Particularization of the sequence of spacetime/intrinsic spacetime geometries and associated sequence of theories in metric force _elds in the four-world picture to the gravitational _eld I

Research Article

Abstract

The two stages of evolutions of metric spacetime and intrinsic metric spacetime and the associated spacetime/intrinsic spacetime geometries in long range metric force _elds, derived in the four-world picture in previous articles, are particularized to the gravitational _eld. The theory of relativity on at four-dimensional relativistic metric spacetime (IE3; cst) and the theory of intrinsic relativity on the underlying at two-dimensional relativistic intrinsic metric spacetime (?_;?cs?t), due to the presence of a long range metric force _eld in spacetime, as well as the absolute intrinsic metric theory (of the metric force _eld) on the curved `two-dimensional' absolute intrinsic metric spacetime (?^_;?^cs?^t) with absolute intrinsic sub-Riemannian metric tensor ?^gik, all of which evolve at two stages of evolutions of metric spacetimes and intrinsic metric spacetimes in long range metric force _elds in general, developed in the previous articles, are particularized to the gravitational _eld. They become the theory of gravitational relativity (TGR) on at four-dimensional gravitational-relativistic metric spacetime, the theory of intrinsic gravitational relativity (T?GR) on the underlying at two-dimensional gravitational-relativistic intrinsic metric spacetime and the metric theory of absolute intrinsic gravity (MA?G) on the curved `two-dimensional' absolute intrinsic metric spacetime, which evolve at two stages of evolutions of metric spacetime and intrinsic metric spacetime and of parameters and intrinsic parameters in the gravitational _eld. The basic aspects of T?GR and TGR are developed in this _rst part of this article.

at four-dimensional metric spacetime, curved `two-dimensional' absolute intrinsic metric spacetime, absolute intrinsic metric tensor, metric theory of absolute intrinsic gravity, theory of gravitational relativity, gravitational length contraction, gravitational time dilation

1 Introduction

The special theory of relativity (SR) on at four-dimensional proper spacetime and a newly added intrinsic special theory of relativity (?SR) on a formally derived at two-dimensional proper intrinsic spacetime, which underlies the at four-dimensional proper spacetime, in assumed Newtonian gravitational _eld, are reformulated on a four-world background in a series of articles [1{4]. A new set of a_ne spacetime and intrinsic a_ne spacetime diagrams in the four-world picture are drawn, from which Lorentz transformation and intrinsic Lorentz transformation and the inverse are derived.

The new development in SR/?SR in the four-world picture is extended to a general long-range metric force _eld of arbitrary strength in spacetime and its underlying long-range intrinsic metric force _eld in intrinsic spacetime in a series of articles [5{8]. Two stages of evolutions of metric spacetime and intrinsic metric spacetime in a general long-range metric force _eld and the underlying long-range intrinsic metric force _eld are isolated and the associated sequence of metric spacetime and intrinsic metric spacetime diagrams are developed progressively in those articles. The two stages of evolutions of metric spacetime/intrinsic metric spacetime and the associated sequence of spacetime/intrinsic spacetime diagrams in long range metric force _elds and long-range intrinsic metric force _elds in general in the previous articles [5{8], are particularized to gravitational _eld of arbitrary strength in spacetime and a newly added intrinsic gravitational _eld in intrinsic spacetime in section 2 of this article. Gravitational and non-gravitational parameters, such as gravitational potential and _eld, mass, energy, electric and magnetic _elds, etc, and their intrinsic counterparts, undergo two stages of evolutions along with spacetime and intrinsic spacetime in the gravitational _eld. The basic aspects of the theories of gravity and theories of intrinsic gravity encompassed by the sequence of diagrams are formulated in sections 3 and 4.

The two stages of evolutions of spacetime/intrinsic spacetime and the associated sequence of spacetime/intrinsic spacetime geometries developed in long-range metric force _elds in general in the previous articles [5{8] and their particularization to the gravitational _eld in this article, are pure novel e_ort of 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 of the author cited above, upon which this paper is based essentially. It is to be remarked however that the progression made in the present work from SR/?SR on at spacetime/at intrinsic spacetime in a four-world picture in [1{4] to the theories of gravity and theories of intrinsic gravity on at spacetime and curved intrinsic spacetimes in the four-world picture in [5{8] and this article, follows the same trend as Einstein's progression from the special relativity on at spacetime [9] to the general theory of relativity on curved spacetime in the gravitational _eld [10].

2 Metric spacetime/intrinsic metric spacetime geometries at the _rst and second stages of evolutions of spacetime/ intrinsic spacetime in the gravitational _eld in the four-world picture

2.1 The _rst stage of evolutions of spacetime/intrinsic spacetime and parameters/intrinsic parameters in the gravitational _eld

Let us start by reproducing the geometry of Fig. 7 of [7], reproduced as Fig. 2 of [8], which existed with the assumed absence of long-range metric force _eld (or prior to the _rst stage of evolutions of spacetime and intrinsic spacetime in long-range metric force _elds) in our universe, as Fig. 1 of this article. The absence of absolute intrinsic Riemannian metric spacetime geometry implies the absence of curved `two-dimensional' absolute intrinsic metric spacetime (?^_;?^cs?^t) and its projective at (or non-curved) `two-dimensional' absolute proper intrinsic metric spacetime (?_0
ab;?csab?t0
ab) and the outward manifestation of the latter namely, the at (or non-curved) `two-dimensional' absolute proper metric spacetime (_0
ab; csabt0
ab)
in that _gure. There is also the absence of the at (or non-curved) two-dimensional relative proper intrinsic metric spacetime (?_0;?cs?t0) and its outward manifestation namely, the at (or non-curved) four-dimensional relative proper metric spacetime (IE03; cst0), which appear automatically in absolute intrinsic Riemannian spacetime geometgry, as is the case in Fig. 1 of this article.

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Figure 1: Flat `four-dimensional' absolute metric spacetime and its underlying at `two-dimensional' absolute intrinsic metric spacetime with the assumed absence of a long-range metric force _eld (or absence of absolute intrinsic Riemannian spacetime geometry) in our universe; (Fig. 7 of [7]).

On the other hand, Fig. 7 of [7], reproduced as Fig. 1 of this article, evolves into Fig. 11 of that article, reproduced as Fig. 2 of this article, at the _rst stage of evolutions of metric spacetime and intrinsic metric spacetime in all _nite neighbourhood of a long-range meric force _eld in our universe. The metric spacetimes and intrinsic metric spacetimes, which are absent in Fig. 1 of this article, due to the absence of long-range metric force _eld (or absence of absolute intrinsic Riemannian metric spacetime geometry), mentioned in the preceding paragraph, are contained in Fig. 2 of this article.

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Figure 2: The at four-dimensional relative proper metric spacetime/at `two-dimensional' absolute proper metric spacetime and hierarchy of two-dimensional intrinsic metric spacetimes that evolve at the _rst stage of evolutions of metric spacetimes and hierarchy intrinsic spacetimes in long-range metric force _elds in our universe; (Fig. 11 of [7]).

Let us consider the reference metric spacetime and intrinsic metric spacetime geometry of Fig. 1 of this article in our universe assumed to be devoid of a long-range metric force _eld, now being considered to be the absence of gravitational _eld in this article. There is the absence of absolute intrinsic Riemannian metric spacetime geometry in the universe by this assumption.

On the other hand, let us introduce the absolute rest mass, to be denoted by ^M0, of a gravitational _eld source at a point ^ S on the at `three-dimensional' absolute space I^E
3 in our universe in Fig. 1. The absolute rest masses, ^M 0
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0 and ^M 0_
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of the identical symmetry-partner gravitational _eld sources will be automatically introduced at the symmetry-partner points, ^ S0;^S
_ and ^ S0_, in the assumed initially
empty at absolute metric 3-spaces, I^E
03;I^E
3_ and I^E
03_, of the positive time-
universe, negative universe and negative time-universe respectively, simultaneously with the introduction of ^M0 at point ^ S in I^E
3 in the positive (or our) universe. This
follows from the perfect symmetry of state among the four universes established in section 2 of [4]. The fact that ^M0, ^M 0
0 , ^M _
0 and ^M 0_
0 are identical in magnitude,
size and shape is also established in sub-sections 2.1 and 2.2 of [4].

As explained in sub-section 3.1 of [3], the appearance of ^M0 at point ^ S in I^E

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0 at point ^ S_ in I^E
3_ and of ^M 0
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_ at point
^ S0_ in I^E
03_, where ^ S; ^ S0; ^ S_ and ^ S0_, are symmetry-partner points, will lead to the appearance of identical symmetry-partner `one-dimensional' absolute intrinsic rest masses, ? ^M0 in `one-dimensional' absolute intrinsic metric space ?^_ directly underneath ^M0 in I^E
3 in the positive (or our) universe; ? ^M 0
0 in ?^_0 directly
underneath ^M 0
0 in I^E
03 in the positive time-universe; ? ^M _
0 in ? ^ __ directly
underneath ^M _
0 in I^E
3_ in the negative universe and ? ^M 0_
0 in ?^_0_ directly
underneath ^M 0_
0 in I^E
03_ in the negative time-universe, as illustrated in Fig. 3.
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Figure 3: The mutually orthogonal at `three-dimensional' absolute metric spaces (as at hyper-surfaces) and their underlying straight line `one-dimensional' absolute intrinsic metric spaces of four symmetrical universes namely, the positive (or our) universe, the negative universe, the positive time-universe and the negative time-universe, containing identical assumed spherical absolute rest masses in the absolute metric 3-spaces and lines of absolute intrinsic rest masses in the `one-dimensional' absolute intrinsic metric spaces directly underneath the absolute rest masses in the absolute spaces, of symmetry-partner gravitational _eld sources at symmetry-partner points in the absolute spaces within the assumed otherwise empty universes.

Let us recall the explanation of the transformation of Fig. 1 into Fig. 4a of [3], with respect to 3-observers in the relative proper Euclidean 3-space IE$_{03}$ (denoted by _$_0$ in those _gures), of the positive (or our) universe in section 2 of that article. Figures 1 and 4a of [3] are reproduced as Figs. 4a and 4b respectively of this article, for convenience of reading. It follows from the transformation of Fig. 4a into Fig. 4b of this article, as explained in section 2 of [3] that, the geometry of Fig. 3 of this article will naturally transform into that of Fig. 5 of this article, with respect to `3-observers' in the absolute metric spaces, I^E$_3$ and I^E$_{3_}$, of our universe and the negative universe.

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Figure 4: Figure 4a naturally transforms into Fig. 4b with respect to 3-observers in the proper Euclidean 3-space IE$_{03}$; (Figs. 1 and 4a of [3])

The geometry of Fig. 5 will emerge automatically in the positive (or our) universe and the negative universe as the absolute rest mass ^M$_0$ of a gravitational _eld source is introduced at a point ^ S in the empty at absolute space I^E$_3$ in our universe, which is being hypothetically considered to be otherwise devoid of gravitational _eld source. This happens by virtue of the prefect symmetry of state among the four universes, established in section 2 of [4].

The empty exterior neighborhood of one external gravitational _eld source in our universe and its symmetry-partner in the negative universe, as illustrated in Fig. 5, shall be considered in order to make this _rst article on the particularization to the gravitational _eld of the two stages of evolutions of metric spacetime and intrinsic metric spacetime and parameters/intrinsic parameters and the associated new metric spacetime/intrinsic metric spacetime geometries in the four-world picture in long-range metric force _elds, developed in the previous papers [1{4] and [6{8] concise, revealing only the essential features, while extension to the neighbourhood of two and larger number of external gravitational _eld sources in each universe shall be considered elsewhere.

2.2 Introducing absolute intrinsic static gravitational ow speed and absolute static gravitational ow speed

Now the absolute intrinsic rest mass ? ^M_0 will establish non-uniform absolute intrinsic `static ow' speed ?^ V_m (isolated geometrically in section 2 of [7]), which has its largest magnitude at point ^L at the edge of ? ^M_0 (point ^ S being at the base of ? ^M_0), and decreases continuously to zero magnitude virtually at point O that is far removed from point ^ S. The absolute intrinsic rest mass ?^E =?^c^2_s
(= ? ^M_0) in the absolute
intrinsic metric time `dimension' ?^c_s?^t (which has identical absolute inertial and

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Figure 5: The diagram of Fig. 3 of four symmetrical universes in the four-world picture naturally transforms into at `four-dimensional' absolute metric spacetimes and the underlying at `two-dimensional' absolute intrinsic metric spacetimes of the positive (or our) universe and the negative universe, with respect to `3-observers' in the absolute metric spaces in our universe and the negative universe.

absolute gravitational attributes as ? ^M0 in I^E
3), will likewise establish non-uniform
absolute intrinsic `static ow' speed ?^ Vm that has its largest magnitude at point
^L
0 at the edge of ?^E =?^c2s
(point ^ S0 being at the base of ?^E =?^c2s
), and decreases
continuously to zero magnitude virtually at point O that is far removed from point
^S
0. (Recall from discussion in sub-section 3.1 of [3] that, ?^E=?^c2s
in ?^cs?^t possesses
absolute intrinsic gravitational or absolute intrinsic inertial attributes like absolute intrinsic rest mass ? ^M 0
0 in ?^_0 in Fig. 3).

