimensions, in terms of intrinsic angle $\varnothing \psi_{m, \rho}$ and relative proper proper intrinsic static flow speed $\varnothing V_{m, \rho}'$ of the new symmetry-partner points, and this can be done at every symmetry-partner points along these curved intrinsic metric spacetime dimensions.

It follows from the preceding paragraph that the intrinsic local Lorentz invariance (16) obtains between every point of the global curved two-dimensional relative proper intrinsic metric spacetime ($\varnothing \rho', \varnothing \rho_{s, \rho}d\varnothing t'$) and the corresponding point of the projective relativistic intrinsic metric spacetime ($\varnothing \rho, \varnothing \rho_{s, \rho}d\varnothing t$) in Fig. 5 through Fig. 11. This guarantees that the projective two-dimensional relativistic intrinsic metric spacetime ($\varnothing \rho, \varnothing \rho_{s, \rho}d\varnothing t$) is everywhere flat within every long range metric force field.

Having derived the local diagrams of Figs. 12 and 13 from the global diagrams of Figs. 5 and 7 respectively and the inverse local diagrams of Figs. 14 and 15 from the inverse global diagrams.
of Figs. 10 and 11 respectively, let us now demonstrate how the global diagrams arise from the respective local diagrams. Now when the inclinations of the primed (or proper) intrinsic local metric frame \((d\varphi_\rho', \varphi_c, dt')\) relative to its projective flat (or non-inclined) unprimed (or relativistic) intrinsic local metric frame \((d\varphi_\rho, \varphi_c, dt)\) by positive intrinsic angle \(\vartheta_\psi_{m, p}\) in Figs. 12 and 13, are drawn at consecutive points away from point O (where \(\vartheta_\psi \approx 0\) and \(\vartheta_\psi' \approx 0\)), then one obtains the extended curved relative proper intrinsic metric spacetime \((\varphi_\rho', \varphi_c, dt')\) relative to its projective extended flat relativistic intrinsic metric spacetime \((\varphi_\rho, \varphi_c, dt)\) in the positive universe, and the symmetrical extended curved \((-\varphi_\rho^{*'}, -\varphi_c, dt^{*'})\) relative to its projective extended flat \((-\varphi_\rho^*, -\varphi_c, dt^*)\) in the negative universe in Figs. 5 and 7.

Now let us return to the elementary intrinsic metric spacetime interval transformation (14) and its inverse (15) and collect the partial intrinsic transformations that are valid with respect to 3-observers in the relativistic Euclidean 3-space \(E^3\) in those systems to have

\[
\begin{align*}
  d\varphi_\rho &= \vartheta_{\gamma_{m, p}}((d\varphi_\rho' + \varphi_{V_{m, p}'}, dt')d\varphi_\rho' \pm \varphi_{\varphi_{V_{m, p}}}, dt) ; \\
  d\rho'_t &= \vartheta_{\gamma_{m, p}}((d\varphi_\rho' + \varphi_{V_{m, p}'}, dt')d\varphi_\rho'' \pm \varphi_{\varphi_{V_{m, p}}}, dt) ;
\end{align*}
\]

(w.r.t 3-observers in \(E^3\)).

Now from the point of view of what can be observed and measured as intrinsic space interval with intrinsic laboratory rod and as intrinsic time interval with intrinsic laboratory clock by ‘intrinsic 3-observers’ in the intrinsic space \(\varphi_\rho\), the terms \(-\vartheta_{\gamma_{m, p}}((d\varphi_\rho' + \varphi_{V_{m, p}'}, dt')d\varphi_\rho' \pm \varphi_{\varphi_{V_{m, p}}}, dt)\) and \(\vartheta_{\gamma_{m, p}}((d\varphi_\rho' + \varphi_{V_{m, p}'}, dt')d\varphi_\rho' \pm \varphi_{\varphi_{V_{m, p}}}, dt)\) and \(\varphi_{\varphi_{V_{m, p}}}d\varphi_\rho'\) must be set to zero in system (17), thereby reducing that system as follows from the point of view of what can be measured with intrinsic laboratory rod and clock by hypothetical intrinsic 1-observers in \(\varphi_\rho\)

\[
\begin{align*}
  d\varphi_\rho &= \vartheta_{\gamma_{m, p}}((d\varphi_\rho')^{-1}d\varphi_\rho' = d\varphi_\rho(1 - \frac{V_{m, p}'^{2}}{c_m^{2}})^{1/2} ; \\ (18) \\
  d\rho'_t &= \vartheta_{\gamma_{m, p}}((d\varphi_\rho')d\varphi_\rho' = d\rho'_t(1 - \frac{V_{m, p}'^{2}}{c_m^{2}})^{-1/2} . \\ (19)
\end{align*}
\]

Equations (18) and (19) give intrinsic metric space contraction and intrinsic metric time dilation formulae with respect to 3-observers in the relativistic Euclidean 3-space \(E^3\), explicitly in terms of relative proper intrinsic static flow speed at point P along the curved \(\varphi_\rho'\) and the symmetry-partner point \(O'\) along the curved \(\varphi_c, dt\) in the global diagrams. These are intrinsic length contraction and intrinsic time dilation formulae in the context of the intrinsic theory of relativity associated with the presence of a long-range intrinsic metric force field in intrinsic metric spacetime.

