COSMIC MECHANICS THEORY (CMT)

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ABSTRACT

***CMT** postulates that space is the 3D surface of a 4D spherical universe in constant expansion embedded in a euclidian space of n dimensions (n≥4). All 3D material entities survive only in this space, and all bodies of mass are 3 dimensional. Surface of the 4D spherical universe (space) for us is extrinsically curved in the 4th dimension. The extrinsic curvature of the universe and space is caused by a constant and evenly distributed 4D spherical flow of pure energy (non-condensed) away from a cosmic point of origin. It is not shaped by the condensed matter content of space. In consideration of the immense size of the inflating universe, a local region in space for instance of the size of our solar system may be assumed in close proximity to have a zero curvature. The intrinsic curvature of space on the other hand is not needed to be any different(±) than zero.*

Bending of space by a body of mass in space is also extrinsic and it causes a tiny 4D indentation or dimple (a sag in cosmic surface) form in space around the body.

Time measured in a reference frame in 3D space is relativistic and in dichotomy with the implicit cosmic time defined by the constant motion of cosmic expansion in the 4th dimension. Pace of time-flow in a spatial reference frame is identical to the speed of the cosmic expansion of that reference frame in the 4th dimension. Time-flow is continuous and one-way.

The velocity of motion of the cosmic expansion which is always in the direction of the 4th dimension away from the center of the universe is at its maximum speed and coincidental with the direction of the cosmic radius ($\boldsymbol{v_R}$) where space is not bent extrinsically any further by gravitation or any other reason in the form of a 4D indentation. But if and where space is bent extrinsically further by a body of mass, the direction of expansion diverges from the cosmic radial direction by some $\boldsymbol{\theta}$ and the speed of the velocity is posited to decrease by an amount dependent on $\boldsymbol{\theta}$. The continuum of potential velocities postulated to be emergent in space around the mass as vector components of $\boldsymbol{v_R}$ in compensation of the loss of $\boldsymbol{v_R}$, manifests an integral function of gravitational force which always points and gets stronger toward the center of gravity of the mass.

*Mass bends space, but motion of a body of mass bends space even further. Any velocity in the range from zero (rest position) up to **c** of a body of mass in space is always a vector component of $\boldsymbol{v_R}$, and a net force is required to alter the state or the velocity of the body. The state or velocity of the body is altered by starting or removing or changing the degree of space bending. If a body of mass is at rest in space, then $\boldsymbol{v_R}$ of the body has no vector component in space. On the other hand $\boldsymbol{v_R}$ which is the speed of the cosmic radial growth is found to be equal to **c**.*

*The hypothesis of **CMT** on gravity and inertia is congruent with the principle of conservation of energy posing however significant differences with the relativistic mass and energy conservation.*

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1. INTRODUCTION

The objective of this treatise is to introduce a new theory, namely the Cosmic Mechanics Theory (**CMT**) designed to provide an alternative perspective to our understanding of space, time, gravity, inertia, momentum and energy, based on the cosmic mainstream motion of expansion in the fourth dimension. An expanding 4D spherical model of the universe embedded in an *n* dimensional euclidian space ($n \geq 4$) is postulated as the cosmological model of **CMT**, and our entire space is posited to be limited to the 3D surface of the universe.

CMT presents a radical theory to both gravity and inertia in consistency. Inspired by **GRT** yet fundamentally different from it, the solution is based on the 4D geometry and kinetics of the universe and space. Moreover the so called dark energy and dark matter issues are explicit in the model.

Although the theoretical work presented below focuses essentially on the said macro topics of physics, it is also bound to have important consequences on physics of waves, subatomic particles, E-M and quantum fields. The consequences on microphysics however merit in whole to be treated under a separate title. Nevertheless **CMT** may also contribute in laying the groundwork for a real unified theory in physics.

2. THE SHAPE AND DYNAMICS OF THE UNIVERSE

2.1. The Model of GRT and Beyond: Physicists and cosmologists do not yet have a thorough and definite understanding of the exact shape of the universe. The difficulty of the problem involves not only the inadequacy of our means of measurement and observation to cover an inconcievably large universe, but also the fact that the universe in contrast to our own reality is predominantly accepted by physicists to have more than 3 dimensions.

Thanks to the developments largely in connection to Einstein's General Relativity Theory in the last century however, we do seem to have some reasonable clues about the shape of the universe. But these clues concerning the cosmic properties such as the expansion of the universe, gravitation, farthest measurable distances and the cosmic microwave background radiation are still not totally conclusive in defining one completely reliable solution for the overall shape of the universe. Neither can we be certain that the present observations and measurements on these properties are ultimate.

Einstein held on "with great tenacity to two beliefs concerning the universe that guided him in the construction of his cosmological model: first, that the universe is static, and second that its metric structure is fully determined by matter"[1] After abondoning the idea of infinity, Einstein's initial conception of the universe was that of a static hypersphere with a temporal component embedded in a 4D Euclidian space.

After years of intensive discussions on cosmic geometry and dynamics[2] Alexander Friedmann in 1922 and Georges Lemaitre in 1927 independently presented solutions for the field equations of Einstein which pointed to "an expanding rather than a static universe".[3] Shortly after these developments in 1929 Edwin Hubble and Milton L. Humason formulated the Redshift Distance Law of galaxies, known generally as the Hubble Law which provided evidence that the universe was expanding on the grounds that the light observed from distant galaxies irrefutably shifted to red.[4] Upon turn of events as such Einstein had to drop his famous cosmological constant which he had invented to preserve the static character of his model of the universe.