The absolute rest mass ^M0 (assumed spherical), will establish non-uniform absolute `static ow' speed ^ Vm, which has maximum magnitude at the surface of ^M0 and decreases continuously to zero magnitude virtually at point O, along every radial direction from its centre in I^E
03 in Fig. 6. The `one-dimensional' absolute rest mass
^E
=^c2s
(= ^M0) in the absolute metric time `dimension' ^cs^t (that possesses absolute gravitational and absolute inertial attributes like ^M 0
0 in I^E

03 in Fig. 6), will likewise
establish non-uniform absolute `static ow' speed ^ Vm along ^cs^t, which has the largest magnitude at point ^L0 and decreases continuously to zero magnitude virtually at point O in Fig. 5.

The discussions in the preceding two paragraphs for (^M0; ^E =^c2s
) in (I^E
3; ^cs^t) and
its underlying (? ^M0;?^E=?^c2s
) in (?^_ ;?^cs?^t) in the positive (or our) universe,
obtain for (^M _
0 ;^E_=^c2s
) in (I^E
3_ ; ^cs^t_) and its underlying (? ^M _
0 ;?^E _=?^c2s
)
in (?^_ _;?^cs?^t_) in the negative universe as well. It is important to note that the two-world diagram of Fig. 5 has arisen from the four-world diagram of Fig. 3.

Let us for convenience replace the representation of the `three-dimensional' absolute spaces, I^E
3 and I^E
3_, by horizontal plane surfaces in Fig. 5 by lines along the horizontal. Let us also revert back to the notations, _ and __, respectively for Euclidean 3-spaces adopted in [1{4]. That is, let us replace I^E
3 and I^E
3_ that
appear in Fig. 5 and in the diagrams in [6{8] by ^_
and ^_
_ respectively henceforth.

The assumed spherical absolute rest masses, ^M0 and ^M _
0 , represented by circles
on I^E
3 and I^E
3_ in Fig. 5, shall be represented by short line segments in ^_
and
^_
_ respectively. These representations are dummy with no consequence on the geometry and theory being developed.

Further more, since we are now particularizing to the gravitational _eld, the absolute intrinsic `static ow' speed ?^ Vm(?^r) at `distance' ?^r from the base ^ S of ? ^M0 in Fig. 5, shall be re-denoted by ?^ Vg(?^r) and referred to as absolute intrinsic static gravitational ow speed. The absolute `static ow' speed ^ Vm(^r) at radial distance ^r from the centre of ^M0 shall likewise be re-denoted by ^ Vg(^r) and referred to as absolute static gravitational ow speed.

The absolute intrinsic static gravitational ow speed ?^ Vg(?^r) and absolute static gravitational ow speed ^ Vg(^r), are static like ?^ Vm and ^ Vm in [7,8] which they replace. This means that ?^ Vg(?^r) is not made manifested in actual absolute intrinsic ow of the absolute intrinsic metric spacetime dimensions, ?^_ and ?^cs?^t, along which it is established and ^ Vg(^r) is not made manifested in actual absolute ow of the absolute metric 3-space ^_
in which it is established and of the absolute metric time
dimension ^cs^t along which it is established.

As follows from the discussions to this point in this sub-section, Fig. 5 shall be replaced with Fig. 6, where only absolute intrinsic static gravitational ow speed ?^ Vg(?^r) at an arbitrary `distance' ?^r along ?^_ from the base ^ S of ? ^M0 in ?^_ and at equal `distance' ?^r along ?^cs?^t from the base ^ S0 of ?^E=?^c2s
in
?^cs?^t, corresponding to absolute static gravitational ow speed ^ Vg(^r) at an arbitrary absolute radial distance ^r in the absolute 3-space ^_
from the centre of ^M0 in ^_
are
shown.
The line of absolute rest mass ^M0 of length ^S
^L
in Fig. 6 is actually a spherical
absolute rest mass (as being assumed) of radius, ^R0 = ^ S^ L, and the segment ^ SO of the line of universal absolute space ^_
is actually a spherical region of absolute
3-space of large radius ^ SO with ^M0 at its centre. The `one-dimensional' absolute intrinsic metric space ?^_ is an isotropic intrinsic metric dimension with respect to `3-observers' in the absolute metric space ^_. It can be considered to lie along any of the radial directions from the centre of the spherical region of absolute space of radius ^ SO.
The spherical region of the universal absolute space ^_
within the gravitational
_eld of ^M0 (assuming the gravitational _eld of ^M0 can be considered to vanish outside this sphere), is just a portion of the vast `three-dimensional' at universal
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Figure 6: The absolute rest masses of symmetry-partner gravitational _eld sources on at absolute metric spacetimes establish non-uniform absolute static gravitational ow speed in all their _nite neighborhoods in absolute metric spacetimes and their absolute intrinsic rest masses in the underlying absolute intrinsic metric spactimes establish non-uniform absolute intrinsic static gravitational ow speed in all their _nite neighborhoods in absolute intrinsic metric spacetimes in the positive and negative universes.

absolute space, which is being assumed to be devoid of the absolute rest mass of any other gravitational _eld source at present.

The reference geometry of Fig. 5 or 6 above, in which symmetry-partner absolute gravitational _eld sources are present in absolute metric spacetimes and symmetry-partner absolute intrinsic gravitational _eld sources are present in absolute intrinsic metric spacetimes in our universe and negative universe, will endure for no moment before transforming into the geometry of Fig. 7, at the _rst stage of evolutions of spacetimes and intrinsic spacetimes within the symmetry-partner gravitational _elds in our universe and negative universe.

Again the line of rest mass M_0 of length S_0L_0 in Fig. 7 is actually a spherical rest mass M_0 (as being assumed) of radius R_0 (=S_0L_0) and the line of relative proper metric Euclidean 3-space _$_0$ in that _gure, is actually a spherical relative proper metric Euclidean 3-space of large radius S_0O with M_0 at its centre. The one-dimensional relative proper intrinsic metric space ?_$_0$ is an isotropic intrinsic dimension with respect to 3-observers in _$_0$ in Fig. 7. It can be considered to lie along any of the radial directions of the spherical _$_0$ from the centre of M_0.

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Figure 7: The metric spacetime/intrinsic metric spacetime geometry that evolves from the reference geometry of Fig. 5 at the _rst stage of evolutions of spacetimes/intrinsic spacetimes in all _nite neighbourhoods of symmetry-partner gravitational _eld sources within assumed otherwise empty positive and negative universes.

The spherical relative proper metric Euclidean 3-space $\_{0}$ of large radius S_0O evolves around the rest mass M_0 of the gravitational _eld source at its centre in Fig. 7, such that the gravitational _eld of M_0 can be considered to vanish outside the $\_{0}$. The region of the universal 3-space outside $\_{0}$ (or outside the gravitational _eld of M_0), remains the at absolute space ^_, since this gravitational _eld source is the only one in our universe as being assumed.

The segment ^ SO of the straight line universal absolute intrinsic metric space ?^_ along the horizontal, containing the absolute intrinsic rest mass ? $\hat{}M_0$ of the gravitational _eld source within interval ^ S^L of segment ^ SO of ?^_ in Fig. 6, becomes curved toward the vertical as a plane curve on the vertical (?$\_{0}$-?c_s?t_0)□intrinsic spacetime hyperplane, by virtue of the non-uniform absolute intrinsic static gravitational ow speed ?^ V_g(?^r) established along the segment ^ SO of ?^_ by ? $\hat{}M_0$ in that _gure.

The curved ?^_ in Fig. 7 projects a straight line isotropic absolute proper intrinsic metric space ?$\_{0}$
ab that is imperceptibly embedded in the straight line relative proper intrinsic metric space ?$\_{0}$, which appears automatically along with the projection of ?$\_{0}$
ab along the horizontal. The projective ?$\_{0}$
ab is made manifested outwardly in `one-dimensional' absolute proper metric space $\_{0}$
ab that is imperceptibly embedded in the relative proper metric Euclidean 3-space $\_{0}$, as the outward manifestation of ?$\_{0}$, which appears automatically with the projection of ?$\_{0}$
ab within the gravitational _eld in Fig. 7.

The line of absolute intrinsic rest mass ? $\hat{}M_0$ of the gravitational _eld source located at the origin (or base) of the curved segment ^SO of ?^_, likewise forms

(or `projects') absolute proper intrinsic mass ?M_{0ab} at the origin (or base) of the projective absolute proper intrinsic metric space ?_$_0$
$_{ab}$, which is imperceptibly embedded in the relative intrinsic rest rest mass ?M_0 of the gravitational _eld source that appears automatically with the relative proper intrinsic metric space ?_$_0$ along the horizontal. The ?M_{0ab} is made manifested in `one-dimensional' absolute proper mass M_{0ab} in _$_0$
$_{ab}$ and it is imperceptibly embedded in the three-dimensional relative rest mass M_0 of the gravitational _eld source in relative proper physical Euclidean 3-space _$_0$.

The segment ^ S_0O of the straight line universal absolute intrinsic metric time `dimension' ?^c_s?^t along the vertical, containing the line of absolute intrinsic rest mass ?^E =?^c^2_s
(= ? ^M_0) of the gravitational _eld source within interval ^S
$_0$^L_0 at the origin (or base) of the segment ^ S_0O of ?^c_s?^t in Fig. 6, becomes curved toward ?_$_0$ along the horizontal, by virtue of the non-uniform absolute intrinsic static gravitational ow speed ?^ V_g(?^r) established along the segment ^ S_0O of ?^c_s?^t by ?^E=?^c^2_s
(= ? ^M_0) in Fig. 5 or Fig. 6.

The curved ?^c_s?^t projects a straight line absolute proper intrinsic metric time dimension ?c_{sab}?t_0
$_{ab}$ that is imperceptibly embedded in the relative proper intrinsic metric time dimension ?c_s?t_0, which appears automatically with the projection of ?c_{sab}?t_0
$_{ab}$ along the vertical within the gravitational _eld. It is made manifested outwardly in absolute proper metric time dimension $c_{sab}t_0$
$_{ab}$ that is imperceptibly embedded in the relative proper metric time dimension c_st_0, which appears automatically with the projection of ?c_{sab}?t_0
$_{ab}$ along the vertical within the gravitational _eld in Fig. 7.

The line of absolute intrinsic rest mass ?^E =?^c^2_s
(= ? ^M_0) of the gravitational _eld source at the origin (or base) of the curved segment ^ S_0O of ?^c_s?^t, likewise forms (or `projects') a line of absolute proper intrinsic mass ?E_0
$_{ab}$=?c^2_s
$_{ab}$ (= ?M_{0ab})
that is imperceptibly embedded in the line of relative rest mass E_0=c^2_s
(_ M_0),
which appears automatically at the origin (or base) of the relative proper intrinsic metric time dimension ?c_s?t_0 that appears automatically along the vertical. The ?E_0
$_{ab}$=?c^2_s
$_{ab}$ (= ?M_{0ab}) is made manifested outwardly in absolute proper mass E_0
$_{ab}$=c^2_s
$_{ab}$ (= M_{0ab}), which is imperceptibly embedded in the line of relative rest mass E_0=c^2_s
(= M_0) at the origin (or base) of the relative proper metric time dimension c_st_0 in Fig. 7.

Only the relative proper intrinsic metric spacetimes, (?_0;?cs?t0) and (□?_0_;□?cs?t_), and the relative proper metric spacetimes, (_0; cst0) and (□_0_;□cst0_), which appear automatically and the relative intrinsic rest masses, (?M0;?E0=?c2s) and (□?M_ 0 ;□?E0_=?c2s), and the relative rest masses, (M0;E0=c2s) and (□M_ 0 ;□E0_=c2s), in them shall be shown, as done in Fig. 7 already, while their embedding projective absolute proper intrinsic metric spacetimes, (?_0 ab;?csab?t0 ab) and (□?_0_ ab;□?csab?t0_ ab), containing `projective' absolute proper intrinsic masses, (?M0ab;?E0 ab=?c2s ab) and (□?M_ 0ab;□?E0_ ab=?c2s ab), and the absolute proper metric spacetimes, (_0 ab; csabt0 ab) and (□_0_ ab;□csabt0_ ab), containing `projective' absolute proper (or classical) masses, (M0ab;E0 ab=c2s ab) and (□M_ 0ab;□E0_ ab=c2s ab), which are imperceptibly embedded in the relative intrinsic rest masses and relative rest masses, shall be hidden in the diagrams in this article. On the other hand, (?_0 ab;?csab?t0 ab) and (_0 ab; csabt0 ab), are shown along with (?_0;?cs?t0) and (_0; cst0) in the one-world diagram of Fig. 2 of this article in a general long-range metric force _eld.