Now the intrinsic theory of relativity on the flat two-dimensional relativistic intrinsic metric spacetime \((\varphi_\rho, \varphi_c, dt)\) associated with the presence of a long-range relativistic intrinsic metric force field on \((\varphi_\rho, \varphi_c, dt)\), will be made manifest outwardly in the theory of relativity on the flat four-dimensional relativistic metric spacetime \((E^3, c_s, t)\), due to the presence of a long-range relativistic metric force field in \((E^3, c_s, t)\). Consequently the intrinsic local Lorentz transformation (\(\varphi\)LLT) of system (7) and its inverse of system (10) in the two-dimensional intrinsic metric spacetime, will be made manifest outwardly in local Lorentz transformation (LLT) and its inverse in the four-dimensional metric spacetime respectively as

\[
\begin{align*}
  c_s dt' &= c_s dt \sec \psi - dx^1 \tan \psi_{m, p} ; \quad \text{(w.r.t. 1 - observers in } c_s, t) ; \\
  dx^1 &= dx^1 \sec \psi_{m, p} - c_s dt \tan \psi_{m, p} ; \quad dx^2 = dx^2 ; \quad dx^3 = dx^3 ; \quad \text{(w.r.t. 3 - observers in } E^3) \quad (20)
\end{align*}
\]
respectively as

\[
\frac{dx}{dr} = \frac{dx}{dt'} \sec \psi_{m,p} + dx^1 \tan \psi_{m,p};
\]

(w.r.t. 3 - observers in \(\mathbb{E}^3\));
\[
dx^1 = dx^1 \sec \psi_{m,p} + c_s dt' \tan \psi_{m,p}; \quad dx^2 = dx^2; \quad dx^3 = dx^3;
\]

(w.r.t. 1 - observers in \(c_s t\)).

The explicit forms of \(\varphi\)LLT (14) and its inverse (15) in the two-dimensional intrinsic metric spacetime are likewise made manifested in LLT and its inverse on the flat four-dimensional metric spacetime respectively as

\[
dt' = \gamma_{m,p}(V'_{m,p})(dt - \frac{V'_{m,p}}{c^2_{m,p}} dx^1);
\]

(w.r.t. 1 - observers \(c_s t\));
\[
dx'^1 = \gamma_{m,p}(V'_{m,p})(dx^1 + V'_{m,p} dt'); \quad dx'^2 = dx^2; \quad dx'^3 = dx^3;
\]

(w.r.t. 3 - observers in \(\mathbb{E}^3\))

and

\[
dt = \gamma_{m,p}(V'_{m,p})(dt' + \frac{V'_{m,p}}{c^2_{m,p}} dx^1);
\]

(w.r.t. 3 - observers in \(\mathbb{E}^3\));
\[
dx^1 = \gamma_{m,p}(V'_{m,p})(dx^1 + V'_{m,p} dt'); \quad dx^2 = dx^2; \quad dx^3 = dx^3;
\]

(w.r.t. 1 - observers in \(c_s t\));

where

\[
\gamma_{m,p}(V'_{m,p}) = \sec \psi_{m,p} = \left(1 - \frac{V'^2_{m,p}}{c^2_{m,p}}\right)^{-1/2}.
\]

The dimension \(x^1\) of the relativistic Euclidean 3-space \(\mathbb{E}^3\) is considered to be orientated along the isotropic relativistic intrinsic metric space \(\varphi_{\rho}\), while the dimensions \(x^2\) and \(x^3\) of \(\mathbb{E}^3\) are orientated along other directions in \(\mathbb{E}^3\). It then follows that the dimension \(x^1\) of the relative proper Euclidean 3-space \(\mathbb{E}^3\) was orientated along the isotropic relative proper intrinsic metric space \(\varphi_{\rho'}\), while the dimensions \(x^2\) and \(x^3\) of \(\mathbb{E}^3\) were orientated along other directions in \(\mathbb{E}^3\) in Fig. 4 or Fig. 11 of [3], reproduced as Fig. 1 of this article, at the first stage of evolution of spacetimes and intrinsic spacetimes in a long-range metric force field, prior to the evolution of Figs. 5, 7, 10 and 11 at the second stage.

Now the intrinsic static flow speed \(\varphi V'_{m,p}\) lies along the isotropic proper intrinsic metric space \(\varphi_{\rho'}\) underlying \(\mathbb{E}^3\) (in Fig. 1) at the first stage and along \(\varphi_{\rho}\) underlying \(\mathbb{E}^3\) at the second stage. Consequently the static flow velocity \(V'_{m,p}\) lies along \(x^1\) in \(\mathbb{E}^3\) and along \(x^1\) in \(\mathbb{E}^3\). It has no component along the coordinate \(x^2\) or \(x^3\) in \(\mathbb{E}^3\) and no component along coordinate \(x^1\) or \(x^3\) in \(\mathbb{E}^3\). These make systems (20) through (23) to take on their forms, in which the intervals \(dx^2\) and \(dx^3\) transform into intervals \(dx^2\) and \(dx^3\) trivially as, \(dx'^2 = dx^2\) and \(dx'^3 = dx^3\). A robust explanation of why systems (20) – (23) take on their forms in all long-ranged metric force-fields—spherically symmetric or not—shall be given when we fully make connection to the gravitational field elsewhere.