The relativistic model of the universe today may be defined as a finite and closed model, most probably a hypersphere in constant inflation embedded in 4D euclidian space. Space-time consists of all points in and on the hypersphere and it is curved solely by the matter (condensed) content of the universe. It is still canonical to describe the total curvature of the space-time as being caused by the gravitational field which as Einstein justifiably argued is an exact equivalent of the inertial field. The relativistic model of the universe in overall is homogenous and isotropic.

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[1] "The Einstein-De Sitter Debate and Its Aftermath" Michel Janssen, Hsci/Phys 4121, 2008
[2] Particularly in the period from 1914 to the beginning of 1920's during when the theory of general relativity was published (1916) there had been, as widely known, long controversies and exchanges of views over the shape of the universe between Einstein and Hermann Weyl, Felix Klein, Gustav Mie and Willem de Sitter.
[3] "The Einstein-De Sitter Debate and Its Aftermath" Michel Janssen, Hsci/Phys 4121, 2008
[4] The redshift of the light from distant galaxies was already discovered in 1918.

More recent observations reported suggest the possibility of acceleration of the cosmic expansion and a “dark energy” is suspected to be responsible of this phenomenon. However, as proposed and discussed in the forthcoming sections, the speed of the cosmic expansion in **CMT** is related to inertia and must be constant.

Quite opposite to the dark energy another current problem concerns the need for more condensed matter than what is observable in the universe. It is argued that there seems to be insufficient visible matter content in the galaxies to hold them together and provide for their high spinning speed. Thus it is proposed that there should be some “dark matter” in the universe to compensate the visible shortage of the observable matter. If true both the presence of "dark matter" and accelerating cosmic expansion would undoubtedly have very important and complex consequences on the dynamic balance and stability issue of the universe.[5]

2.2. Model Postulated by CMT: The model of the universe adopted by **CMT** is a closed, finite, elastic universe in the shape of a constantly expanding 4 dimensional sphere (with a 3D surface) with no boundaries. The model is embedded in an *n* dimensional space where $n \geq 4$. **CMT** postulates that space is confined only in the 3D surface of a 4D spherical universe. The surface of the 4D spherical universe (space) is extrinsically curved in the 4^{th} dimension. It is crucial that in the **CMT** model, contrary to **GRT** neither the overall shape of the universe nor of space is caused by the condensed matter content of space. The extrinsic curvature of the universe and space is caused by a constant and evenly distributed (equal radial displacement all around due to equal momentum, density etc.) 4D spherical flow of pure energy (non-condensed) in all radial directions outward from a cosmic point of origin which is the centre of the 4D sphere in expansion. In consideration of the immense size of the inflating universe, a local region in space for instance of a size comparable to our solar system may be assumed to have in close proximity a zero curvature. The intrinsic curvature of space on the other hand

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[5] Regarding the dynamics of the universe, there are alternative theories that challenge today’s most credited cosmological theories. Among them the Cyclic Endless Universe (Ekpyrotic Universe) Theory by Paul j. Steinhardt, and the Vorticitating Universe Theory, which was first suggested by Kurt Godel’s solution to Einstein’s field equations for a rotating universe are particularly noteworthy. Steinhardt’s theory, if correct invalidates the theories developed to explain the origin of the universe such as the widely recognized Big Bang Theory. The Vorticitating Universe Theory undertakes to show that the increasing red shift may not necessarily point out to an accelerating cosmic expansion and to explain what is called the “hyperspherical lensing effect” through which the universe looks larger than it really is.
There are still differences of opinion on the shape of the 4D universe over whether it is spherical or more like an oblate or prolate spheroid. There are also suggestions that the universe may be shaped like a cone or a funnel

is not needed to be any different(±) than zero. It is all reasonable that space may be flat to our observation and measurements. Nonetheless moving steadily in the same direction it is possible at least in theory to travel all the way around *space* back to the same point of departure, due to the extrinsic curvature of the 4D sphere.

In conformity with the definition of the **CMT** model of the universe, the concepts of space and time are re-postulated in the following sections in ways quite dissimilar to Einstein's relativistic space-time.

3. SPACE

3.1. Material Entity: Exploring down into deeper micro levels of the matter through intensive studies and experiments in particle physics up to the first decade of the 21.Century has not been successful in capturing or defining a single ultimate (indivisible) building unit valid for all matter. There seems so far no rock-bottom core of matter. On the contrary there seems to be too many particles of elementary character discovered and systemized. If hadrons which are known to be made of quarks are split, still other hadrons are generated in numbers more than the energy released in the split process would permit.[6]Some particles are observed to vanish or (re)emerge in “space-time”.

A ‘physical entity’ in the universe is known to be material as long as it has extentions in spatial dimensions and is movable or in motion as a whole and/or in parts (*particulate theory of matter*). A material entity is thus observable and measurable by means of motion and dimensions.[7]Consequently all ponderable bodies[8], waves, radiation, electromagnetic and gravitational fields are material.

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[6] The Cosmic Code: Quantum Physics as the Language of Nature, Heinz R. Pagels, Simon and Schuster, NY, 1982 (Edition in Turkish: "*Kozmik Kod II: maddenin içine gezi", Sarmal, 1993*, p.41)

[7] Apart from all its contents observed or identified individually as material entities or waves, space acts like an indivisible whole in the form of an aetheric medium that pervades surface of the whole universe. We still call it material, because it has overall dimensions and it is totally in constant motion in the 4th dimension.

[8] 'Ponderable body' is meant to be an individual material entity/object which has a positive rest mass.