The `one-dimensional' absolute intrinsic rest mass ? ^M0 in the straight line absolute intrinsic metric space ?^_ along the horizontal and ?^E=?^c2s in the straight line absolute intrinsic metric time `dimension' ?^cs?^t along the vertical, of the gravitational _eld source, in the reference geometry of Fig. 6, are indeed curved along with ?^_ and ?^cs?^t, at the _rst stage of evolutions of metric spacetimes and intrinsic metric spacetimes in the gravitational _eld, as illustrated in Fig. 7. However, the curvatures of ? ^M0 within segment ^ S^L of the curved ?^_ and the curvature of ?^E=?^c2s

within segment ^ S0^L0 of the curved ?^cs?^t, shown in Fig. 7, are temporary.
The _nal forms of the segment ^ S^L of the curved ?^_ containing ? ^M0 and segment
^ S0^L0 of the curved ?^cs?^t containing ?^E =?^c2s
in Fig. 7, shall be derived elsewhere
when the need for the spacetime and intrinsic spacetime geometry at the interior
of a gravitational _eld source arises. On the other hand, the segments ^ LO of the
curved ?^_ and and ^L0O of the curved ?^cs?^t at assumed empty space at the exterior
of a gravitational _eld source in Fig. 7 are valid.
It is being assumed that the absolute gravitational _eld source (^M0; ^E =^c2s
),
introduced at point (^S
, ^ S0) on (^_
; ^cs^t) in our universe and its symmetry-partner
(□ ^M _
0 ;□^E_=^c2s
), introduced simultaneously at the symmetry-partner point (^S
_; ^ S0_)
on (□^_
_;□^cs^t_) in the negative universe in Fig. 5 or 6, are the only gravitational _eld
sources in our universe and the negative universe. Consequently only the segment
^ SO of the curved absolute intrinsic metric space ?^_, the straight line relative proper
intrinsic metric space ?_0 between points S0 and O along the horizontal, and the
outward manifestation of ?_0 namely, the large spherical proper metric Euclidean
3-space _0, represented by a line segment in Fig. 7, exist within our universe, while
the regions of the at universal absolute metric spacetime (^_
; ^cs^t) underlay by at
universal absolute intrinsic metric spacetime (?^_ ; ?^cs?^t), outside the gravitational
_eld of the introduced lone absolute gravitational _eld source in our universe, remain
unchanged. Likewise for the assumed lone symmetry-partner absolute gravitational
_eld source (□ ^M _
0 ;□^E _=^c2s
) introduced simultaneously at the symmetry-partner
point (^ S_; ^ S0_) in (□^_
_;□^cs^t_) in Fig. 5 or 6 in the negative universe.
The absolute intrinsic static gravitational ow speed ?^ Vg(?^r) at arbitrary `distance'
?^r from the base ^ S of ? ^M0 along the straight line absolute intrinsic metric space
?^_ in Fig. 6, is now at an arbitrary `distance' ?^r from the base ^ S of ? ^M0 along
the curved ?^_ in Fig. 7. It invariantly projects absolute proper intrinsic static
gravitational ow speed ?V 0
gab(?r0
ab) (= ?^ Vg(?^r)) into the projective straight line
absolute proper intrinsic metric space ?_0
ab embedded in the relative proper intrinsic
metric space ?_0 along the horizontal. The projective ?V 0
gab(?r0
ab) (= ?^ Vg(?^r)) is
consequently established in the relative proper intrinsic metric space ?_0
ab at the
corresponding `distance' ?r0 from the base of the relative intrinsic rest mass ?M0
in ?_0, which is made manifested outwardly in absolute proper static gravitational
ow speed V 0

gab(r0
ab) (= ^ Vg(^r)) at radial distance r0 from the centre of the relative
rest mass M0 in _0, with respect to 3-observers in _0.
The absolute intrinsic static gravitational ow speed ?^ Vg(?^r) at `distance' ?^r
from the base of ^ S0 of ?^E =?^c2 along the curved absolute intrinsic metric time
`dimension' ?^cs?^t, also invariantly projects absolute proper intrinsic gravitational
ow speed ?V 0
gab(?r0
ab) into the projective straight line absolute proper intrinsic
metric time dimension ?csab?t0
ab embedded in the relative proper intrinsic metric
time dimensions ?cs?t0. Thus the projective ?V 0
gab(?r0
ab) (= ?^ Vg(?^r)) is established
in ?cs?t0, which is made manifested outwardly in absolute proper static gravitational
ow speed Vgab(r0
ab) (= ^ Vg(^r)) at `distance' r0 from the base of E0=c2s
in cst0, with
respect to 1-observers in cst0 in Fig. 7. The discussions on the _rst quadrant (or in
the positive universe) in Fig. 7 in the preceding two paragraphs and this paragraph,
equally obtain for the third quadrant (or in the negative universe).
There are the invariance of absolute intrinsic static gravitational ow speed and
absolute static gravitational ow speed in the contexts of the theory of absolute
intrinsic gravity and theory of absolute gravity (A?G/AG) (which are the theories
associated with the geometry of Fig. 7 to be discussed at the end of this article).
The ?^ Vg(?^r) along the curved absolute intrinsic metric spacetime `dimensions', ?^_
and ?^cs?^t, are invariantly projected as absolute proper intrinsic gravitational ow
speed ?V 0
gab(?r0
ab) (= ?^ Vg(?^r)) into the projective straight line absolute proper
intrinsic metric spacetime dimensions, ?_0
ab and ?csab?t0
ab, which are imperceptibly
embedded in the relative proper intrinsic metric spacetime dimensions, ?_0 and
?cs?t0, respectively that appear automatically in the contexts of A?G in Fig. 7.
These are then made manifested outwardly in absolute proper static gravitational
ow speed V 0
gab(r0
ab) (= ^ Vg(^r)) along the `one-dimensional' absolute proper metric
space _0
ab and absolute proper metric time `dimension' csabt0
ab (the outward manife-
stations of ?_0
ab and ?csab?t0
ab respectively), where _0
ab and csabt0
ab are imperceptibly
embedded in the relative proper metric 3-space and time dimension, _0 and cst0.
The invariance of absolute intrinsic static gravitational ow speed and absolute
static gravitational ow speed have been stated as the invariance of absolute intrinsic
`static ow' speed and absolute `static ow' speed by Eqs. (79a) and (79b) in [7],

in the context of the absolute intrinsic metric phenomenon and absolute metric phenomenon that give rise to the geometry of Fig. 11 of that article, reproduced as Fig. 2 of this article in the one-world picture. It corresponds to Fig. 7 of this article in the contexts of AG and A?G in the two-world picture. They shall be re-stated as the invariance of absolute intrinsic static gravitational ow speed and absolute static gravitational ow speed in the contexts of the theory of absolute intrinsic gravity and theory of absolute gravity (?AG/AG) in the geometry of Fig. 7 as

?V 0
gab(?r0
ab) = ?^ Vg(?^r) (1a)

and

V 0
gab(r0
ab) = ^ Vg(^r) (1b)

Equation (1a) states that the absolute proper intrinsic static gravitational ow speed ?V 0
gab(?r0
ab) projected along the relative proper intrinsic metric spacetime dimensions, ?_0 and ?cs?t0, by the absolute intrinsic static gravitational ow speed ?^ Vg(?^r) along the curved absolute intrinsic metric spacetime `dimensions', ?^_ and ?^cs?^t, is the same as the absolute intrinsic static gravitational ow speed ?^ Vg(?^r). Equation (1b) says that the absolute proper gravitational ow speed
V 0
gab(r0
ab) established in _0 and along cst0 in Fig. 7, is the same as the absolute static gravitational ow speed ^ Vg(^r).

It is crucial to note that the line of relative intrinsic rest mass ?M0 of the gravitational _eld source in ?_0 is not the source of the non-uniform absolute proper intrinsic static gravitational ow speed ?V 0
gab(?r0
ab) (= ?^ Vg(?^r)) along ?_0 and that
the assumed spherical relative rest mass M0 of the _eld source is not the source of the non-uniform absolute proper static gravitational ow speed V 0
gab(r0
ab) (_ ^ Vg(^r))
along every radial direction from its centre in _0, with respect to 3-observers in _0 in Fig. 7. Rather the non-uniform absolute proper intrinsic static gravitational ow speed ?V 0
gab(?r0
ab)(= ?^ Vg(?^r)) along ?_0 is the projections of the non-uniform
absolute intrinsic static gravitational ow speed that ? ^M0 at the origin of the curved ?^_ establishes along the curved ?^_ and the non-uniform absolute proper static gravitational ow speed V 0
gab(r0
ab)(= ^ Vg(^r)) in _0 is the outward manifestations of
the projective non-uniform ?V 0
gab(?r0
ab) (= ?^ Vg(?^r)) along ?_0.

Likewise the non-uniform absolute proper intrinsic static gravitational ow speed
?V 0
gab(?r0

ab) along the relative proper intrinsic metric time dimension ?cs?t0 along
the vertical has not been established by the relative intrinsic rest mass ?E0=?c2s
in
?cs?t0 and the non-uniform absolute proper static gravitational ow speed V 0
gab(r0
ab)(=
^ Vg(^r)) along the relative proper metric time dimension cst0 has not been established
by the relative rest mass E0=c2s
(= M0) of the gravitational _eld source in cst0
in Fig. 7. Rather the non-uniform ?V 0
gab(?r0
ab)(= ?^ Vg(?^r)) along ?cs?t0 is the
invariant projection along the vertical of the non-uniform ?^ Vg(?^r) established along
the curved ?^cs?^t by ?^E =?^c2 (= ? ^M0) at the origin of the curved ?^cs?^t and
V 0
gab(r0
ab) (= ^ Vg(^r)) along cst0 is the outward manifestations of the projective
?V 0
gab(?r0
ab) (= ?^ Vg(?^r)) along ?cs?t0.
It is to be remembered however that ?^ Vg(?^r) along the curved ?^_ and ?^cs?^t
actually projects ?V 0
gab(?r0
ab) into the projective ?_0
ab along the horizontal and the
projective ?csab?t0
ab along the vertical. It is because ?_0
ab is embedded in ?_0 and
?csab?t0
ab is embedded in ?cs?t0 that ?V 0
gab(?r0
ab) appear along ?_0 and ?cs?t0
in Fig. 7. Having now known that ?^ Vg(?^r) and ?V 0
gab(?r0
ab) are absolute intrinsic
static ow speeds and that ^ Vg(^r) and V 0
gab(r0
ab) are absolute static ow speeds, the
quali_cation \static" in absolute intrinsic static gravitational ow speed and absolute
static gravitational ow speed shall be suppressed largely henceforth.

2.3 The second stage of evolutions of spacetime/intrinsic spacetime and parameters/intrinsic parameters in the gravitational _eld

The geometry of Fig. 7 evolves from the reference geometry of Fig. 5 or Fig. 6 at the
_rst stage of evolutions of spacetime/intrinsic spacetime and parameters/intrinsic
parameters in the gravitational _eld. There is a second stage, which shall be
presented in this section.

As discussed in section 2 of [7], the projective non-uniform absolute proper
intrinsic gravitational ow speed ?V 0
gab(?r0
ab) (_ ?^ Vg(?^r)) along the relative proper
intrinsic metric space ?_0 and along the relative proper intrinsic metric time dimension

?cs?t0 in Fig. 7, cannot give rise to the curvature of these relative proper intrinsic metric dimensions, or produce any other e_ect on them. The non-uniform absolute proper gravitational ow speed V 0
gab(r0
ab) in the relative proper metric Euclidean
3-space _0 and along the relative proper metric time dimension cst0, can likewise produce no detectable e_ect on the at relative proper metric spacetime (_0; cst0).
Thus if the projective static absolute proper intrinsic gravitational ow speed
?V 0
gab(?r0
ab) (= ?^ Vg(?^r)) along the straight line relative proper intrinsic metric
spaces, ?_0 and ?_0_, and straight line relative proper intrinsic metric time dimensions, ?cs?t0 and ?cs?t0_, are all that is possible and, consequently, only their outward manifestations namely, the non-uniform absolute proper gravitational ow speed
V 0
gab(r0
ab) (= ^ Vg(^r)) in the relative proper metric Euclidean 3-spaces, _0 and _0_,
and along the relative proper metric time dimensions, cst0 and cst0_, are all that are possible in Fig. 7, then the geometry of Fig. 7 will endure and evolutions of spacetimes and intrinsic spacetimes will terminate at the _rst stage within the gravitational _eld.

However the second stage of evolutions of spacetime/intrinsic spacetime and parameters/intrinsic parameters within the gravitational _eld is immutable. This is so because, apart from the non-uniform absolute proper intrinsic gravitational ow speed ?V 0
gab(?r0
ab) (= ?^ Vg(?^r)), projected along the straight line relative proper
intrinsic dimensions, ?_0, ?cs?t0, ?_0_ and ?cs?t0_, the relative intrinsic rest mass ?M0 that automatically appears in ?_0 along with the automatic appearance of ?_0 (as the absolute proper intrinsic mass ?M0ab is `projected' into ?_0
ab by ? ^M0
in the curved ?^_), serving as a relative proper intrinsic gravitational _eld source, establishes relative proper intrinsic static gravitational ow speed ?V 0
g (?r0) along
?_0, whose magnitude is largest at the edge L0 of ?M0 and decreases continuously to zero virtually at point O that is far removed from the base S0 of ?M0 in Fig. 7.

The relative intrinsic rest mass ?E0=?c2s
(= ?M0) in ?cs?t0 also establishes non-
uniform relative proper intrinsic gravitational ow speed ?V 0
g (?r0) along ?cs?t0,
whose magnitude is largest at the edge L00 of ?E0=?c2s
and decreases continuously to
zero virtually at point O. The intrinsic rest mass ?M_
0 in ?_0_ likewise establishes
non-uniform relative proper intrinsic static gravitational ow speed ?V 0
g (?r0) along
?_0_ and ?E0_=?c2 in ?cs?t0_ establishes non-uniform relative proper intrinsic static gravitational ow speed ?V 0
g (?r0) along ?cs?t0 in Fig. 7.