Either the LLT (20) or its inverse (21), or the explicit form (22) or (23), leads to local Lorentz invariance (LLI)

\[
c^2 dt'^2 - (dx^1)^2 - (dx^2)^2 - (dx^3)^2 = c^2 dt^2 - (dx'^1)^2 - (dx'^2)^2 - (dx'^3)^2.
\]

This is the outward manifestation in the four-dimensional metric spacetime of the intrinsic local Lorentz invariance (\(\varphi\)LLI) (16) in the two-dimensional intrinsic metric spacetime. The local Lorentz invariance (25) is valid at every point on the four-dimensional spacetime, implying flatness everywhere in a long-range metric force field of the four-dimensional relativistic metric spacetime (\(\mathbb{E}^3, c_s t\)).
The intrinsic length contraction formula (18) and intrinsic time dilation (19) on the flat two-dimensional intrinsic metric spacetime are likewise made manifested outwardly in length contraction and time dilation formulae on the flat four-dimensional metric spacetime as

\[ dx_1^1 = \gamma_{m, (V'_{m, P})}^{-1} dx'^1 = \left(1 - \frac{V'^2_{m, P}}{c^2_m}\right)^{1/2} dx'^1; \quad dx'^2 = dx^2; \quad dx'^3 = dx^3 \quad (26) \]

and

\[ dt = \gamma_{m, P} (V'_{m, P}) dt' = \left(1 - \frac{V'^2_{m, P}}{c^2_m}\right)^{-1/2} dt'. \quad (27) \]

As a summary of this section, we have derived the global curved intrinsic metric spacetime/global flat metric spacetime geometries of Figs. 5 – 11 and the associated local spacetime/intrinsic spacetime geometries of Figs. 12 – 15 in the four-world picture. We have derived the intrinsic local Lorentz transformation (\(\emptyset\text{LLT}\)) and its inverse of systems (7) and (10), or systems (14) and (15); we have validated intrinsic local Lorentz invariance (\(\emptyset\text{LLI}\)) and have derived the intrinsic length contraction and intrinsic time dilation formulas (18) and (19), at an arbitrary point in spacetime within a long range metric force field, with the aid of Figs. 12 – 15 (as must be done at every point in spacetime) in every long-range metric force field. These are results in the context of the intrinsic theory of relativity associated with the presence of an intrinsic metric force field in intrinsic metric spacetime.

The theory of relativity in the metric spacetime due to the presence of a long-range metric force field in the metric spacetime, being mere outward manifestation of the intrinsic theory of relativity in intrinsic metric spacetime; the results of the theory of relativity in spacetime have been written directly from the corresponding results of intrinsic theory of relativity in intrinsic metric spacetime. These are the local Lorentz transformation (LLT) and its inverse of system (20) and (21) or system (22) and (23); local Lorentz invariance (LLI) and the length contraction and time dilation formulae (26) and (27), all of which have been written at an arbitrary point in spacetime in a long-range metric force field. The central purpose of this article is to develop a new geometrical background for the theory of relativity associated with the presence of a long-range metric force field in the metric spacetime within the four-world picture, in which the four-dimensional metric spacetime is underlay by a hidden two-dimensional intrinsic metric spacetime in each universe, derived in [5–8]. We deem the results derived in this section and summarized in the foregoing two paragraphs as adequate for this purpose.

2.3 Clarifications of the Concepts of Relative Static Flow-Speed, Relativity Associated with Static Flow-speed and Relative Metric Force Fields

It is appropriate to shine some light on the new concepts in the topic of this sub-section that are introduced in this article. Let us start with the familiar concept (or parameter) in physics namely, the dynamical velocity \(\vec{v}\) (or speed \(v\)). It is an observable and measurable property of a particle or object in motion. The dynamical velocity is a relative parameter because its magnitude varies with the observer or frame of reference relative to which the particle is in motion. The relativity of dynamical velocity is the origin of the relativity of motion of material particles and objects described by the special theory of relativity.

On the other hand, the relative proper static flow speed \(V'_{m, P}\) is a property of space, established in space by the source of a long-range metric force field, underlay by a hidden two-dimensional intrinsic metric spacetime in each universe. We deem the results derived in this section and summarized in the foregoing two paragraphs as adequate for this purpose. It is to be recalled from the derivation of the concept of intrinsic static flow speed and static flow speed in part three of this paper [3] that, the intrinsic static flow speed and static flow speed, which appear in the intrinsic theory of relativity and theory of relativity associated with the presence of a long-range metric force field in spacetime in this article are pure geometrical parameters. Nevertheless, they will not arise in the absence of a source of a metric force field and a source of intrinsic metric force field.
relative proper (or classical) metric force field, irrespective of whether a particle or object is present in space or not. A particle or object of any mass located at a point \( P \) in space where the relative proper static flow speed is \( V_{m,P} \), will acquire \( V_{m,P}' \) but will not move relative to any observer or frame of reference at this speed. If it also possesses dynamical velocity \( \vec{v} \) relative to an observer while moving through point \( P \), then it will be observed to move at the velocity \( \vec{v} \) only relative to the observer, despite the static flow speed \( V_{m,P}' \) it has acquired.