Material objects that have mass on the super atomic scale are acknowledged to be formed by condensation of wave and particle energy. Down at the subatomic scales of micro physics where randomness and probability is suggested to rule, matter shows both particle and wave characters and ultimately boils down to nothing but energy or the motion itself. The sole footing of matter or material entity seems to be motion. If this is true, then motion becomes a bizarre and difficult elementary concept to be digested. If not, the question of what is it that ultimately moves or what is it that moves it needs yet to be resolved.

It is also important to keep in mind in the context of entities that dimensions are only spatial attributes of entities measured in terms of geometric extension or distance. They are not entities *per se*. They can neither be equivalents of physical entities nor exist apart from them.

Point also is an interesting geometric concept in relation to entities. Essentially a point is always a point in any geometric space or form. Point is dimensionless by definition, yet it may represent the intersection of lines in multiple dimensions. It is odd that although it always has the most fundamental place in the making of physical and material entity or dimension, point is an infinitesimal concept and belongs to the domain of singularity.

3.2. Space Redefined: Existence of all material entities always necessitates space no matter how small. Bodies at rest or in motion need space to occupy. Space is a definite requisite of motion of waves and all material entities with or without rest mass, whereas fields are already regions of space carrying dynamic potentials on other matter.

Geometrically a 3D material entity (apart from the space itself) that exists as an individual body may only belong to a space of 3 dimensions on the following grounds:

(1) All individual material entities exist as 3D bodies/objects in space.

(2) No material entity with more than 3 dimensions can totally exist in space.[9]

(3) A form with less than 3 dimensions in space is never a material entity by itself. Such forms exist only inseparably on the surface of or embedded in 3D bodies.

(4) Finally by the analogy of (3) above, a 3D material entity is not expected to exist individually inside a 4 or more dimensional space;

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[9] Only 3D cross-sections of 4 or more dimensional bodies could be visible in space. But we do not have a convincing clue, evidence or argument to support the existence of such multidimensional entities.

As 3D material entities are contingent on being in the 3D surface of the universe[10], it can also be shown that material entities with mass may exist only in 3 dimensions or in a 3 dimensional entity form in the 3D space. A body of any size that has a rest mass always bends space extrinsically and the spatial warp formed this way is constantly transported within the expanding 3D surface of the universe as long as it survives. It can bee seen in this regard and in relation to the making of the cosmic time that existence of an extrinsic warp of space inside the 4D sphere of the universe is but an infringement of the cosmic time-flow or the causality principle. This argument is made more explicit and substantiated by further explanation on the formation of mass and gravitation.

The same holds for 3D radiation in space. The E-M waves such as light for instance move (as energy transfer) observedly as 3D waves in or across the surface of the universe while at the same time they are dragged along by the cosmic expansion in the 4th dimension.

All 3D bodies of mass including ourselves, as well as all "3D" waves are postulated in this treatise to be contained solely in the 3D surface of the universe. Our 3D reality can not be valid in a 4D space beneath or beyond the surface of the universe. ***The 3D surface of the universe happens to be our entire space.***[11]

Definition of space as the 3D surface of the 4D spherical model of universe is of primal importance. The 3D surface of the universe is the surface of a 4D sphere and it is posited to be extrinsically curved. Any “straight” line all the way around the extrinsically curved space will end up at the starting point. There is no however any acceptable reason or evidence for the 3D surface of the universe to be intrinsically curved.

Space as the surface of the universe is a 3D material whole that constantly moves in the 4th dimension. Analogous to the 2D surface of an inflating sphere, ***all points in space are in the surface of the 4D universe and at equal radial metrics from the 4D spherical center*** so long

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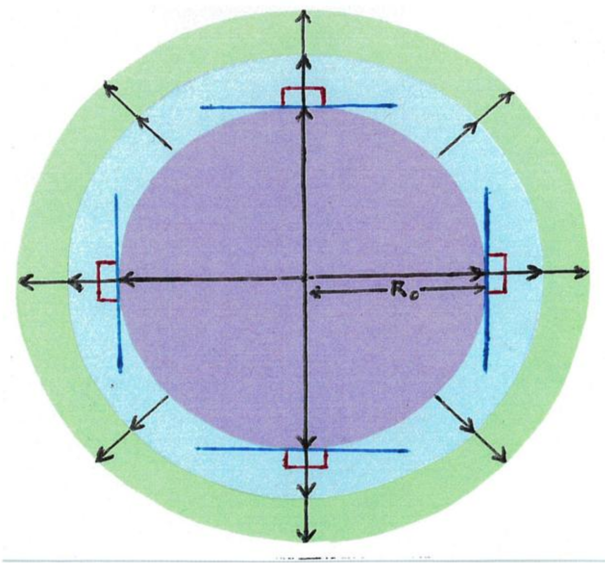
[10] The arguments used here on the possibilities of material entities to exist in different numbers of dimensions are not meant or claimed to be unprecedented. They are put forth previously by numerous mathematicians and physicists in various publications.
[11] This postulate merely confines the 3D and mass reality in the surface of the universe. However it does not necessarily imply or conclude anything on the inner content of the universe. Nevertheless it seems plausible and possible that the whole universe comprises of a huge radial 4D flow of "fine/pure"energy which also feeds space (see **Section 8** on **Energy**).

as there are no warps in the surface. It is an elemental fact that in this model all 4 dimensions always intersect at each and every point in the 3D surface of the universe.

The motion of expansion of a point in the 3D surface of the universe is always away from the center of the universe in the direction which forms a right angle with the tangent to the space at that point. In Figure 1, the universe is shown expanding in a cross sectional view (2D) of a 3D sphere which is intended to represent the 4D sphere with no warping in the surface.