Quite apart from the non-uniform absolute proper static gravitational ow speed
V 0

gab(r0
ab) (= ^ Vg(^r)) in _0 and along cst0 in Fig. 7, the rest mass M0 in _0, as a relative gravitational _eld source, establishes non-uniform relative proper static gravitational ow speed V 0
g (r0) along every radial direction from its centre in _0 and the rest mass
E0=c2s
(= M0) in cst0, establishes non-uniform relative proper static gravitational
ow speed V 0
g (r0) along cst0. Likewise □M_
0 in □_0_ and □E0_=c2s
in □cst0_ in the
third quadrant in Fig. 7.

The relative proper intrinsic gravitational ow speed ?Vg(?r0) has not been shown along with the absolute proper intrinsic gravitational ow speed ?V 0
gab(?r0
ab)
along the relative proper intrinsic metric spacetime dimensions, ?_0, ?cs?t0, □?_0_, □?cs?t0_, and Vg(r0) has not been shown along with Vgab(r0
ab) in _0, □_0_ and
along cst0 and □cst0_ in Fig. 7, in order to arti_cially freeze the evolutions of metric spacetimes and intrinsic metric spacetimes to the _rst stage that has the geometry of Fig. 7. However they actually exist and cause the second stage of evolutions of metric spacetimes and intrinsic metric spacetimes in the gravitational _eld as described below.

The non-uniform relative proper intrinsic static gravitational ow speed ?V 0
g (?r0)
established along the relative proper intrinsic metric spacetime dimensions, ?_0;?cs?t0; □?_0_ and □?c?t0_, by the relative proper intrinsic rest mass of the gravitational _eld sources, ?M0, ?E0=?c2s
, □?M_
0 and □?E0_=?c2s
, respectively, in these relative
proper intrinsic metric spacetime dimensions, as described above, being relative intrinsic gravitational ow speed (i.e. with magnitude that varies along the lengths of ?_0 and ?cs?t0), will cause the relative proper intrinsic metric spacetime dimensions, ?_0 and ?cs?t0, to be simultaneously curved anticlockwise into the _rst quadrant and second quadrant respectively to form pseudo-orthogonal curvilinear intrinsic metric spacetime dimensions. This is so, because ?_0 and ?cs?t0 are simultaneously relative intrinsic dimensions at equal footing with respect to 3-observers in _0, in the context of the intrinsic theory of relativity in intrinsic metric spacetime associated with the presence of non-uniform relative proper intrinsic gravitational ow speed
?V 0
g (?r0) along ?_0 and ?cs?t0.

The curved ?_0 in the _rst quadrant will then project a straight line isotropic relativistic intrinsic metric space ?_ along the horizontal, which will be made manifested in a spherical region of relativistic metric Euclidean 3-space _ in the _rst quadrant. The curved ?cs?t0 in the second quadrant will likewise project straight line relativistic intrinsic metric time dimension ?cs?t along the vertical, which will be made manifested outwardly in the relativistic metric time dimension cst along the vertical in the _rst quadrant.

As discussed in the process of transforming Fig. 11 of [7], reproduced as Fig. 2

of this article, into Fig. 5 of [8] (reproduced as Fig. 16 on page 44 of this article), Fig. 7 above at the _rst stage of evolutions of spacetime/intrinsic spacetime and parameters/intrinsic parameters in the gravitational _eld, will endure for no moment before transforming into Fig. 8 at the second stage in the gravitational _eld. Figure 5 of [8], drawn within an attractive long-range metric force _eld in general, has simply been adapted to the gravitational _eld as Fig. 8 of this article. Consequently the symmetry-partner gravitational _eld sources in the metric spacetimes and the underlying symmetry-partner intrinsic gravitational _eld sources in the intrinsic metric spacetimes in the positive (or our) universe and the negative universe, have been integrated into the diagram in Fig. 8. The non-uniform relative proper intrinsic static ow speed and relative proper static ow speed, denoted by $?V^0_{m;P}$ and $V^0_{m;P}$, in Fig. 5 of [8] (reproduced as Fig. 16 on page 44 of this article), have also been re-denoted by $?V^0_g(?r_0)$ and $V^0_g(r_0)$ and referred to as relative proper intrinsic gravitational ow speeds and relative proper gravitational ow speed in Fig. 8, as the appropriate names in the present case of metric gravitational _eld.

The gravitational-relativistic mass M represented by a line segment of length SL in Fig. 8 is actually a spherical gravitational-relativistic mass M (as being assumed), of radius, R = SL, and the relativistic metric Euclidean 3-space _ represented by a line of length SO, is actually a spherical relativistic metric Euclidean 3-space of large radius SO with M at its centre. The relativistic intrinsic metric space ?_ is an isotropic intrinsic metric dimension with respect to 3-observers in the relativistic Euclidean 3-space _. It can be considered to lie along any of the radial direction from the center of M in _, with respect to 3-observers in _.

As illustrated in Fig. 8, the relative proper intrinsic static gravitational ow speed $?V^0_g(?r_0)$ along the curved relative proper intrinsic metric space $?\_0$ is projected invariantly as non-uniform relative proper intrinsic static gravitational ow speed $?V^0_g(?r_0)$ along the projective straight line relativistic intrinsic metric space ?_ along the horizontal, which is made manifested in non-uniform relative proper gravitational velocities $\sim V^0_g(r_0)$ along every radial direction from the centre of the relativistic mass M of the gravitational _eld source in _. The non-uniform relative proper intrinsic gravitational ow speed $?V^0_g(?r_0)$ along the curved relative proper intrinsic metric time dimension $?c_s?t_0$, is likewise invariantly projected as non-uniform relative proper intrinsic gravitational ow speed along the projective relativistic

The term `relativistic' in the gravitational _eld (in the absence of SR) in this article is `gravitational-relativistic' in the context of the theory of relativity associated with the presence of gravitational _eld in spacetime, to be identi_ed shortly in this article.

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Figure 8: The global metric spacetime/intrinsic metric spacetime geometry of combined _rst and second stages of evolutions of spacetime/intrinsic spacetime and parameters/intrinsic parameters within the identical gravitational _elds of a pair of symmetry-partner sources in the positive and negative universes, with respect to 3-observers in the Euclidean 3-spaces in the two universes, which evolves upon the geometry of Fig. 7 at the _rst stage.

intrinsic metric time dimension ?c_s?t along the vertical, which is made manifested in non-uniform relative proper gravitational ow speed $V^0_g(r_0)$ along the relativistic metric time dimension ct.

The foregoing paragraph describes the graphical representation of the invariance of relative intrinsic gravitational ow speed and relative gravitational ow speed in the context of the theory of relative intrinsic gravity and theory of relativive gravity that transform Fig. 7 into Fig. 8, at the second stage of evolutions of spacetime/intrinsic spacetime and parameters/intrinsic parameters in the gravitational _eld, expressed as follows

?V_g(?r) = ?V^0_g(?r_0) (2a)

and

$V_g(r) = V^0_g(r_0)$ (2b)

Equation (2a) states that the non-uniform gravitational-relativistic intrinsic static gravitational ow speed ?V_g(?r) that is expected to be projected into the relativistic intrinsic metric space ?_ by the non-uniform relative proper intrinsic static gravitational ow speed ?V^0_g(?r_0) along the curved relative proper intrinsic metric space ?$\_0$, are the same as the non-uniform relative proper intrinsic gravitational ow speed along the curved ?$\_0$, and Eq. (2b) states that the non-uniform gravitational-relativistic gravitational ow speed $V_g(r)$ that is expected to be established along every radial direction from the centre of the relativistic mass M of the gravitational _eld source in the relativistic metric Euclidean 3-space _ in Fig. 8, is non-uniform relative proper static gravitational ow speed $V^0_g(r_0)$. Formal explanations of the invariance (2a) and (2b) along with those of Eqs. (1a) and (1b) shall be given elsewhere.

The geometry of Fig. 8 will endure for as long as the `projective' relativistic intrinsic mass ?M does not establish a new non-uniform relativistic intrinsic gravitational ow speed ?$V_g$(?r) 6= ?$V^0_g$(?$r_0$) along the relativistic intrinsic space ?_, which could cause the curvature of ?_, and as long as the `projective' relativistic intrinsic mass ?E=?c^2_s (_ ?M) does not establish a new non-uniform relativistic intrinsic gravitational ow speed ?V_g(?r) 6= ?V^0_g(?r_0) along the relativistic intrinsic time dimension ?c_s?t along the vertical, which could cause the curvature of ?c_s?t. Now the gravitational-relativistic massM in the gravitational-relativistic Euclidean

3-space _ shall be identi_ed as the inertial mass and passive gravitational mass, which is non-trivially related to the rest mass M_0 according to a relation that shall be established elsewhere. The relativistic mass (i.e. the inertial mass or passive gravitational mass) is not a gravitational _eld source; the active gravitational mass, denoted by M_{0a} in the present theory, being the source of the Newtonian gravitational _eld [11, 12]. Consequently M is not a source of gravitational ow speed. This means thatM cannot establish a new non-uniform relativistic gravitational ow velocity ~V_g(r) 6= ~V 0
g (r_0) radially from its centre in _ and, consequently, ?M
cannot establish a new non-uniform relativistic static intrinsic gravitational ow speed ?V_g(?r) 6= ?V_g(?r_0) along the relativistic intrinsic space ?_. The relativistic mass E=c_s^2
(_ M) in the relativistic time dimension $c_s t$ cannot establish a new non-uniform relativistic gravitational ow speed V_g(r) 6= V 0
g (r_0) along $c_s t$ and ?E=?c_s^2
cannot establish non-uniform relativistic static intrinsic gravitational ow speed
?V_g(?r) 6= ?V 0
g (?r_0) along ?c_s?t.
The non-existence of non-uniform relativistic intrinsic gravitational ow speed
?V_g(?r) 6= ?V 0
g (?r_0) along the relativistic intrinsic metric spacetime dimensions,
?_, ?c_s?t, □?__ and □?c_s?t_, either by projections from the curved relative proper intrinsic metric spacetime dimensions, ?$\_0$, ?c_s?t_0, □?$_0$_ and □?c_s?t_0_, or by establishments by ?M;?E=?c_s^2
; □?M_, □?E_=?c_s^2
respectively as sources, as
discussed in the preceding paragraph, implies that the relativistic intrinsic metric spaces, ?_ and □?__, and relativistic intrinsic metric time dimensions, ?c_s?t and □?c_s?t_, in Fig. 8 cannot be curved. This makes the geometry of Fig. 8

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1-observers
Figure 9: The complementary geometry to the global geometry of Fig. 8 is valid

with respect to 1-observers in the relativistic metric time dimensions in the positive and negative universes.

to endure for as long as the symmetry-partner gravitational _eld sources in the positive and negative universes exist. A consequence of this is that the evolutions of spacetime/intrinisic spacetime and parameters/intrinsic parameters in the gravitational _eld terminates at the second stage naturally. This immutable fact shall become solidly established upon this initial introduction to it elsewhere.

The geometry of Fig. 8 is valid with respect to 3-observers in the relativistic Euclidean 3-spaces, _ and □__, in the positive and negative universes as indicated. It corresponds to Fig. 5 of [8] (reproduced as Fig. 16 on page 44 of this article).

There is a complimentary diagram to Fig. 8 of this article, which corresponds to Fig. 7 of [8] (reproduced as Fig. 17 on page 44 of this article). It is depicted in Fig. 9 of this article. Figure 9 is valid with respect to 1-observers in the relativistic time dimensions, c_st and □c_st_, as indicated. While Fig. 8 has evolved from Fig. 7 with respect to 3-observers in $\_{0}$ and □_$_0$_, Fig. 9 has evolved from Fig. 7 with respect to 1-observers in c_st_0 and □c_st_0_.

The global metric spacetime/intrinsic metric spacetime diagram of Fig. 8 and its complimentary diagram of Fig. 9, evolve at the second stage of evolutions of spacetime/intrinsic spacetime in the gravitational _eld. The remarkable feature of the diagrams, as discussed for Figs. 5 and 7 of [8] (reproduced as Fig. 16 and Fig. 17 on page 44 of this article), in a long-range metric force _eld in general is that, the four-dimensional relativistic metric spacetime (_; c_st) in which the observers are located and its underlying two-dimensional relativistic intrinsic metric spacetime (?_ ; ?c_s?t), are everywhere at in an arbitrary gravitational _eld. This fact has been solidly established by demonstrating local Lorentz invariance in a long-range metric force _eld in general in [8]. Gravitational local Lorentz invariance (GLLI) shall be established within a gravitational _eld of arbitrary strength shortly in this article.

Although the extended two-dimensional relative proper intrinsic metric spacetimes, (?_$_0$;?c_s?t_0) and (□?_$_0$_;□?c_s?t_0_), are curved in the gravitational _eld in Figs. 8 and 9, they possess pseudo-orthogonal curvilinear intrinsic metric dimensions. This means that they possess the Lorentzian metric tensor at every point of them with respect to 3-observers in the relativistic metric Euclidean metric 3-spaces, _ and □__, and 1-observers in the relativistic metric time dimensions, c_st and □c_st_, as has been demonstrated in long-range metric force _elds in general in [8].