The static flow speed established at a point in space cannot be observed or measured. It does not give rise to flow of space and, consequently, it does not give rise to translation in space of a material particle or object that acquired it, as mentioned above. Further more, the static flow speed of a point in space is the same with respect to all observers of frames of reference. It is hence an absolute parameter from the point of view of dynamical relativity (or the special theory of relativity). Then how come the concepts of relative static flow speed and relativity associated with static flow speed?

In order to answer the question ending the preceding paragraph, let us revisit the length contraction and time dilation formulae (26) and (27). Although the relative proper static flow speed \( V_{m}' \) of a point in space cannot be observed or measured and, although its square \( V_{m}'^2 \) cannot be observed or measured, the quantities \( (1 - V_{m}'^2/c_m^2)^{2} dx^1 \) and \( (1 - V_{m}'^2/c_m^2)^{-2} \frac{dt'}{c_m} \) can be observed and measured. This follows from the fact to be formally derived upon making connection to gravity elsewhere that \( V_{m}'^2 \) is related to the classical potential \( \Phi_m' \) of the metric force field that establishes \( V_{m}' \) in space as, \( \Phi_m' = -\frac{1}{2} V_{m}'^2 \) (for an attractive metric force field). The quantity \( V_{m}'^2 \), like the potential \( \Phi_m' \) at a point in space, cannot be observed or measured (as is the case with gravitational potential in particular).

Now the quantities,

\[
(1 - V_{m}'^2/c_m^2)^{2} dx^1 = (1/c_m)(c_m^2 - V_{m}'^2)^{\frac{1}{2}} dx^1
\]

and

\[
(1 - V_{m}'^2/c_m^2)^{-2} \frac{dt'}{c_m} = c_m(c_m^2 - V_{m}'^2)^{-\frac{1}{2}} dt',
\]

can be measured, since, \( c_m^2 - V_{m}'^2 \) being equivalent to difference of potentials, can be measured. It then follows that the length contraction and time dilation formulae (26) and (27) can be observed and measured.

Thus by allowing an event that involves proper time interval \( dt' \) and proper space intervals, \( dx'^1, dx'^2 \) and \( dx'^3 \), to occur at different positions in space within a long-range metric force field, the observed (or relativistic) time interval \( dt \) and the observed (or relativistic) interval \( dx \) of the relativistic Euclidean 3-space \( \mathbb{E}^3 \) (in Fig.5) involved in the same event, will vary with position in \( \mathbb{E}^3 \), while the observed intervals, \( dx^2 \) and \( dx^3 \), of \( \mathbb{E}^3 \) involved in the event will be the same at all positions within the metric force field, according to systems (26) and (27). The variations with the magnitude of the relative proper static flow speed \( V_{m}' \) and, consequently, with position in space within a long-range metric force field, of the observed (or relativistic) time interval \( dt \) and the observed (or relativistic) interval \( dx \) of the Euclidean 3-space \( \mathbb{E}^3 \), of an event, is the concept of relativity associated with relative proper static flow-speed, or with the presence of a long-range metric force field in spacetime.

In brief, the relativity associated with relative proper static flow speed in a long-range metric force field is relativity with position in space within the field (and not relativity with observer or frame of reference). Relativity of relative proper static flow speed likewise refers to variation of magnitude of relative proper static flow speed with position in space within a long-range metric force field. In other words, it refers to the fact that the relative proper static flow speeds, \( V_{m,P}' \) and \( V_{m,Q}' \), of two positions \( P \) and \( Q \) of different distances, \( x_P^1 \) and \( x_Q^1 \), respectively, from the origin of the long-range metric force field, have different magnitudes. It does not refer to variation of the magnitude of a static flow speed with observers or frames of reference. As mentioned earlier, the relative proper static flow speed at a point in space is the same relative to all observers or frames of reference.

In the light of the foregoing, a relative (or relativistic) metric force field is the one that establishes non-zero relative proper static flow speed in space. That is, one that establishes relative proper static flow speeds of different magnitudes (no matter how small in magnitudes in a strict sense), at different positions in
the relative proper metric Euclidean 3-space $\mathbb{E}^3$, which transforms invariantly as relative proper static flow speeds in the relativistic metric Euclidean 3-space $\mathbb{E}^3$ within the metric force field. The possibility of the relativity of other physical parameters, such as mass, electric and magnetic fields, energy, fluxes, temperature, entropy, potentials, etc, in the sense of the variations of their observed (or relativistic) magnitudes with relative proper static flow speed and, consequently, with position in space within a long-range metric force field, on the flat four-dimensional relativistic metric spacetime $\left(\mathbb{E}^4, c, s, t\right)$ (in Fig. 5), now isolated, shall be investigated upon applying the results of this article to the gravitational field elsewhere.

Expectedly, it will be possible to derive the transformations of physical parameters and physical constants, classical and special-relativistic non-gravitational laws, as well as classical gravitational laws, on flat spacetime within a long-range metric force field, with the aid of the local Lorentz transformation and its inverse in terms of relative proper static flow speed of systems (22) and (23), in the context of the theory of relativity associated with the presence of a long-range metric force field in metric spacetime and, in particular, in the gravitational field. This will be analogous to the Lorentz transformations of parameters and natural laws on flat spacetime in the context of the special theory of relativity.