Clearly the understanding of space described above poses a major divergence from the relativistic "space-time" definition. Space and time at every point in Einstein’s gravitational

Figure 1



aether or "space-time" are inseparably interwoven and the cosmic fabric as a continuum of dynamic space-time knots in 4 dimensions throughout the universe forms the basis of matter. Space and time everywhere in the universe are elastically interchangeable to a certain extent in the relativistic concept.

Following Minkowski’s work, the 4th dimension of the 4D universe is defined as ***ct*** where ***t*** is time and ***c*** is the ultimate space-time conversion rate in the relativistic model, and "space-time" materially fills in the entire 4D sphere. The relativistic universe therefore has been frequently understood or interpreted as a model of universe to include all space and time in past, present and future and therefore points of specific space and time dimensions are permanent in it. But the constant expansion of the universe in the 4th dimension inevitably plagues this 'all space-time included' understanding of the universe as long as questions like the following remain unanswered: Are entirely new space-time points added or formed in the process, or is the cosmic expansion merely a scanning motion over the already existing space-time points?, or are the positions of the space-time points inside or in the surface of the universe changed (e.g. relative to the center of the universe) during expansion?

In the model of cosmic mechanics proposed in this treatise, space defined solely as the 3D surface of the universe is accepted to be elastic as well as interactive and interdependent with matter. Space is locally recessed or held back in the 4th dimension opposite to the radial direction of the cosmic expansion around a body that has mass. Mass causes what may be described as a sag of space around itself. Space forms a continuum of spherical surface layers inside the 3D surface of a sag at rest in space. The sag is so formed that all points at equal distances to the center of gravity (c.g.) of the body of mass always take place in the same spherical surface in the said continuum of spheres of varying sizes. The size of the spherical surfaces of the sag decreases gradually in a specific pattern (gradient) from the farthest points of sag toward the c.g. of the body. This is illustrated in a 2D diagram in Figure 2 where continuum of spherical surfaces around the c.g. of mass are represented as points on two reciprocal curvilinear lines extending from the c.g. of the mass until the farthest points (A and F) where bending of space ends .

The size of the sag in space (Figure 2) is formed in proportion to the body mass (**m**) which causes it in the first place. It is formed strictly not in a retroactive or regressive way but on a progressive basis, i.e. forward in the direction of time-flow and expansion in space[12]. In the sag formation, the region of space around the acting body (**m**) is relatively held-back or retarded in its constant motion outward in the 4th dimension. Any space point in any sag would move such that it shall never fall behind its initial position on the cosmic radius.

An eventual retardation in cosmic time also occurs inside the sag, which is discussed in length in the forthcoming sections. The time lag is directly proportional to the difference of the

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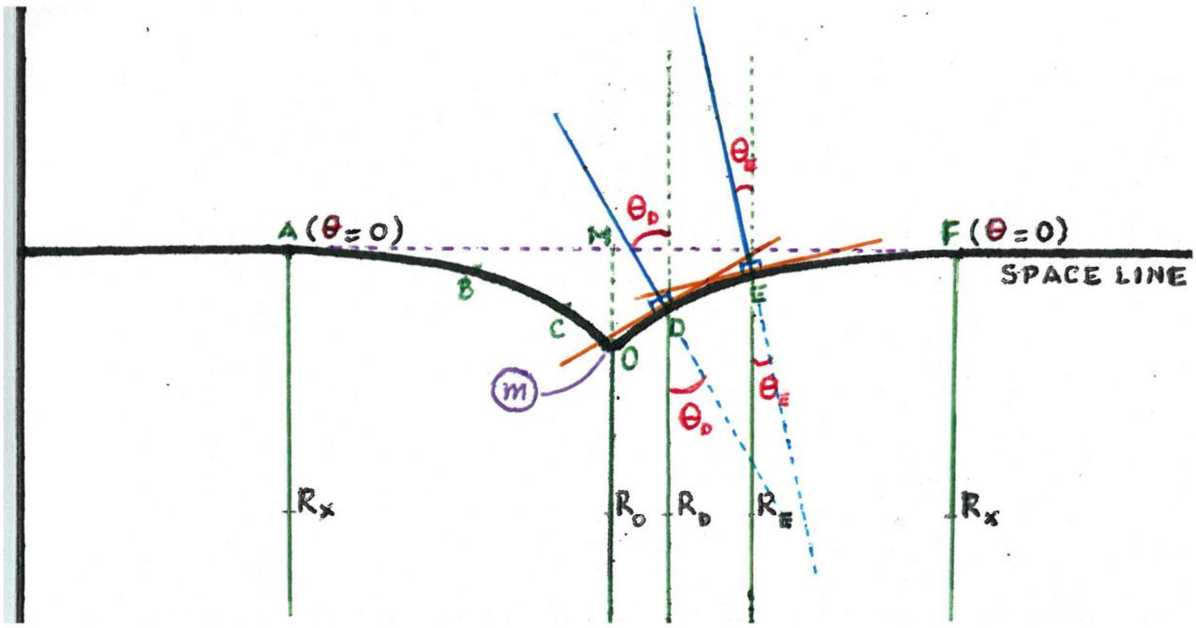
[12] Otherwise the asymmetric flow of time and the principle of 'cause and effect' order is violated. There can not be sags or warps inside the cosmic 4D sphere underneath space.

length of the maximum cosmic radius and the shorter radius at the considered spot in the sagged space.