The only curved spacetime with a Riemannian metric tensor, so to speak, in Figs. 8 and 9, at the second stage of evolutions of spacetime/intrinsic spacetime in the gravitational _eld in our universe, is the `two-dimensional' absolute intrinsic metric spacetime (?^_ ;?^c_s?^t) with absolute intrinsic sub-Riemannian metric tensor ?^g_{ik}, with respect to 3-observers in the relativistic metric Euclidean 3-space _ in the positive (or our) universe (Fig. 8) and 1-observers in the relativistic metric time dimension c_st (Fig. 9), as has been established within long-range metric force _elds in general in [8]. The curved (?^_ ; ?^c_s?^t) in Figs. 8 and 9, at the second stage of evolutions of spacetime/intrinsic spacetime and parameters/intrinsic parameters in the gravitational _eld, has been brought forward from the geometry of Fig. 7 at the _rst stage.

For completeness and in order to be able to derive the inverse intrinsic gravitational local Lorentz transformation (inverse ?GLLT) and inverse gravitational local Lorentz transformation (inverse GLLT), the inverses of the global diagrams of Figs. 8 and 9 must also drawn as Fig. 10 and Fig. 11 respectively. The explanations of how Figs. 10 and 11 of this article are the inverses of Figs. 8 and 9 of this article respectively, with respect to the indicated observers, are the same as the explanations of how Figs. 8 and 9 of [8] (reproduced as Fig. 18 and Fig. 19 on page 45 of this article) are the inverses of Figs. 5 and 7 of [8] (reproduced as Fig. 16 and Fig. 17 on page 44 of this article), in a long-range metric force _eld in general, done in [8].

The next step in this article is to adapt the new results derived in section 2 of [8] from the local spacetime/intrinsic spacetime geometries of that article, at the second stage of evolution of metric spacetime/intrinsic metric spacetime in a long-

Local Lorentz invariance in a long-range metric force _eld is associated with the theory of relativity within the _eld due to the non-uniform `static ow' speed V_{0m} established within the _eld by the source.

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Figure 10: The inverse of the global metric spacetime/intrinsic metric spacetime geometry of Fig. 8 of combined _rst and second stages of evolutions of spacetimes/intrinsic spactimes and parameters/intrinsic parameters within symmetry-partner gravitational _elds in our universe and negative universe is valid with respect to 1-observers in the relativistic metric time dimensions cst and □cst_ in the two universes.

range metric force _eld in general, to the gravitational _eld. This is the subject ot the next section.

3 The theory of gravitational relativity and theory of intrinsic gravitational relativity associated with the presence of gravitational _eld and intrinsic gravitational _eld at the second stage of evolutions of space-

time/intrinsic spacetime and parameters/intrinsic parameters in the gravitational _eld

As stated above, the programme of this section is to adapt the results of section 2 of [8] in a long-range metric force _eld in general to the gravitational _eld. Those

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Figure 11: The inverse of the global metric spacetime/intrinsic metric spacetime geometry of Fig. 9 of combined _rst and second stages of evolutions of spacetimes/intrinsic spactimes and parameters/intrinsic parameters within symmetry-partner gravitational _elds in the positive and negative universe is valid with respect to 3-observers in the relativistic Euclidean 3-spaces in the two universes.

results are the intrinsic local Lorentz transformation (?LLT) in terms of relative proper intrinsic `static ow' speed ?V 0m ; local Lorentz transformation (LLT) in terms of relative proper `static ow' speed V 0m ; intrinsic local Lorentz invariance (?LLI) and local Lorentz invariance (LLI) implied by ?LLT and LLT respectively; intrinsic metric time dilation and intrinsic metric length contraction formulae in terms of relative proper intrinsic `static ow' speed ?V 0m and metric time dilation and metric length contraction formulae in terms of relative proper `static ow' speed V 0m .

The relative proper intrinsic `static ow' speed ?V 0 m;P and relative proper `static ow' speed V 0 m;P that appear in those results must simply be replaced by the relative proper intrinsic static gravitational ow speed ?V 0 g (?r0) and relative proper static gravitational ow speed V 0 g (r0) respectively, where ?V 0 g (?r0) must be related to the relative proper intrinsic gravitational parameters and V 0

g (r0) must be related to the
relative proper gravitational parameters of the source of the external gravitational _eld.
It thus follows that the place to start this section from is the derivation of expressions for ?V 0
g (?r0) and V 0
g (r0) that will appear in the theory of relativity and
theory of intrinsic relativity associated with the presence of relative gravitational _eld in spacetime and relative intrinsic gravitational _eld in intrinsic spacetime, as well as absolute intrinsic static gravitational ow speed ?^ Vg(?^r) that will appear in the absolute intrinsic metric tensor ?^gij , absolute intrinsic Ricci tensor ?^Rij and absolute intrinsic line element of the metric theory of absolute intrinsic gravity (M?AG) on the curved `two-dimensional' absolute intrinsic metric spacetime (?^_;?^cs?^t), with respect to 3-observers in the relativistic metric Euclidean 3-space _ in Fig. 8.

3.1 Relating static gravitational ow speed and intrinsic static gravitational ow speed to gravitational parameters and intrinsic gravitational parameters

Figure 7 that is valid partially with respect to 3-observers in the _0 and _0_ and partially with respect to 1-observers in cst0 and cst0_, is a valid geometry at the _rst stage of evolutions of spacetime/intrinsic spacetime and parameters/intrinsic parameters in the gravitational _eld. It does not exist however, because there was no time for it to be formed, since the second stage of evolutions commences at the same moment that the geometry of Fig. 7 at the _rst stage begins to evolve, as shall be shown in the second part ov this article. It thereby yields the geometry of Figs. 8 of combined _rst and second stages of evolutions of spacetime/intrinsic spacetime and and parameters/intrinsic parameters in the gravitational _eld, as the geometry that exists with respect to 3-observers in the relativistic metric Euclidean 3-spaces, _ and _, and Fig. 9 as the geometry that exists with respect to 1-observers in the relativistic metric time dimensions, cst and cst_, in a gravitational _eld of arbitrary strength.

Now let the `one-dimensional' absolute intrinsic rest mass ?^m0 of a test particle be in absolute intrinsic gravitational fall (at increasing absolute intrinsic dynamical speed ?^ Vd) along the curved absolute intrinsic space ?^_, toward the absolute intrinsic rest mass ? ^M0 of the gravitational _eld source at the origin of the curved ?^_ in the _rst quadrant (or our universe) in Fig. 8. In perfect symmetry, the symmetry-partner test particle of negative absolute intrinsic rest mass ?^m_0
is in absolute
intrinsic gravitational fall (at identical increasing absolute intrinsic dynamical speed ?^ Vd), along the curved absolute intrinsic space ?^_, toward the negative absolute intrinsic rest mass ? ^M _
0 of the symmetry-partner gravitational _eld source at the
origin of the curved ?^_ in the third quadrant (or the negative universe) in Fig. 8.

Let the absolute intrinsic rest mass ?^m0 of the test particle in our universe possess absolute intrinsic dynamical speed ?^ Vd upon falling along the curved ?^_ to a position P of `distance' ?^r from the base ^ S of ? ^M0 at the origin of the curved ?^_. It will acquire the absolute intrinsic static gravitational ow speed ?^ Vg(?^r) at position P, of the non-uniform absolute intrinsic static gravitational ow speed established along the curved ?^_ by ? ^M0. Thus the absolute intrinsic rest mass ?^m0 of the test particle will possess absolute intrinsic dynamical speed ?^ Vd and

absolute intrinsic static gravitational ow speed ?^ Vg(?^r) it acquires at position P, upon falling to this position along the curved ?^_.
On the other hand, the curved relative proper intrinsic metric space ?_0 possesses relative proper intrinsic static gravitational ow speed ?V 0
g (?r0) at the corresponding
point P0 along ?_0, which the relative intrinsic rest mass ?M0 of the gravitational _eld source at the origin of the curved ?_0 establishes along ?_0, as well as absolute proper intrinsic static gravitational ow speed ?V 0
gab(?r0
ab) (= ?^ Vg(?^r)) invariantly
projected into the curved ?_0 by ?^ Vg(?^r) at point ^P
along the curved ?^_. Recall
that the absolute proper intrinsic metric space ?_0
ab into which ?V 0
gab(?r0
ab) is
projected is embedded in the straight line ?_0 in Fig. 7 and the curved ?_0 in Fig. 8.
The relative intrinsic rest mass ?m0 of the test particle in absolute intrinsic fall at absolute proper intrinsic dynamical speed ?V 0
dab through point P0 on the curved ?_0,
therefore acquires relative proper intrinsic static gravitational ow speed ?V 0
g (?r0)
and absolute proper intrinsic static gravitational ow speed ?V 0
gab(?r0
ab) (= ?^ Vg(?^r)),
in addition to its absolute proper intrinsic dynamical speed ?V 0
dab (= ?^ Vd).
Now the curved two-dimensional relative proper intrinsic metric spacetime (?_0;?cs?t0) with pseudo-orthogonal curvilinear intrinsic dimensions, ?_0 and ?cs?t0, possesses the Lorentzian metric tensor at every point with respect to the 3-observers in _. Consequently the 3-observers in _ will formulate the theory of combined intrinsic gravity and intrinsic motion with the relative proper intrinsic static gravitational ow speed ?V 0
g (?r0) and its absolute proper intrinsic dynamical speed ?V 0
dab
along the curved ?_0 and write the proper intrinsic total energy of the intrinsic rest mass of the test particle as
?U0 =
1
2
?m0?V 02
dab
1
2
?m0?V 0
g (?r0)2 : (3)
The fact that the proper intrinsic static gravitational ow speed ?V 0
g (?r0) is an
absolute intrinsic speed in the context of intrinsic dynamical relativity (since it is the same relative to all observers), makes the combination of absolute proper intrinsic kinetic energy and relative proper intrinsic gravitational energy possible in Eq. (3).

On the other hand, Eq. (3) takes on the Newtonian form in terms of the relative proper (or classical) intrinsic gravitational potential function as
?U_0 =
1
2
?m_0?V_0^2
dab
G?M_0?m_0
?r_0 : (4a)
Equation (4a) is correct numerically, but the intrinsic rest mass ?M_0 of the gravitational _eld source, as source of the intrinsic Newtonian gravitational _eld in that equation, must be replaced by the intrinsic active gravitational mass of the _eld source, to be denoted by ?M_{0a}. The fact that the active gravitational mass is the source of the Newtonian gravitational potential and _eld is known [12{14]. This fact shall be abundantly justi_ed elsewhere in the present theory.

It is also known that the rest mass and the active gravitational mass are equivalent, which means that M_0 and M_{0a} have equal magnitude but are distinct masses [12]. The fact that the active gravitational mass M_{0a} is an immaterial entity with the same shape and size and equal magnitude as the rest mass M_0 and that M_{0a} is imperceptibly contained in M_0, shall also be fully justi_ed elsewhere in the present theory. Thus the immaterial M_{0a} that imperceptibly wholly occupies M_0 is the source of the massless gravitational potential and _eld, which appear to originate from M_0 in $\_{0}$, in the present theory.

Equation (4a) must be replaced with the following equivalent form
?U_0 =
1
2
?m_0?V_0^2
dab
G?M_{0a}?m_0
?r_0 : (4b)
Equation (4b) along the curved relative proper intrinsic metric space ?$\_{0}$ is valid for all magnitudes of the classical intrinsic gravitational potential and absolute proper intrinsic dynamical speed, with respect to the intrinsic 1-observers on the curved ?$\_{0}$ at the location of the intrinsic rest mass ?m_0 of the test particle and 3-observers at any position in _.

A comparison of Eqs. (4b) and (3) yields the following expressions for relative proper intrinsic gravitational ow speed,
?V^0_g (?r_0)^2 = 2G?M_{0a}=?r_0 ; (5a)
?V^0_g (?r_0) =
p
2G?M_{0a}=?r_0 : (5b)
The negative root of 2G?M_{0a}=?r_0 is chosen in the de_nition of ?V^0_g (?r_0), because of the attractive nature of the intrinsic gravitational _eld ?g_0 and the fact that ?g_0 and ?V^0_g (?r_0) are collinear and co-directional. This fact shall be fully entrenched with further development elsewhere.