![Fig. 16. The curved 'two-dimensional' absolute intrinsic metric spacetime made valid with respect to 3-observers in the flat relative proper metric 3-space solely; the correct diagram for absolute intrinsic Riemannian metric spacetime geometry in our universe; (Fig. 7 of [3])](image)

### 3 ABSOLUTE INTRINSIC RIEMANN GEOMETRY ON THE CURVED ‘TWO-DIMENSIONAL’ ABSOLUTE INTRINSIC METRIC SPACE-TIME AT THE SECOND STAGE OF EVOLUTIONS OF SPACE-TIME/INTRINSIC SPACETIME IN A METRIC FORCE FIELD

The ‘two-dimensional’ absolute intrinsic metric spacetime $(\rho, c, t)$ is curved relative to its projective flat ‘2-dimensional’ absolute proper intrinsic metric spacetime $(\rho', c, t')$, which is imperceptibly embedded in the flat relative proper intrinsic metric spacetime $(\rho, c, t)$ in Fig. 1, at the first stage of evolution of spacetimes and intrinsic spacetimes within a long-range metric force field. Consequently the absolute intrinsic Riemann geometry has been formulated on the curved $(\rho, c, t)$ with respect to 3-observers in the relative proper Euclidean 3-space $\mathbb{E}^3$ that overlies $\rho'$ in [3].

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On the other hand, the ‘two-dimensional’ absolute intrinsic metric spacetime \((\varphi_\rho, \varphi_c, \varphi_t)\) is curved relative to the flat two-dimensional relativistic intrinsic metric spacetime \((\varphi_\rho, \varphi_c, \varphi_t)\) in Fig. 5, at the second stage of evolution of spacetime/intrinsic spacetime in a long-range metric force field. It then follows that absolute intrinsic Riemann geometry must be formulated on the curved \((\varphi_\rho, \varphi_c, \varphi_t)\) with respect to 3-observers in the relativistic Euclidean 3-space \(\mathbb{E}^3\) that overlies \(\varphi_\rho\) in Fig. 5, at the second stage of evolution of spacetime and intrinsic spacetime.

In order to show that absolute intrinsic Riemann geometry on the curved absolute intrinsic metric spacetime \((\varphi_\rho, \varphi_c, \varphi_t)\) takes on the same form with respect to 3-observers in the relativistic Euclidean 3-space \(\mathbb{E}^3\), reproduced as Fig. 16 of this article, from Eq. (48a-b) through Eq. (64) of [3].

Let us revisit the derivation of the absolute intrinsic metric tensor without star label with the aid of Fig. 7 in [3], reproduced as Fig. 16 of this article, from Eq. (48a-b) through Eq. (64) of [3].

Let us re-write Eq. (53) of that article as follows

\[
(d\varphi s'_a)^2 = \varphi c_{a'b}(d\varphi t'_a)^2 \left( \cos^2 \varphi \psi_{m,p} + \sin^2 \varphi \psi_{m,p} \right) - (d\varphi p'_a)^2 \left( \sec^2 \varphi \psi_{m,p} - \tan^2 \varphi \psi_{m,p} \right).
\]

Equation (28) gives the absolute intrinsic line element on the curved ‘two-dimensional’ absolute intrinsic metric spacetime \((\varphi_\rho, \varphi_c, \varphi_t)\), written in terms of the intervals of the absolute proper intrinsic metric spacetime \((\varphi_{p_{ab}}, \varphi_{c_{ab}}, \varphi_{t_{ab}})\) in Fig. 16, which is valid with respect to 3-observers in the relative proper Euclidean 3-space \(\mathbb{E}^3\) in that figure.

Then the established invariance of intrinsic line element (or absolute intrinsic local Lorentz invariance (\(\&\&LLI\))) is derived between the curved \((\varphi_\rho, \varphi_c, \varphi_t)\) and its projective flat \((\varphi_{p_{ab}}, \varphi_{c_{ab}}, \varphi_{t_{ab}})\) in Fig. 7 of [3], reproduced as Fig. 16 of this article and expressed by Eq. (54) of that article. It shall be reproduced here as

\[
\varphi c_d^2(d\varphi t)^2 - (d\varphi \rho)^2 = \varphi c_{a'b}(d\varphi t'_a)^2 - (d\varphi p'_a)^2. \tag{29}
\]

The \((d\varphi p'_a)^2\) and \(\varphi c_{a'b}(d\varphi t'_a)^2\) in this equation are replaced with \((d\varphi \rho)^2\) and \(\varphi c^2(d\varphi t)^2\) respectively, yielding Eq. (56) of [3], reproduced here as

\[
(d\varphi s)^2 = \varphi c_d^2(d\varphi t)^2(\cos^2 \varphi \psi_{m,p} + \sin^2 \varphi \psi_{m,p}) - (d\varphi \rho)^2(\sec^2 \varphi \psi_{m,p} - \tan^2 \varphi \psi_{m,p}). \tag{30}
\]

The absolute intrinsic metric tensor without star label of Eq. (63) or Eq. (64) of [3] and the absolute intrinsic Ricci tensor without star label of Eq. (67) or Eq. (68) of that article, were then derived with respect to 3-observers in the relative proper Euclidean 3-space \(\mathbb{E}^3\) solely in Fig. 16, from Eq. (30) above (or Eq. (56) of [3]), between Eqs. (58) and (68) of that article.