Figure2



The image of a 4D sag can not be visualized. Therefore it is usually illustrated in a 3D view where the spherical surfaces around the body of mass (**m**) are represented by circles growing in a decreasing way from the c.g.of **m**, outward until there is no more extrinsic bending of space. To make the illustration even simpler a 2D cross-section of the 3D view through the center of gravity of (**m**) is used above, where the cross-section of the continuum of spherical surfaces are shown by two identical lines (surface of the universe shown as space line) curving inward reciprocally from the points where the bending of space starts (A and F), to the c.g. of **m** (O) following the shortest paths from point A to O and from point O to F. The bending of space is indicated by the angle of **θ** which is different at each point on A-O or on O-F. Finally the curvature of the A-M-F line is not explicit (omitted) in the Figure, because an individual sag in space is normally far too small in comparison to the circumference of the universe.

In Einstein's overall space-time that enfolds bodies of mass however, warps of space-time may occur not only in the surface but anywhere in the universe in forms of dilation or contraction both in space and in time inversely to one another; i.e. space would contract while time is dilated (runs slower), and vice versa.

3.3. Continuum of Space: The observed matter and energy occupy a very small part of the 3D space. Space seems mostly empty. An atom for instance enfolds relatively enormous rooms of empty space between a very tiny, but highly condensed nucleus and a surrounding nebula of revolving electrons at different energy levels. All super atomic matter is made up of atoms and that all other observable particles outside an atomic structure constitute a very small volume in space. Consequently space seems largely empty with the exception of the scarce matter that it is observed to contain.

Although the space defined above exposes itself merely as an empty space in 3 dimensions, it has the qualities of one cohesive substratum at the tips of a continuum of "pure"energy flow in all directions of the 4^{th} dimension.

Emptiness in space as the way we establish it indicates that matter or energy in that locality is merely not observable. As a matter of fact empty space acts like one whole elastic material entity.It is made of a continuum of motion in the 4^{th} dimension and the 3D spatial dimensions. But we are not able to see or observe the motion in the 4^{th} dimension.[13] Space contains fields, radiation, and condensed matter. But even when there is no any material entity in any form such as matter or 3D waves detectable in a region (volume) of 3D space, all points in that region still move in an unnoticed but constant way in the 4^{th} dimension, carrying expansive momentum and energy. Regardless of being observed as empty or not, space offers a medium for E-M radiation/waves. Permeability, permittivity, Planck constant, speed of light etc. are peculiar to the so called empty space.

Empty space defined as a material continuum, requires the existence of always a minimum energy level at every point. Accordingly the temperature in empty space can not be below the absolute zero $\mathbf{0^0\ K\ (-270^0\ C)}$. It is reasonable that the absolute zero temperature indicates only the energy level of the overall motion or flow of cosmic expansion exclusively in the 4^{th} dimension reflected in space. This being so the absolute zero can never be reached in space, as this would not be possible as long as there is motion or energy at work in space.[14] There is no place for nothingness in space at least until a possible end of universe.

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[13] This is because we exist physically in a 3D surface of the universe as 3D beings and our senses are constrained in 3 dimensions. Motion is a material quality, and although the motion in the 4th dimension supports the material being of the space, it is not directly sensed.

[14] In fact the average temperature of empty space is measured to be slightly over the absolute zero ($\mathbf{270.43^0C}$ or $\mathbf{2.73\ K^0}$).

4. TIME

4.1. Cosmic Expansion and Time Concept: The idea of time is intriguing and a highly challenging issue for physics. Real or unreal, time is an indispensable concept for physics and in general for human life. It is remarkable that the way time is used in mathematical formulaes or equations has not changed in the least since the times of the classical mechanics of Sir Isaac Newton, despite the fact that concept of time has undergone a major change by the theories of relativity and quantum mechanics.

Motion is expressed in physics as displacement in a specified direction, or as the number of repeated displacements. Fundamentally motion is change of placement or position. Linear orangular velocity denotes motion in physics. Frequency is also a physical concept used to describe repeated identical motions per unit time. Motion as denoted by velocity ($\mathbf{v} = \mathbf{s} \div \mathbf{t}$) always involves space (**s**), time (**t**) and direction (→). As already mentioned space is a requisite of motion or put the other way around, motion requires space; whereas time is an effect of motion and it is always conceived and measured by the virtue of spatial dimensions. Measurement of time is instrumented by comparative spatial changes through motion.

Speed too can be broken down to spatial changes and ordinal positioning of observed events on an axis of reference. While motion requires space and it is understood in terms of space, time and direction, motion and space are both required in order to speak of time.[15] Time and space inversely define motion. Space is directly perceived by our senses but time is not. Time is a device derived of motion and space. It is a derivative concept and most people will intuitively agree that if there is no motion, there is no time.

The connection between motion and time is founded by observation or deduction of 'events,'[16] in an ordinal way, i.e. comparative order of events in terms of concepts like before, after or simultaneously. Sequential apprehension of events connects motion to the concept of time. This can be achieved by positioning each event in a consistent sequence on a standard

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[15] Whether space can exist without motion is an unsettled issue. On the other hand, the inflationary motion of space itself requires an absolute Euclidian space (flat, stationary, undivided, and not inelastic or plastic).

[16] The term 'event' is used here to mean an individual happening in the domain of our observations or experience represented on the time axis of reference as a single mark or point. A process of events takes place from one point to another on the tim axis progressively. An individual happening of course is always made up of a meaningful or definable unit or set of motion (change) in 3D space.

axis of reference. The elapsed time (**t**) then is simply the distance *(***s)** between two specific markings or positions always in the same direction on the said axis of reference, divided by the uniform or average velocity (**v**) on the basis of which the ordinal markings are made on the axis (**t=s÷v**).

The problem however is how to appoint an axis of reference as such in the universe, common everywhere and to all events under all circumstances in the 4D universe.