The relative proper intrinsic gravitational potential is dependent on the relative

proper intrinsic static gravitational ow speed as
?_0(?r0) = □
1
2
?V 0
g (?r0)2 = □
G?M0a
?r0 : (6)
Also because of the local Lorentzian metric tensor on the curved (?_0;?cs?t0) with respect to 3-observers in _, the relative proper intrinsic gravitational acceleration (or relative proper intrinsic gravitational _eld) at the point P along the curved ?_0, is given from de_nition like in Euclidean geometry, with respect to the 3-observer in _ as
?g0(?r0) =
1
2
d?V 0
g (?r0)2
d?r0 = □
d?_0(?r0)
d?r0 = □
G?M0a
?r02 : (7)
Removing the symbol ? from Eqs. (5a-b) { Eq. (7) gives the expressions for relative proper gravitational ow speed (or velocity), relative proper gravitational potential and relative proper gravitational acceleration respectively as
V 0
g (r0)2 =
2GM0a
r0 ; (8a)
~V
0
g (r0) = □
r
2GM0a
r0
~r 0
r0 ; (8b)
_0(r0) = □
1
2
V 0
g (r0)2 = □
GM0a
r0 (9)
and
~g 0(r0) =
1
2
dV 0
g (r0)2

dr0 =
d_0(r0)
dr0 =
GM0a~r 0
r03 : (10)
The ~V 0
g (r0) and ~g0(r0) are collinear and parallel vectors from Eqs. (8b) and (10).
In order to derive expressions for the absolute intrinsic gravitational ow speed ?^ Vg(?^r), absolute intrinsic gravitational potential ?^_(?^r) and absolute intrinsic gravitational acceleration (or _eld) ?^g(?^r), along the curved absolute intrinsic metric space ?^_, which correspond to Eqs. (5b), (6) and (7) for the respective relative proper intrinsic parameters along the curved relative proper intrinsic metric space ?_0, we shall employ the natural covariance of absolute intrinsic natural laws on the curved absolute intrinsic metric spacetime (?^_;?^cs?^t), with respect to 3-observers in _0 in Fig. 7 and 3-observers in _ in Fig. 8. The covariance of absolute intrinsic natural laws implies that the absolute intrinsic natural laws remain the same at every point on the curved (?^_;?^cs?^t) with respect to the 3-observers in _, including at the point O at `in_nity' where the curved (?^_ ; ?^cs?^t) is at.
The natural covariance of absolute intrinsic natural laws on the curved (?^_;?^cs?^t) with respect to all 3-observers in _ in Fig. 8 follows from the invariance of absolute intrinsic spacetime coordinate interval projections, d?_0
ab = d?^_ and d?t0
ab = d?^t
and of all absolute intrinsic parameters ^q in physics as, ?q0
ab = ?^q, at every point
of the curved (?^_;?^cs?^t) and its invariantly projected at absolute proper intrinsic metric spacetime (?_0
ab;?csab?t0
ab), with respect to 3-observers in _. The invariance,
d?_0
ab = d?^_ and ?csabd?t0
ab = ?^csd?^t, have been introduced and applied to
establish absolute intrinsic local Lorentz invariance (A?LLI) on the curved absolute intrinsic metric spacetime (?^_;?^cs?^t), which also possesses absolute intrinsic sub-Riemannian metric tensor ?^gik, with respect to 3-observers in _ in [7].
The invariance, d?_0
ab = d?^_ and ?csabd?t0
ab = ?^csd?^t, at every point of
the curved (?^_;?^cs?^t) with respect to 3-observers in _, implies that local absolute intrinsic coordinate at every point of the curved (?^_;?^cs?^t) is the same as the local `coordinate' (?^r;?^cs?^t) of any given point on the curved (?^_;?^cs?^t), including points at in_nity where (?^_;?^cs?^t) is at, with respect to 3-observers in _. This, along with the invariance, ?q0
ab = ?^q, of all absolute intrinsic parameters?^q in
physics, guarantees the covariance of all absolute intrinsic natural laws on the curved (?^_;?^cs?^t), with respect to 3-observers in the relativistic Euclidean 3-space _. A more formal proof of covariance of all absolute intrinsic natural laws on the curved (?^_;?^cs?^t), with respect to 3-observers in _ shall be supported quantitatively by derivation elsewhere.
An absolute intrinsic natural law formulated at an arbitrary point P on the curved ?^_ will remain the same at the point O at in_nity where (?^_;?^cs^t) is at,

according to the natural covariance of absolute intrinsic natural laws on the curved (?^_;?^cs?^t) with respect to 3-observers in _ in Fig. 7. It follows from this that the absolute intrinsic natural laws take on their absolute intrinsic Newtonian forms on at (?^_;?^cs?^t) at every point on the curved (?^_;?^cs?^t), with respect to all 3-observers in _ in the gravitational _eld in Fig. 8.

As follows from the preceding paragraph, the absolute intrinsic total energy ?^U of the absolute intrinsic rest mass ?^m0 of the test particle at the position
^P
of `distance' ?^r from the base of the absolute intrinsic rest mass ? ^M0 of the gravitational _eld source along the curved ?^_ in Fig. 8, is given in terms of the absolute intrinsic speeds ?^ Vd and ?^ Vg(?^r) in the following absolute intrinsic Newtonian form

?^U =
1
2
?^m0?^ V 2
d □
1
2
?^m0?^ Vg(?^r)2 : (11)

This is the same as the following absolute intrinsic Newtonian expression for absolute intrinsic total energy

?^U =
1
2
?^m0?^ V 2
d □
G? ^M0a?^m0
?^r
: (12)

The expression for the absolute intrinsic static gravitational ow speed ?^ Vg(?^r) that follows from Eqs. (11) and (12) is the following

?^ Vg(?^r)2 = 2G? ^M0a=?^r ; (13a)
?^ Vg(?^r) = □
q
2G? ^M0a=?^r : (13b)

The dependence of the absolute intrinsic gravitational potential and absolute intrinsic gravitational acceleration on the absolute intrinsic gravitational ow speed, obtained by writing Eqs. (6) and (7) in terms of absolute intrinsic gravitational parameters are the following

?^_(?^r) = □
1
2
?^ Vg(?^r)2 = □
G? ^M0a
?^r
: (14)

and

?^g(?^r)=
1
2

d?^ V_g(?^r)$_2$
d?^r
=
d?^_(?^r)
d?^r
=
G? ^M_0a
?^r$_2$: (15)

The absolute intrinsic static gravitational ow speed ?^ V_g(?^r) is taken to be the negative root of 2G? ^M_0=?^r in Eq. (13b), because of the attractive nature of the gravitational _eld.

Removing the symbol ? from Eqs. (13a-b) { Eq. (15), gives expressions for absolute gravitational ow speed, absolute gravitational potential and absolute gravitational acceleration respectively as

^ V_g(^r)$_2$ = 2G ^M_0a=^r ; (16a)
^ V_g(^r) =
q
2G ^M_0a=^r ; (16b)
^_(^r) =
1
2
^ V_g(^r)$_2$ =
G ^M_0a
^r
; (17)
^g(^r) =
1
2
d ^ V_g(^r)$_2$
d^r
=
d ^_(^r)
d^r
=
G ^M_0a
^r$_2$: (18)

3.2 Deriving intrinsic gravitational local Lorentz transformation and gravitational local Lorentz transformation and establishing intrinsic gravitational local Lorentz invariance and gravitational local Lorentz invariance in the gravitational _eld

The intrinsic local Lorentz transformation and its inverse in terms of relative proper intrinsic `static ow' speed ?V $_{0m}$
, as well as intrinsic local Lorentz invariance, intrinsic
metric time dilation and intrinsic metric length contraction formulae they imply, derived with the aid of the local metric spacetime/intrinsic metric spacetime diagrams of Figs. 10 and 11 and their inverses, Figs. 12 and 13 of [8], within arbitrary long-range metric force _eld, in sub-section 2.2 of [8] and the outward manifestations of those results namely, local Lorentz transformation and its inverse in terms of relative proper `static ow' speed V $_{0m}$
, as well as local Lorentz invariance, metric time dilation

and metric length contraction formulae they imply, on the at four-dimensional relativistic metric spacetime, in a long-range metric force _eld, shall be adapted to the gravitational _eld in this sub-section. The local metric spacetime/intrinsic metric spacetime diagrams in general long-range metric force _eld in sub-section 2.2 of [8] shall not be reproduced in this article to conserve space.

The counterparts in the gravitational _eld of the local metric spacetime/intrinsic metric spacetime geometries of Fig. 10 { Fig. 13 of [8] in long-range metric force _elds in general, drawn from the global diagrams of Figs. 5 and 7 and their inverses, Figs. 8 and 9 of [8], (reproduced as Figs. 16 and 17 and Figs. 18 and 19 on pages 44 and 45 of this article), must be drawn from the global diagrams of Fig. 8 { Fig. 11 of this article in the gravitational _eld. This will be an easy task, since the counterpart local geometries to be derived from Figs. 8 { Fig. 11 of this article are exactly the same as Fig. 10 { Fig 13 of [8], except that the relative proper intrinsic static `ow speed' ?V_{0m}, which appears in those diagrams in [8] in long-range metric force _elds in general, must be replaced by relative proper intrinsic static gravitational ow speed ?V^0_g (?r_0) in the gravitational _eld.

For completeness of this article, the counterpart in the gravitational _eld of Fig. 10 of [8] in long-range metric force _elds in general is presented as Fig. 12 of this article.

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Figure 12: Local metric spacetime/intrinsic metric spacetime diagram derived from the global diagram of Fig. 8 is valid respect to 3-observers in the relativistic Euclidean 3-spaces in the positive and negative universes.

The local geometry of Fig. 12 derived from the global geometry of Fig. 8 of this article, by following the explanation of the derivation of the local diagram of Fig. 10 from the global diagram Fig. 5 of [8], in sub-section 2.2 of that article, is valid with respect to 3-observers in the relativistic Euclidean 3-spaces, _ and □_, as is the case with Fig. 8. This is so because, the anti-clockwise rotation by a positive relative intrinsic angle ? g(?r0) of the relative proper intrinsic metric spacetime intervals, d?_0 and ?csd?t0, relative to their projective relativistic intrinsic metric spacetime intervals, d?_ and ?csd?t, in Fig. 12 is valid with respect to these 3-observers. The partial intrinsic metric spacetime interval transformation that can be derived with respect to 3-observers in _ in the _rst quadrant in Fig. 12, which follows from the derivation of Eq. (5) from Fig. 10 in [8], is the following

d?_0 = d?_ sec? g(?r0) □ ?csd?t tan? g(?r0) ;
(w:r:t: 3 □ observers in _) : (19)

The counterpart in the gravitational _eld of Fig. 11 of [8], in a long-range metric force _eld in general, is depicted as Fig. 13 of this article. The local diagram of Fig. 13, drawn from the global diagram of Fig. 9, by following the explanation of the derivation of Fig. 11 from Fig. 7 of [8], in sub-section 2.2 of that article, is valid with respect to 1-observers in the relativistic metric time dimensions, cst and □cst_, as is the case with Fig. 9. This is so, because the clockwise rotation by a positive relative intrinsic angle ? g(?r0) of the relative proper intrinsic metric spacetime intervals, d?_0 and ?csd?t0, relative to their projective relativistic intrinsic metric spacetime intervals, d?_ and ?csd?t, in Fig. 13 is valid with respect to these 1-observers in cst and □cst_.

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Figure 13: Local metric spacetime/intrinsic metric spacetime diagram derived from the global diagram of Fig. 9 is valid with respect to 1-observers in the relativistic metric time dimensions in the positive and negative universes; the complementary diagram to Fig. 12.

The partial intrinsic metric spacetime interval transformation that can be derived with respect to 1-observers in cst in the _rst quadrant from Fig. 13, which follows from the derivation of Eq. (6) from Fig. 11 in [8], is the following

?csd?t0 = ?csd?t sec? g(?r0) □ d?_ tan? g(?r0) ;
(w:r:t: 1 □ observers in cst) : (20)

Collecting Eqs. (19) and (20) gives the full inverse intrinsic metric spacetime interval transformation with respect to 3-observers in _ and 1-observers in cst, at `distance' ?r0 along the curved relative proper intrinsic metric space ?_0 from the base S0 of the intrinsic rest mass ?M0 of the gravitational _eld source at the origin of the curved ?_0 in Figs. 12 and 13 as

?csd?t0 = ?csd?t sec? g(?r0) □ d?_ tan? g(?r0) ;
(w:r:t: 1 □ observers in cst) ;
d?_0 = d?_ sec? g(?r0) □ ?csd?t tan? g(?r0) ;
(w:r:t: 3 □ observers in _) : (21)

There is an inverse of system (21), which must be derived from the inverses of Figs. 12 and 13 of this article. The inverse of Fig. 12 is the counterpart in the gravitational _eld of Fig. 12 of [8] in long range metric force _elds in general. It is depicted in Fig. 14 of this article. Figure 14 derived from the inverse global geometry Fig. 10 of this article, is valid with respect to 1-observers in the relativistic metric time dimensions, cst and □cst_, as is the case with Figs. 10 and 12 of this article. This, as explained for Fig. 12 of [8] of this article), is so, because the clockwise rotation of the relativistic intrinsic metric spacetime intervals, d?_ and ?csd?t, relative to the inclined relative proper intrinsic metric spacetime intervals, d?_0 and ?csd?t0, by a negative relative intrinsic angle □? g(?r0) in Fig. 14, is equivalent to clockwise rotation of the inclined relative proper intrinsic metric spacetime coordinate intervals, d?_0 and ?csd?t0, relative to their projective relativistic intrinsic metric spacetime coordinate intervals, d?_ and ?csd?t, by a positive relative intrinsic angle ? g(?r0) in Fig. 13. Consequently Fig. 14, like Fig. 13, is valid with respect to 1-observers in the relativistic metric time dimensions, cst and cst_, as is the case for Figs. 9 and 10, from which Figs. 13 and 14 have been drawn respectively.

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Figure 14: The inverse of Fig. 12 is valid with respect to 1-observers in the relativistic metric time dimensions in the positive and negative universes.