Now the absolutism of the absolute intrinsic metric spacetime \((\varphi_\rho, \varphi_c, \varphi_t)\) and absolute proper intrinsic metric spacetime \((\varphi_{p_{ab}}, \varphi_{c_{ab}}, \varphi_{t_{ab}})\), implies that they are invariant with intrinsic local Lorentz transformation (14) and its inverse (15) in the context of the theory of relativity associated with the presence of a long-range metric force field in spacetime. In other words, we can write as follows

\[
(d\varphi p_{ab})^2 - \varphi c_{a'b}(d\varphi t_{ab})^2 = (d\varphi p'_{ab})^2 - \varphi c'_{a'b}(d\varphi t'_{ab})^2. \tag{31}
\]

Just as the flat absolute proper intrinsic metric spacetime \((\varphi_{p_{ab}}, \varphi_{c_{ab}}, \varphi_{t_{ab}})\) is imperceptibly embedded in the flat relative proper intrinsic metric spacetime \((\varphi_{p'}, \varphi_{c'}, \varphi_{t'})\) in Fig. 1, at the first stage of evolution of metric spacetimes and intrinsic metric spacetimes in a long-range metric force field, the flat ‘absolute relativistic’ intrinsic metric spacetime \((\varphi_{p_{ab}}, \varphi_{c_{ab}}, \varphi_{t_{ab}})\) is imperceptibly embedded in the flat relativistic intrinsic metric spacetime \((\varphi_{p}, \varphi_{c}, \varphi_{t})\) in Fig. 5, at the second stage of evolution of metric spacetimes and intrinsic metric spacetimes in a long-range metric force field, and the
invariance (31) obtains between \((d\omega^2_{\rho} , \omega^2_{\rho ab} d\omega^2_{\rho ab})\) and its projective \((d\omega^2_{\rho} , \omega^2_{\rho ab} d\omega^2_{\rho ab})\). This allows us to replace \(\omega^2_{\rho ab} (d\omega^2_{\rho ab})^2\) and \((d\omega^2_{\rho ab})^2\) with \(\omega^2_{\rho ab} (d\omega^2_{\rho ab})^2\) and \((d\omega^2_{\rho ab})^2\) respectively in Eq. (28) to have

\[
(d\omega^2_{\rho ab})^2 = \omega^2_{\rho ab} (d\omega^2_{\rho ab})^2 \left(\cos^2 \hat{\psi}_{m,p} + \sin^2 \hat{\psi}_{m,p}\right) - (d\omega^2_{\rho ab})^2 \left(\sec^2 \hat{\psi}_{m,p} - \tan^2 \hat{\psi}_{m,p}\right). \tag{32}
\]

While the absolute proper intrinsic line element \(d\omega'_s\) in Eq. (28) on absolute proper intrinsic metric spacetime \((\rho_{ab}, \omega_{c\rho ab} \omega^2_{ab})\) is valid with respect to 3-observers in the flat relative proper metric spacetime of evolution of metric spacetimes and intrinsic metric spacetimes in a long-range metric force field, the unprimed absolute intrinsic line element \(d\omega_s\) in Eq. (32) on the ‘absolute relativistic’ (or absolute unprimed) intrinsic metric spacetime \((\rho_{ab}, \omega_{c\rho ab} \omega^2_{ab})\), is valid with respect to 3-observers in the relativistic Euclidean 3-space \(\mathbb{E}^3\) solely in Fig. 5 of this article at the second stage.

Combining the absolute intrinsic local Lorentz invariance (\(\omega\text{LLI}\)) (29) and (31) we have

\[
\omega^2_{\rho ab}(d\omega^2_{\rho ab})^2 - (d\omega^2_{\rho ab})^2 = \omega^2_{\rho ab}(d\omega^2_{\rho ab})^2 - (d\omega^2_{\rho ab})^2 = \omega^2_{\rho} (d\omega^2_{\rho})^2 -(d\omega^2_{\rho})^2. \tag{33}
\]

Equation (33) allows us to replace \(\omega^2_{\rho ab}(d\omega^2_{\rho ab})^2\) and \((d\omega^2_{\rho ab})^2\) by \(\omega^2_{\rho}(d\omega^2_{\rho})^2\) and \((d\omega^2_{\rho})^2\) respectively in Eq. (32) to have Eq. (30) again.

It then follows that the absolute intrinsic metric tensor of Eq. (63) or (64) and absolute intrinsic Ricci tensor of Eq. (67) or (68) of [3], derived from Eq. (30) of this article, with respect to 3-observers in the relative proper Euclidean 3-space \(\mathbb{E}^3\) solely in Fig. 4 or Fig. 11 of [3], reproduced as Fig. 1 of this article, but with the aid of Fig. 7 of that article, reproduced as Fig. 16 of this article, at the first stage of evolution of metric spacetimes and intrinsic metric spacetimes in a long-range metric force field, are equally valid with respect to 3-observers in the relativistic Euclidean 3-space \(\mathbb{E}^3\) solely in Fig. 5 of this article at the second stage.