It is important to note in this regard that the ever increasing radius of the 4D universe which is also the radius of the surface does avail itself as a cosmic axis of time common to all events in the universe. Ignoring relative retardations caused by bending in the 3D surface of the universe, all 3D spatial points that correspond to the apex of the radius ($\mathbf{R_x}$) moving continuously in the 4th dimension form an ever growing (changing) iso-temporal sphere of space as *cosmic present*, and any point on the radius below apex can be thought to represent a past instant of cosmic time. Thus theoretically and from an overall cosmic standpoint, the cosmic time indicated by the apex of the full cosmic radius at any instant ($\mathbf{R_{x\div}v_R}$) is the instantaneous *Cosmic Time Front* (***CTF***) of the universe. By cosmic expansion all points in space always move one-way in the 4th dimension and at any instant there is always one single outer surface of the universe. The expansion in the 4th dimension generates successive infinitesimal instants of cosmic present time from past to future[17]. Every unique moment of space corresponds to a unique point on **R**. Equal radii in the 4th dimension mean iso-temporal points or volumes of space on the cosmic scale.

The continuously changing infinitesimal instants of cosmic present as described above are valid in all points except those in the parts of space which fall relatively behind ***CTF*** by varying degrees in the course of expansion. This happens because space is extrinsically bent inward or rather held back by a ponderable body at rest or in motion, forming what looks like a spaceline sag in a 2D representative view (cross-sectional) of the universe and space. Cosmic time is retarded inside a sag directly proportional to the spatial recession which is the difference between the maximum radius of the universe ($\mathbf{R}_x$), and the smaller local radius ($\mathbf{R}_i$**,**

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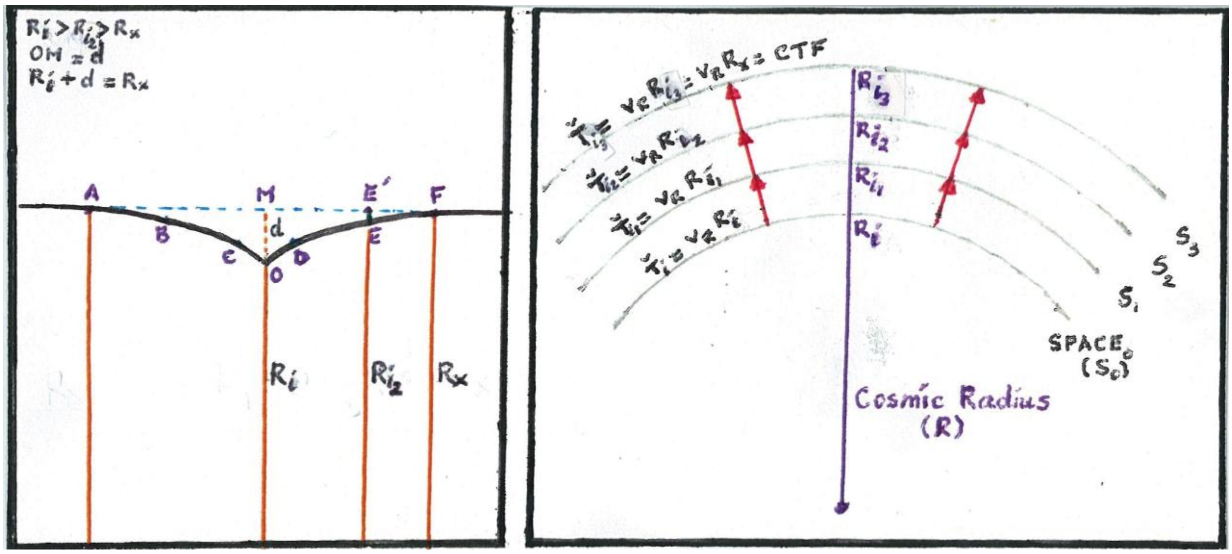
[17] There are identical or similar analyses and propositions on the cosmic mechanics of time which precede this work. The same conception on cosmic time for example is presented in a very neat and inspiring way in the article titled "The Hypersphere and Time", by jeffsf@hotpop.com/2007

i=0,…,x) at the point considered in the sagged space ($R_i < R_{i2} < R_x$ in Figure 3a). The difference between the apex of the cosmic radius and the c.g. of the body of mass **m** (OM in Figure 3a) is defined here as the maximum radial lag (**d**). **d** and the radial velocity of cosmic expansion determine the maximum retardation in cosmic time due to the extrinsic spatial bending by **m**.

Radial growth of the universe functions like a cosmic time axis or meter where events take place in a definite cosmic sequence and the maximum size of the radius ($\mathbf{R_x}$) of the universe together with $\mathbf{v_R}$ defines the age of the universe.[18]

Figure 3

(a) **(b)**



As previously said the inflationary motion of space in the 4th dimension has a one-way time-flow effect on our 3D world, that is to say our impression of an asymmetric time-flow in space is caused by the expansion of space and the universe in the direction of the 4th dimension. Constant motion of all points and all matter in space in the 4th dimension, which is not directly received by our senses is impressed upon us as time. The 4th dimension in the Minkowski space-time is conveniently defined as ***ct***, as the 4th dimension is indeed a spatial

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[18] Radial expansion velocity (v_R) of space and matter is taken to be a constant at least over a long span of cosmic time, although it may have changed in much longer time spans since the beginning of the universe, if there had indeed been a beginning like the Big Bang.

dimension (**w**) just like the other 3 dimensions x,y,z, rather than time and its unit must be expressed as a unit of space as provided by ***ct.*** The 4D sphere of Minkowski therefore is described by the following equation:

$$\mathbf{x^2 + y^2 + z^2 + (ct)^2 = R^2} \quad \textit{where } \boldsymbol{ct = w}$$

An individual material body at any locality in space as well as space itself moves **constantly and always in the 4th dimension away from the center of the universe**. If there is no any bending of space at that spot, then the 4th dimension for the said motion will be exactly equal to the radial direction of the universe. But if there is a space bending, then the 4th dimension is no longer coincident with the radial direction of the universe in which case the angle $\boldsymbol{\theta}$ between the radial direction and the tilted 4th dimension as shown in Figure 2 is bigger than zero.