The partial intrinsic metric spacetime interval transformation that can be derived with respect to 1-observers in cst in the _rst quadrant (or in the positive universe) from Fig. 14, which follows from the derivation of Eq. (8) from Fig. 12 of [8], is the following

d?_ = d?_0 sec? g(?r0) + ?csd?t0 tan? g(?r0) ;
(w:r:t: 1 observers in cst) : (22)

Finally the inverse of Fig. 13 is the counterpart in the gravitational _eld of Fig. 13 of [8] in long range metric force _elds in general. It is depicted in Fig. 15 of this article. The inverse local diagram of Fig. 15, derived from the inverse global diagram Fig. 11 of this article, is valid with respect to 3-observers in the relativistic Euclidean 3-spaces, _ and □__, of the positive and negative universes, as is the case with Fig. 11. This, as explained for Fig. 13 of [8], is so, because the anti-clockwise rotation of the relativistic intrinsic spacetime coordinate intervals, d?_ and ?c_sd?t, relative to the inclined relative proper intrinsic metric spacetime coordinate intervals, d?$\_0$ and ?c_sd?t_0, by a negative intrinsic angle □? g(?r_0) in Fig. 15, is equivalent to anti-clockwise rotation of the inclined proper intrinsic metric spacetime coordinate intervals, d?$\_0$ and ?c_sd?t_0, relative to relativistic intrinsic metric spacetime coordinate intervals, d?_ and ?c_sd?t, by positive relative intrinsic angle ? g(?r_0) in Fig. 12. Consequently Fig. 15, like Fig. 12, is valid with respect to 3-observers in the relativistic Euclidean 3-spaces, _ and □__.

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Figure 15: The inverse of Fig. 13 is valid with respect to 3-observers in the relativistic metric Euclidean 3-spaces in the positive and negative universes.

The partial intrinsic metric spacetime coordinate interval transformation that can be derived with respect to 3-observers in _ in the _rst quadrant (or in the positive universe) from Fig. 15, which follows from the derivation of Eq. (9) of [8] from Fig. 13 of that article, is the following

?csd?t = ?csd?t0 sec? g(?r0) + d?_0 tan? g(?r0) ;
(w:r:t: 3 □ observers in _) : (23)

Collecting Eqs. (22) and (23) gives the full intrinsic metric spacetime coordinate interval transformations with respect to 3-observers in _ and 1-observers in cst, derived with the aid of the inverse local diagrams of Figs. 14 and 15, at `distance' ?r0 along the curved relative proper intrinsic metric space ?_0, from the base S0 of the relative intrinsic rest mass ?M0 of the gravitational _eld source at the origin of the curved ?_0 in the global diagrams of Figs. 8 or 9 as

?csd?t = ?cd?t0 sec? g(?r0) + d?_0 tan? g(?r0) ;
(w:r:t: 3 □ observers in _) ;
d?_ = d?_0 sec? g(?r0) + ?csd?t0 tan? g(?r0) ;
(w:r:t: 1 □ observers in cst) ; (24)

where, as follows from the derivation of relations (12) { (13a-b) of [8],

d?_
?csd?t
=
?Vg(?r0)
?cs
= sin? g(?r0) ; (25)

and d?_=d?t = ?V 0
g (?r0), since only relative proper intrinsic static gravitational
ow speed is present in the absence of of a test particle in intrinsic motion (or in the absence of SR) in the external gravitational _eld, as being inherently assumed in this article.

Now following the discussion that led to the replacement of Eqs. (79) and (80) by Eqs. (81) and (82) in [7], the divisor in ?Vg(?r0)=?cs in Eq. (25) cannot be the maximum intrinsic static geodesic ow speed ?cs that appears in ?cs?t, but the maximum over all relative intrinsic static gravitational ow speeds, to be denoted by ?cg, with magnitude of 3 _ 10^8 ms□1. Indeed the presence of intrinsic static geodesic ow speed ?cs at every point along ?cs?t0 does not give rise to intrinsic gravitational potential along ?cs?t0, unlike ?V 0
g (?r0) that is present along ?cs?t0
in the gravitational _eld and gives rise to intrinsic gravitational potential ?_0
g(?r0)
along ?cs?t0, with respect to 1-observers in cst0. Hence cs is equivalent to zero magnitude of static intrinsic gravitational potential ?V 0
g (?r0). This makes ?cs
inappropriate as divisor in ?Vg(?r0)=?cs. Equation (25) must consequently be modi_ed as

sin? g(?r0) =
?V 0
g (?r0)
?cg
= ?_g(?r0) ; (26a)
sec? g(?r0) = (1 □

?V 0
g (?r0)2
?c2g
)□1=2 = ?g(?r0) : (26b)
Using Eqs. (26a) and (26b) in systems (21) and (24) gives the counterparts in the gravitational _eld to systems (14) and (15) of [8] in general long-range metric force _elds respectively as
d?t0 = ?g(?r0)(d?t □
?V 0
g (?r0)
?c2g
d?_) ;
(w:r:t: 1 □ observers in cst) ;
d?_0 = ?g(?r0)(d?_ □ ?V 0
g (?r0)d?t) ;
(w:r:t: 3 □ observers in _)
(27)
and
d?t = ?g(?r0)(d?t0 +
?V 0
g (?r0)
?c2g
d?_0) ;
(w:r:t: 3 □ observers in _) ;
d?_ = ?g(?r0)(d?_0 + ?V 0
g (?r0)d?t0) ;
(w:r:t: 1 □ observers in cst) :
(28)
Finally, using the expression (5a) for the relative proper intrinsic gravitational ow speed in Eq. (26a) and (26b) gives the following relations for the relative intrinsic angle ? g(?r0)
sin? g(?r0) =
?V 0
g (?r0)
?cg
=
s
2G?M0a
?r0?c2g
= ?_g(?r0) ; (29a)
sec? g(?r0) = (1 □
?V 0
g (?r0)2
?c2g
)□1=2 = (1 □
2GM0a
?r0?c2g
)□1=2 = ?g(?r0) :(29b)
Systems (21) and (24) or systems (27) and (28) are then given in terms of the relative intrinsic gravitational parameter 2G?M0a=?r0?c2 respectively as
d?t0 = ?g(?r0)(d?t □

s
2G?M0a
?r0?c4g
d?_) ;
(w:r:t: 1 observers in cst) ; (30)
d?_0 = ?g(?r0)(d?_
r
2G?M0a
?r0 d?t) ;
(w:r:t: 3 observers in _)
and
d?t = ?g(?r0)(d?t0 +
s
2G?M0a
?r0?c4g
d?_0) ;
(w:r:t: 3 observers in _) ;
d?_ = ?g(?r0)(d?_0 +
r
2G?M0a
?r0 d?t0) ;
(w:r:t: 3 observers in cst) :
(31)

Systems (21) and (24), systems (27) and (28) and systems (30) and (31), are alternative forms of intrinsic gravitational local Lorentz transformation (?GLLT) and its inverse on the two-dimensional relative intrinsic metric spacetime in a gravitational _eld of arbitrary strength. The concept of relativity associated with relative static intrinsic gravitational ow speed shall be clari_ed shortly in this section.

Either system (21) or its inverse (24), or the more explicit form (27) or (28) in terms of relative proper intrinsic gravitational ow speed, or the most explicit form (30) or (31) in terms of relative proper intrinsic gravitational parameters 2G?M0a=?r0, leads to intrinsic gravitational local Lorentz invariance (?GLLI)

?c2s
d?t2 d?_2 = ?c2s
d?t02 d?_02 : (32)

It follows from the ?GLLI that the two-dimensional relativistic intrinsic metric spacetime (?_;?cs?t) possesses intrinsic Lorentzian metric tensor at every point and it is consequently everywhere at in a gravitational _eld of arbitrary strength, as illustrated by the extended straight line ?_ and ?cs?t in Fig. 8 { Fig. 13.

Let us collect the partial intrinsic gravitational local Lorentz transformations of elementary intrinsic metric spacetime coordinate intervals with respect to 3-observers in the relativistic Euclidean 3-space _ in systems (21) and (24) to have

d?_0 = sec? g(?r0)(d?_ sin? g(?r0)?csd?t) ;
d?t = sec? g(?r0)(d?t0 +
sin? g(?r0)
?cg
d?_0) ;
(w:r:t 3 observers in _) :
(33)

Now when a hypothetical intrinsic 1-observer in the relativistic intrinsic metric space ?_ underlying _ picks his intrinsic laboratory rod to measure the relativistic intrinsic metric space interval involved in an intrinsic event in the relativistic intrinsic metric spacetime, in the _rst equation of system (33), he will be able to measure the term d?_ sec? g(?r0) but not the term □?csd?t tan? g(?r0) at the right-hand side of that equation, with his intrinsic laboratory rod. Likewise when the hypothetical intrinsic 1-observers in ?_ picks his intrinsic laboratory clock to measure the intrinsic metric time interval involved in the same intrinsic event in the second equation of system (33), he will be able to measure the term d?t0 sec? g(?r0) but not the term (d?_0=?cs) tan? g(?r0), with his intrinsic laboratory clock. Removing the terms that cannot be measured with intrinsic laboratory rod and intrinsic laboratory clock from system (33) gives

d?_ = d?_0 cos? g(?r0) and d?t = d?t0 sec? g(?r0) ;
(w:r:t 3 □ observers in _) :
(34)

System (34) gives the intrinsic gravitational length contraction and intrinsic gravitational time dilation formulae in terms of the intrinsic angle ? g(?r0), with respect to 3-observers in the gravitational-relativistic Euclidean 3-space _, in the context of the intrinsic theory of relativity associated with the presence of a relative intrinsic gravitational _eld in intrinsic metric spacetime (with the global geometry of Figs. 8 and 9).

System (34) is given in terms of the relative proper intrinsic static gravitational ow speed by virtue of relation (26b) as

d?_ = d?_0(1 □
?V 0
g (?r0)2
?c2g
)1=2 and d?t = d?t0(1 □
?V 0
g (?r0)2
?c2g
)□1=2 ;
(w:r:t 3 □ observers in _) :
(35)

And system (35) is given in terms of the relative proper intrinsic gravitational parameter 2G?M0a=?r0 by virtue of relation (29b) as

d?_ = d?_0(1 □
2G?M0a
?r0?c2g
)1=2 and d?t = d?t0(1 □
2G?M0a
?r0?c2g
)□1=2 ;
(w:r:t 3 □ observers in _) :
(36)

Now the intrinsic theory of relativity in intrinsic metric spacetime that is associated with the presence of relative intrinsic gravitational _eld, will be made manifested in the theory of relativity in metric spacetime that is associated with the presence of relative gravitational _eld in metric spacetime. Consequently the intrinsic gravitational local Lorentz transformation (?GLLT) of system (21) and its inverse of system (24), within intrinsic gravitational local Lorentz frames on the at two-dimensional intrinsic metric spacetime in the gravitational _eld, in terms of the intrinsic angle ? g(?r0), will be made manifested outwardly in gravitational local Lorentz transformation

(GLLT) and its inverse within the corresponding gravitational local Lorentz frames
on the at four-dimensional metric spacetime in the gravitational _eld. Essentially
the symbol ? must simply be removed from systems (21) and (24) to have their
outward manifestations in spacetime respectively as
$c_sdt_0 = c_sdt \sec {}_g(r_0)$ □ dr tan $_g(r_0)$;
(w:r:t: 1 □ observers in c_st) ;
dr_0 = dr sec $_g(r_0)$ □ c_sdt tan $_g(r_0)$; $r_0d\_{}_0$ = rd_ ; r_0 sin $\_{}_0d'_0$ = r sin _d' ;
(w:r:t: 3 □ observers in _)
(37)
and
$c_sdt = c_sdt_0$ sec $_g(r_0)$ + dr_0 tan $_g(r_0)$;
(w:r:t: 3 □ observers in _) ;
dr = dr_0 sec $_g(r_0)$ + c_sdt_0 tan $_g(r_0)$; rd_ = $r_0d\_{}_0$; r sin _d' = r_0 sin $\_{}_0d'_0$;
(w:r:t: 1 □ observers in c_st) :
(38)
Now the relative proper static gravitational ow speed V $_0$
$_g$ (r_0) is isotropic in the
relative proper metric Euclidean 3-space $\_{}_0$ and the relativistic Euclidean 3-space _.
It consequently lies radially from the centre of the rest mass M_0 in $\_{}_0$ and from the
centre of the relativistic mass M in _ of the gravitational _eld source, irrespective
of the shape of M_0 and M. It is for this reason that the outward manifestation
in spacetime of systems (21) and (24) take on the forms of systems (37) and (38)
respectively always in all gravitational _elds, where the unprimed (or relativistic)
coordinates, r_ and r sin _', of _, along which V $_0$
$_g$ (r_0) does not lie, which are hence
non-relativistic coordinates, transform into the corresponding proper coordinates,
r_0; $r_0\_{}_0$ and r_0 sin $\_{}_0'_0$, of $\_{}_0$ trivially as, $r_0\_{}_0$ = r_ and r_0 sin $\_{}_0'_0$ = r sin _'. These
facts shall be more rigorously established elsewhere.
The appearance of the angle $_g(r_0)$ in system (37) and (38) conveys the impression
that the proper metric coordinates intervals dr_0 and c_sdt_0 are rotated at angle $_g(r_0)$
relative to their projective relativistic metric coordinate intervals dr and c_sdt and,
consequently that, the extended dimensions, r_0 and c_st_0, of the relative proper metric
spacetime ($\_{}_0$; c_st_0) _ (r_0; $r_0\_{}_0$; r_0 sin $\_{}_0'_0$; c_st_0) are curved with non-uniform curvature
relative to their projective straight line dimensions, r and c_st, respectively of the
relativistic metric spacetime (_; c_st)_(r; r_; r sin _'; c_st), in the gravitational _eld.
It is to be noted however that there is no curvature of the four-dimensional metric
spacetime, or of the dimensions of the four-dimensional metric spacetime, in the
new geometrical background to the theory of relativity and gravitation within a
four-world picture, presented as Figs. 8 { Fig. 11 of this article.
Only the relative proper intrinsic metric spacetime dimensions, $?\_{}_0$ and $?c_s?t_0$,
are actually curved relative to their projective relativistic intrinsic metric spacetime
dimensions, ?_ and $?c_s?t$, respectively in Figs. 8 and 9 and their inverses, Figs. 10
and 11. The curvature of the dimensions of the metric spacetime apparently implied
by systems (37) and (38) is an intrinsic and not observable (or actual) curvature.
This is what the actual curvatures of intrinsic metric spacetime in Fig. 10 { Fig. 13
represent.
The outward manifestations on the four-dimensional metric spacetime of the
intrinsic gravitational local Lorentz transformation of system (27) and its inverse
(28) in terms of gravitational ow speed are likewise given respectively as
dt_0 = $_g(r_0)$(dt □
V $_0$