The starred absolute intrinsic line element \(d\omega^*\), the starred absolute intrinsic metric tensor \(\omega\hat{g}^*_{ij}\), and the starred absolute intrinsic Ricci tensor \(\omega\hat{R}^*_{ij}\) on the curved ‘two-dimensional’ absolute intrinsic metric spacetime \((\omega\hat{\rho}, \omega\hat{c}, \omega\hat{i})\) in Fig. 1, given by Eqs. (31), (33) and (39) respectively of [3], which are valid partially with respect to 3-observers in the flat relative proper metric 3-space \(\mathbb{E}^3\) and partially with respect to 1-observers in the relative proper metric time dimension \(c, t\) in that figure, as explained in that article, are equally valid on the curved \((\omega\hat{\rho}, \omega\hat{c}, \omega\hat{i})\) in Fig. 5 of this article, partially with respect to 3-observers on the flat relativistic metric 3-space \(\mathbb{E}^3\) and partially with respect to 1-observers in the relativistic metric time dimension \(c, t\) in that figure.

Thus the formulation of absolute intrinsic Riemann geometry on the curved ‘two-dimensional’ absolute intrinsic metric spacetime \((\omega\hat{\rho}, \omega\hat{c}, \omega\hat{i})\) with respect to 3-observers in the relativistic Euclidean 3-space \(\mathbb{E}^3\) solely in Fig. 5 of this article, at the second stage of evolution of metric spacetimes and intrinsic metric spacetimes within a long-range metric force field, follows the same procedure used to formulate absolute intrinsic Riemann geometry on the curved \((\omega\hat{\rho}, \omega\hat{c}, \omega\hat{i})\), with respect to 3-observers in the relative proper Euclidean 3-space \(\mathbb{E}^3\), with the aid of Fig. 7 of [3], reproduced as Fig. 16 of this article, in [3] at the first stage.

The preceding paragraph means that just as done at the first stage of evolution of metric spacetimes/intrinsic metric spacetimes, one must write the pair of absolute intrinsic tensor equations involving starred absolute intrinsic tensors \(\omega\hat{g}^*_{ij}\) and \(\omega\hat{R}^*_{ij}\), derived on the curved
(\varrho_{\hat{g}_{ij}}, \omega_{\hat{R}^{ij}}) in [3], and presented as Eqs. (34) and (38) of that article. One must then solve those equations algebraically to obtain \( \varrho_{\hat{g}_{ij}} \) and \( \omega_{\hat{R}^{ij}} \) in terms of the square of the absolute intrinsic curvature parameter \( \varrho k^2 \) as Eqs. (64) and (68), or in terms of absolute intrinsic static flow speed as Eqs. (81) and (82) of [3]. The starred absolute intrinsic tensors so derived are valid partially with respect to 3-observers in the relativistic Euclidean 3-space \( \mathbb{E}^3 \) and partially with respect to 1-observers in the relativistic time dimension \( c_1 t \) in Fig. 5 of this article.

Then in order to obtain the absolute intrinsic metric tensor without star label \( \varrho_{\hat{g}_{ij}} \), which is valid with respect to 3-observers in the relativistic Euclidean 3-space \( \mathbb{E}^3 \) solely, one must use the relations among the components of the starred absolute intrinsic metric tensor \( \varrho_{\hat{g}_{ij}} \) and the components of the absolute intrinsic metric tensor without star label \( \varrho_{\hat{g}_{ij}} \) in systems (65a) and (65b) of [3]. Once \( \varrho_{\hat{g}_{ij}} \) has been obtained, one must apply the tensorial statement of intrinsic local Lorentz invariance (66) of [3] to derive the absolute intrinsic Ricci tensor without star label \( \varrho_{\hat{R}^{ij}} \), which is valid with respect to 3-observers in \( \mathbb{E}^3 \) solely.

The superposition procedure developed in absolute intrinsic Riemann geometry at the first stage of evolution of spacetimes and intrinsic spacetimes in [3], when two or a larger number of curved absolute intrinsic metric spacetimes co-exist, is equally applicable at the second stage. The clarifications of the concepts of absolute intrinsic static flow speed, absolute proper intrinsic static flow speed, absolute intrinsic metric tensor and absolute intrinsic metric theory of physics associated with them, introduced in [3] and this section, shall be done upon making connection to gravity in the next article and elsewhere.