Velocity in the 4th Dimension ($\mathbf{v_4}$): $\mathbf{v_4}$ is the general notation for the uniform velocity of space or any material entity in space moving out in the 4th dimension which may or may be not in the radial direction**:** $\mathbf{v_4 = w \div t_4}$ (*at maximum speed when it is in the radial direction*).

Radial Velocity in the 4th Dimension ($\mathbf{v_R}$): The radial velocity $\mathbf{v_R}$ is equal to $\mathbf{v_4}$ when $\mathbf{v_4}$ is at its maximum speed in the cosmic radial direction where there is no any bending ($\boldsymbol{\theta = 0}$) in space. Hence $\mathbf{v_R}$ is *the constant uniform velocity of space or any material entity in space moving out in the 4th dimension which is conicident with the radial direction:* $\mathbf{v_R} = \mathbf{R \div t_R}$

It must be emphasized that the time of a reference frame in 3D space (**t**), which happens to be our common understanding of time is not the time directly associated with the cosmic expansion in the 4th dimension ($\mathbf{t_4}$ or $\mathbf{t_R}$). There is what may be called a dichotomy between the time-flows in the 4th dimension and in space. The basic understanding here is that time (**t**) is meant to be the time exclusively in space, which is effected by the motion of cosmic expansion in the 4th dimension. The pace or the speed of time-flow in space is always identical to the speed of $\mathbf{v_4}$, which is equal to $\mathbf{v_R}$ at maximum. All clocks in a reference frame in space tick away always at a speed identical to that of $\mathbf{v_4}$ of that reference frame, and the speed of time-flow in a totally unbent space where $\mathbf{v_s = 0}$ is $\mathbf{v_R}$.

Nevertheless it must be acknowledged that since the motion in the 4th dimension ($\mathbf{v_4}$) involves a time factor ($\mathbf{t_4}$) as well, ambiguity exists as to whether time is basically a true dimension of the universe. The growth of the cosmic radius itself requires a definition of its own time which is in reality left out of discussion in modern physics. Time itself is not there in the universe definable as some independent dimension or elemental scale. The fourth dimension of the universe is not truly a time dimension. It is geometric and measurable in spatial (distance) units. Therefore the true nature or identity of time is still a mystery. All we can say in this regard is that the cosmic radius and the expansion of the universe apparently form a cosmic mechanism which functions like a colossal cosmic clock.

4.2. Instantaneous Cosmic Time: Instantaneous cosmic times ($\check{\mathbf{T}}_{\boldsymbol{i}}$) may be traced as successive point-marks on the cosmic radius, progressing from $\check{\mathbf{T}}_{\mathbf{0}}$ to ***CTF*** ($\check{\mathbf{T}}_{\mathbf{i3}}$ in Figure 3b). The radial distance between any two $\check{\mathbf{T}}$'s is the time elapsed (from smaller to bigger $\check{\mathbf{T}}$) between the two instants. There would be no difference of elapsed time between point-marks of equal distances on **R** where space is not bent or warped[19] simply because $\mathbf{v_R}$ is constant.

The cosmic time scale is designed virtually by setting a starting point ($\mathbf{R_1}$) on the cosmic radius placed very close to the center of the universe where radius is zero. Then all distances from the center of the universe or displacements on the radius are conveniently expressed as folds of the unit distance $\mathbf{R_1}$**-0** which is defined here as $\boldsymbol{r_1}$. Since $\mathbf{v_R}$ is constant, all successive time points ($\check{\mathbf{T}}_{\boldsymbol{i}}$) on the cosmic radius may be measured in terms of $\check{\mathbf{T}}_{\mathbf{1}}$ and $\boldsymbol{r_1}$:

$$\check{\mathbf{T}}_{\mathbf{1}} = \mathbf{v_R}.\, \boldsymbol{r_1}$$

$$\textit{and} \quad \check{\mathbf{T}}_{\boldsymbol{i}} = \mathbf{v_R}\, \boldsymbol{r_i}$$

$$\check{\mathbf{T}}_{\boldsymbol{i}} = \check{\mathbf{T}}_{\mathbf{1}}\ \boldsymbol{r_i} / \boldsymbol{r_1}$$

The distances of the point-marks to the center of the universe are invariant. While the cosmic radius is increased at the rate of $\mathbf{v_R}$ in the continuity of the cosmic expansion, entirely new instantaneous time points are added continuously over the lower ghost points of the past on the cosmic radius.

Where space is bent, the instantaneous times may still be shown as fixed point-marks on the cosmic radius. However since $\mathbf{v_4}$, unlike $\mathbf{v_R}$, may vary depending on the rate of space bending, equal distances between point-marks of bent space on the cosmic radius may not always

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[19]Totally unbent space by the way is only reasonable to exist in inter-galactic regions of the cosmic surface sufficiently far away from any galaxy or stellar formation, including the nebulae stages. Inside galaxies there ought to be billions of mass sags inside one another. Moreover time can not be measured inside a totally unbent space, because a time measuring device or an observer will inevitably make their own bending in space.

indicate equal lengths of time, and 'cosmic present time' does not make much sense in the case where $\mathbf{v_4}$ changes.