g (r0)
c2g
dr) ;
(w:r:t: 1 □ observers in cst) ;
dr0 = g(r0)(dr □ V 0
g (r0)dt) ; r0d_0 = rd_ ; r0 sin _0d'0 = r sin _d' ;
(w:r:t: 3 □ observers in _)
(39)
and
dt = g(r0)(dt0 +
V 0
g (r0)
c2g
dr0) ;
(w:r:t: 3 □ observers in _) ;
dr = g(r0)(dr0 + V 0
g (r0)dt0) ; rd_ = r0d_0 ; r sin _d' = r0 sin _0d'0 ;
(w:r:t: 1 □ observers in cst) ;
(40)
where
g(r0) = sec g(r0) = (1 □ V 0
g (r0)2=c2g
)□1=2 : (41)
Systems (39) { (41) correspond to systems (22) { (24) of [8].
The outward manifestations in the four-dimensional spacetime of systems (30) and (31) are given respectively as
dt0 = g(r0)(dt □
s
2GM0a
r0c4g
dr) ;
(w:r:t: 1 □ observers in cst) ;
dr0 = g(r0)(dr □
r
2GM0a
r0 dt) ; r0d_0 = rd_ ; r0 sin _0d'0 = r sin _d' ;
(w:r:t: 3 □ observers in _)
(42)
and
dt = g(r0)(dt0 +
s
2GM0a
r0c4g
dr0) ;
(w:r:t: 3 □ observers in _) ;
dr = g(r0)(dr0 +
r
2GM0a
r0 dt0) ; rd_ = r0d_0 ; r sin _d' = r0 sin _0d'0 ;
(w:r:t: 1 □ observers in cst) ;
(43)

where
g(r0)=(1 □ V 0
g (r0)2=c2g
)□1=2=(1 □ 2GM0a=r0c2g
)□1=2 : (44)
Systems (37) and (38), systems (39) and (40) and systems (42) and (43), are alternative forms of gravitational local Lorentz transformation (GLLT) and its inverse in the four-dimensional relativistic metric spacetime in the gravitational _eld. They are called gravitational local Lorentz transformation, because they are restricted within gravitational local Lorentz frames (within which gravitational potential is constant) in arbitrary gravitational _eld. They pertain to a theory of relativity to be named shortly, which is associated with the presence of relative gravitational _eld in metric spacetime.
Either the GLLT (37), (39) or (42) or its inverse (38), (40) or (43), leads to gravitational local Lorentz invariance (GLLI):
c2s
dt2 □ dr2 □ r2(d_2 + sin2d'2) = c2s
dt02 □ dr02 □ r02(d_02 + sin2 d'02) : (45)
The gravitational local Lorentz invariance (GLLI) (45) is valid at every point on the four-dimensional relativistic metric spacetime in a gravitational _eld of arbitrary strength, implying the atness of the four-dimensional gravitational-relativistic metric spacetime (_; cst) everywhere in a gravitational _eld of arbitrary strength, as deduced graphically and illustrated in Figs. 8 and 9 and their inverses, Figs. 10 and 11 earlier. The GLLI (45) is the outward manifestation on the at four-dimensional metric spacetime of the intrinsic gravitational local Lorentz invariance (?GLLI) (32) on at two-dimensional intrinsic metric spacetime.
Finally the intrinsic gravitational length contraction and intrinsic gravitational time dilation formulae in the context of the intrinsic theory of relativity associated with the presence of relative intrinsic gravitational _eld on the at two-dimensional intrinsic metric spacetime, presented in the alternative forms of systems (34), (35) and (36), are made manifested outwardly on the at four-dimensional metric spacetime, in the context of the theory of relativity associated with the presence of relative gravitational _eld in metric spacetime respectively as
dr = dr0 cos g(r0) ; rd_ = r0d_0 ; r sin _d' = r0 sin _0d'0 ; and
dt = dt0 sec g(r0) : (46)
dr = (1 □
V 0
g (r0)2
c2g
)1=2dr0 ; rd_ = r0d_0 ; r sin _d' = r0 sin _0d'0 ; and
dt = (1 □
V 0
g (r0)2
c2g
)□1=2dt0 (47)
and
dr = (1 □
2GM0a
r0c2g
)1=2dr0; rd_ = r0d_0 ; r sin _d' = r0 sin _0d'0 ; and
dt = (1 □

2GM0a
r0c2g
)□1=2dt0 : (48)

The gravitational length contraction and gravitational time dilation formulae (46) { (48) at radial distance r from the center of the gravitational-relativistic mass M in _ in Fig. 8, corresponding to radial distance r_0 from the centre of the rest mass M_0 in $\_0$ in Fig. 7, are valid with respect to 3-observers in the relativistic Euclidean 3-space _ in Fig. 8.

The theory of relativity on the at four-dimensional relativistic metric spacetime (_; c_st), which is associated with the presence of a relative gravitational _eld, within which the gravitational local Lorentz transformation (GLLT) and its inverse (37) and (38), or (39) and (40), or (42) and (43), have been derived; within which the gravitational local Lorentz invariance (45) on the at four-dimensional metric spacetime in a gravitational _eld of arbitrary strength has been established, and within which the gravitational length contraction and gravitational time dilation formulas of system (46), (47) or (48) have been derived, shall be referred to as the theory of gravitational relativity and given the acronym (TGR).

The TGR is the gravitational counterpart (involving relative static gravitational ow speed $V^0_g(r_0)$), of the special theory of relativity (SR) (involving uniform relative dynamical speed v). However, while the relative dynamical speed is constant in SR, thereby satisfying the special principle of relativity [9], the relative static gravitational ow speed $V^0_g(r_0)$, which appears in TGR, is spatially uniform within a gravitational local Lorentz frame, but varies from one gravitational local Lorentz frame to another, thereby satisfying the general principle of relativity of Einstein [10] globally in the gravitational _eld. Thus the theory of gravitational relativity (TGR) may also be referred to as the general theory of relativity on at spacetime, going by the Einsteinian nomenclature, but TGR shall be preferred.

If we could have our way, the special theory of relativity associated with relative dynamical velocity would be referred to as the theory of dynamical relativity (TDR), which can then take care of the relativity of both uniform and non-uniform relative dynamical velocities. The relativity of non-uniform relative velocity motions shall be investigated in the context of the present theory elsewhere.

The intrinsic theory of relativity on the at two-dimensional relativistic intrinsic metric spacetime (?_;?c_s?t) associated with the presence of relativistic intrinsic gravitational _eld on (?_;?c_s?t), within which the intrinsic gravitational local Lorentz transformation (?GLLT) and its inverse of systems (21) and (24) or systems (27) and (28) or systems (30) and (31), have been derived; within which the intrinsic gravitational local Lorentz invariance (?GLLI) (32) has been established, and within which the intrinsic gravitational length contraction and intrinsic gravitational time dilation formulae of system (34), (35) or (36) have been derived, is the theory of intrinsic gravitational relativity (T?GR). It is the gravitational counterpart of the intrinsic special theory of relativity (?SR).

The theory of gravitational relativity (TGR) on the at four-dimensional relativistic metric spacetime (_; c_st) in an arbitrary gravitational _eld in Figs.10 and 11 and their inverses, Figs. 12 and 13, is mere outward manifestation on the at (_; c_st) of the theory of intrinsic gravitational relativity (T?GR) on the at two-dimensional relativistic intrinsic metric spacetime (?_;?c_s?t) underlying (_; c_st) in those _gures. Once a result of T?GR has been derived on the at intrinsic spacetime (?_ ; ?c_s?t), the corresponding result of TGR on the at four-dimensional spacetime (_; c_st) can

be written straight away, essentially by dropping the symbol ? from the result of T?GR. This procedure, which has been demonstrated above, has also been demonstrated between ?SR and SR in [1].
The \relativity" aspect of the commonly used terminology \relativity and gravitation", when applied in the present context, refers to a theory of relativity on the at spacetime associated with the presence of gravitational _eld, which is the theory of gravitational relativity (TGR), while the \gravitation" part of the \relativity and gravitation" terminology, refers to the theory (or law) of gravity (i.e. of gravitational interaction) on at four-dimensional relativistic metric spacetime (_; cst) in Fig. 10, obtained from the transformations with the aid of GLLT and its inverse (42) and (43) of the classical (or Newtonian) theory (or law) of gravity (or of classical gravitational interaction), as shall be investigated elsewhere. This is analogous to the special theory of relativity and relativistic mechanics, where relativistic mechanics is classical mechanics transformed with the aid of LT and its inverse in the context of SR.
This _rst part of this article shall be ended at this point. The second part shall be a direct continuation of this _rst part. Division into two parts is necessary in order to avoid to long paper.

Conclusion

The summary of the progressive development of the two stages of evolutions of metric spacetime and intrinsic metric spacetime and the associated sequence of metric spacetime/inrinsic metric spacetime geometries in long-range metric force _elds in general, in the previous articles, which culminate in their adaptation to the gravitational _eld in this article and its upcoming second part, along with the developments in this article and its second part, as well as general conclusion and direction for further investigation, shall be presented at the end of the second part of this article. The speci_c conclusion reached in this article that, the four-dimensional gravitational-relativistic metric spacetime and its underlying two-dimensional gravi-tational-relativistic intrinsic metric spacetime are at in arbitrary gravitational _eld, while the `two-dimensional' absolute intrinsic metric spacetime is curved with absolute intrinsic sub-Riemannian metric tensor, shall be mentioned at this point. The derived set of metric spacetime/intrinsic metric spacetime geometries in the gravita-tional _eld in the four-world picture in this article, encompasses theories gravity and hierarchy of theories of intrinsic gravity and it is a more all-encompassing geometrical background for gravitation than a prescribed curved four-dimensional spacetime solely in a one-world picture in the general theory of relativity.

STATEMENT OF FINANCIAL SUPPORT

This paper and the progressive developments in eight previous papers that lead to it were self-sponsored by the author.

COMPETING INTERESTS

No competing interests are involved in this work.

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3-observers
3-observers
cs t
cst cs t
cs t
cs t
cst
cs t
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Figure 16: The global metric spacetime/intrinsic metric spacetime diagram within symmetry-partner long-range relativistic metric force _elds in our universe and negative universe, with respect to 3-observers in the relativistic metric Euclidean spaces in the two universes; (Fig. 5 of [8])

c
c
c
t
t

t
cst
cs t
s
s
s
cs t c t s
cst
m,
m,
m,
m,
m,
m,
m,
m,
m,
m,
m,
m,
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m,
m,
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m,
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m,
m,
m,

Figure 17: The complementary global metric spacetime/intrinsic metric spacetime diagram to Fig. 16; is valid with respect to 1-observers in the relativistic metric time dimensions in our universe and the negative universe; (Fig. 7 of [8])

1-observers
1-observers cst
cs t
cst
cs t
cs t
cs t
cs t
m, cs t
m,
m,
m,
m,
m,
m,
m,
m,
m,
m,
m,
m,
m,
m,
m,
m,
m,
m,
m,
m,
m,
m,
m,

Figure 18: The inverse of the global metric spacetime/intrinsic metric spacetime diagram of Fig. 16; is valid with respect to 1-observers in the relativistic time dimensions cs and □cst_ in the positive and negative universes; (Fig. 8 of [8])

3-observers
3-observers
$c_s t$
$c_s t$
$c_s t$
$c_s t$
$c_s t$
$c_s t$
$c_s t$
$c_s t$
m,
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Figure 19: The inverse of the global metric spacetime/intrinsic metric spacetime diagram of Fig. 17; is valid with respect to 3-observers in the relativistic metric Euclidean 3-spaces IE$_3$ and □IE_$_3$ of the positive and negative universes; (Fig. 9 of [8])