4 SUMMARY, CONCLUSION AND DIRECTION FOR FURTHER INVESTIGATION

The summary in brief of the four parts of this paper is that metric spacetime and its underlying intrinsic metric spacetime follow two stages of evolution in the sequence of absolute metric spacetime/absolute intrinsic metric space \( \rightarrow \) proper metric spacetime/proper intrinsic metric spacetime \( \rightarrow \) relativistic metric spacetime/ relativistic intrinsic metric spacetime in every long-range metric force field. The proper metric spacetime is comprised of ‘two-dimensional’ absolute proper metric spacetime \((\rho'_{ab}, c_{ab}t_{ab})\) and the 4-dimensional relative proper metric spacetime \((\mathbb{E}^3, c'_t)\), where \((\rho'_{ab}, c_{ab}t_{ab})\) is imperceptibly embedded in \((\mathbb{E}^3, c'_t)\), as illustrated in Fig. 1. The proper intrinsic metric spacetime is likewise comprised of ‘two-dimensional’ of absolute proper intrinsic metric spacetime \((\varrho_{ab}, \omega_{ab}t_{ab})\) and the two-dimensional relative proper intrinsic metric spacetime \((\varrho'_{ab}, \omega_{ab}t_{ab})\), where \((\varrho_{ab}, \omega_{ab}t_{ab})\) is embedded in \((\varrho'_{ab}, \omega_{ab}t_{ab})\), as also illustrated in Fig. 1, at the first stage of evolution of metric spacetimes and intrinsic metric spacetimes in a long-range metric force field.

The relativistic metric spacetime is comprised ‘two-dimensional’ ‘absolute relativistic’ metric spacetime \((\rho_{ab}, c_{ab}t_{ab})\) and the four-dimensional ‘relative relativistic’ (simply referred to as relativistic) metric spacetime \((\mathbb{E}^3, c_t)\), where \((\rho_{ab}, c_{ab}t_{ab})\) is imperceptibly embedded in \((\mathbb{E}^3, c_t)\) in Fig. 5. The relativistic intrinsic metric spacetime is likewise comprised of ‘two-dimensional’ absolute relativistic intrinsic metric spacetime \((\varrho_{ab}, \omega_{ab}t_{ab})\) and two-dimensional relativistic intrinsic metric spacetime \((\varrho'_{ab}, \omega_{ab}t_{ab})\), where \((\varrho_{ab}, \omega_{ab}t_{ab})\) is embedded in \((\varrho'_{ab}, \omega_{ab}t_{ab})\) in Fig. 5, at the second stage of evolution of metric spacetimes and intrinsic metric spacetimes in long-range metric force fields. It shall be shown elsewhere that the second stage of evolution of metric spacetimes and intrinsic metric spacetimes in a long-range metric force field is the final stage.

The theories and intrinsic theories of a given long-range metric force field encompassed by the geometry of Fig. 1 at the first stage of evolution of spacetime and intrinsic spacetime in a long-range metric force field and those encompassed by the geometries of Figs. 2 and 7 and their inverses of Figs. 10 and 11, at the second stage,
shall be formulated upon particularizing to the gravitational field elsewhere.

The spacetime/intrinsic spacetime geometry of Fig.1 and the associated theories and intrinsic theories of a given metric force field, which evolve at the first stage of evolution of spacetime and intrinsic spacetime in the long-range metric force field, endure for no moment before transforming into the enduring spacetime/intrinsic spacetime geometries of Figs. 5, 7, 10 and 11 and the associated theories and intrinsic theories of the given metric force field at the second (and final) stage. Indeed the first and second stages commence simultaneously and progress together, as shall be demonstrated upon particularizing to the gravitational field elsewhere. It is therefore the theories and intrinsic theories encompassed by Figs. 5 and 7 and their inverses of Figs. 10 and 11, at the second stage that exist in every long-range metric force field in the universe. A crucial conclusion is that the four-dimensional (relativistic) metric spacetime \((\mathbb{R}^4, c_s t)\) and its underlying two-dimensional (relativistic) intrinsic metric spacetime \((\varnothing p, \varnothing c_s \varnothing t)\) are everywhere flat in long-range metric force fields; the only curved spacetime with Riemannian metric tensor, so to speak, with respect to 3-observers in the flat (or Euclidean) three-dimensional metric space \(\mathbb{R}^3\), being the ‘two-dimensional’ absolute intrinsic metric spacetime \((\hat{\varnothing} p, \hat{\varnothing} c_s \hat{\varnothing} t)\) with absolute intrinsic sub-Riemannian metric tensor \(\hat{\varnothing} g_{ik} \), isolated progressively in the first three parts of this paper [1–3].

The next natural step is to particularize the newly derived spacetime/intrinsic spacetime geometries of Figs. 5 and 7 and their inverses of Figs. 10 and 11, in long-range metric force fields and the associated flat spacetime theory of metric force field on the flat four-dimensional metric spacetime \((\mathbb{R}^4, c_s t)\) and hierarchy of theories of intrinsic metric force field on the hierarchy of intrinsic metric spacetimes namely, the flat relativistic intrinsic metric spacetime \((\varnothing p, \varnothing c_s \varnothing t)\), the curved relative proper intrinsic metric spacetime \((\varnothing p', \varnothing c_s \varnothing t')\) with intrinsic Lorentzian metric tensor and the curved absolute intrinsic metric spacetime \((\varnothing p, \varnothing c_s \varnothing t)\), with absolute intrinsic sub-Riemannian metric tensor, to the gravitational field. This will yield the corresponding flat spacetime theory of gravity and hierarchy of theories of intrinsic gravity in the gravitational field. Particularization to the gravitational field shall be done elsewhere.

**COMPETING INTERESTS**

Author has declared that no competing interests exist.

**REFERENCES**


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