4.3. Time-flow Continuum: Time-flow obviously is not a point concept like the instantaneous time. It is the one-way ticking or running of time through successive instantaneous times. Cosmic motion in the 4th dimension and for that matter time-flow in space is asymmetric and uninterrupted in all points of space. Even in a region of 3D space observed to be empty or devoid of any motion in the spatial dimensions, time still ticks away simply because the motion in the 4th dimension or increase of **R** or **w** is in perpetuity. Similarly in a case where a particle moves in space from a point A to a point B and then back to point A following the exact same path it travelled in the first place, time still elapses for the particle. Moreover time has elapsed asymmetrically that is to say there just is not moving back in time: in all such instances an initial universal set of dimensions (for example $\mathbf{x_j, y_j, z_j}$ **and** $\mathbf{R_j}$) defines the specific space and time in a given spot or frame of reference in space which inevitably changes to a new set where $\mathbf{R_j}$ is bound to have changed to $\mathbf{R_k}$ **(**$\mathbf{R_k} > \mathbf{R_j}$**)** regardless of whether any one, or a combination or none of the spatial dimensions **x, y, z** have changed, which unfailingly leads to a one-way change in time.

No point in the 3D space can be isolated from the reality of the continuous one-way motion in the 4th dimension. A constant change of cosmic time is peremptory in our space as long as the cosmic expansion lasts. Like Heraclitus' river metaphor[20], motion of space and the correlative increase of the radius of the universe in the 4th dimension cause a continuous one-way flow (*time arrow*) of cosmic time for all points in our space.

In order to test the validity of time-flow or asymmetry, we must consider whether there is or has been a change or changes in the rest of space or the universe relative to the position of the individual case in focus. Time-flow involves the whole set of cosmic motions or changes. In the real universe there are billions of billions of moving particles and continuous motion of many energy/matter forms and scales in 3+1 dimensions in the universe, and all that continuous stream of compound motion causes multiple non-repeating or repeating changes in the enormously complex format and composition of space and the universe.

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[20] Heraclitus of Ephesos is alleged to have said "one can not get into the same river water more than once" because of the continuous flow of the river.

Consequently there is always a time change or flow as long as the universe is in motion. Simply in terms of the velocity equation, if time-flow stops i.e. t=0, the speed becomes infinite. This is not physically possible. On the other hand we deem it reasonable, thanks to the theory of relativity, to think that the time-flow in space should practically stop for example for a ponderable body if it were possible to accelerate the speed of this body up to or over ***c***, because then, for reasons to be discussed in the forthcoming sections, the speed of the body in the 4^{th} direction $\mathbf{v_4}$ would be zero. But this is not possible either, because an acceleration of this magnitude would require an infinite energy.

4.4. Measurement of Time in Space: We actually measure or have been measuring time by comparing motions to a standard motion[21] of reliably constant linear or angular or rotational (cycles) speed. All one needs to measure time is observing a continuous motion at invariant speed (preferrably cyclical like sun or a pendulum) and space displacement units. Equal space displacements in constant motion are used as equal time intervals or time units.

When it comes to observing time locally inside space in relation to the spatial motions (events), we are faced with a characteristic set of circumstances. The pace or speed of time-flow of a reference frame in space is inversely related to the pace of time-flow of the same reference frame in the 4^{th} dimension. Moreover confined in space we are impelled to observe time and space in and from separate individual frames of reference. There are necessarily no instants of time common to all points in space so far as the local individual reference frames of different $\mathbf{v_4}$ are concerned. The speed of light (***c***) as a universal constant is the highest speed (or space-time conversion rate in relativistic terms) possible in space and it is the only invariant reference relative to any local individual frame of reference in space.

The relative speed of a local frame of reference, as well as whether it is in or outside a gravitational field affect the observation and measurement of time in that frame of reference. The instant or duration (length of time) of an event is not identical for two separate frames of reference which have different relative speeds or are under different gravitational effects. The primary cause of the relative time-flow difference is the bending of space by which $\mathbf{v_4}$ is also

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[21] Like the motion of pendulum or the sand clock based on the gravitational force, sun clocks based on the rotation of the earth around the sun, and more sophisticated clocks of today based on constant motions of atomic processes

changed. Differences in observing or measuring time and space become significantly large especially in cases where the speed of a reference frame approaches $\boldsymbol{c}$ as opposed to a reference frame at rest or moving relatively very slow, or where a reference frame is under a strong gravitational field as opposed to another reference frame outside the gravitational effects of any significance.

Time observation is not absolute from the view points of different local reference frames in space. It is partial and relative. The Lorentz transformation and Einstein's Special Relativity Theory (**SRT**) hold for local frames of reference inside space. In other words the time observed in the local frames of reference in the 3D space conforms to the Lorentz transformation and **SRT**.

The time hypothesis adopted in **CMT** as explained above does not allow material accessibility of past and future in our universe. Past is no longer a part of the reality of the 3D material existence in space. We can not possibly contact or reach back to past materially even if it were only millionths of a second before[22]. Only the records of the past (bio and artificial memory, photographs, audio-visual recording, documents, diaries, books, drawings, natural and geological marks and traces of past etc. in various forms and means) are carried along the tangible but infinitesimally small instants of present. Similarly for example light (E-M) waves carry only the past images of stars and galaxies to our present time and locality from their distant origins in space. Future on the other hand is not yet materalized and we only have deterministic leads and forecasts on it. It is evident on the basis of the foregoing postulates introduced on space and time that the so-called Einstein-Rosen Bridge or Schwarrtzenchild Wormhole for bodies of mass, or "time travel" are not physically possible.

5. GRAVITATION

5.1. Background: It was Aristotle's conviction that heavier bodies fall faster than the lighter ones. This belief survived almost unquestionably until Galileo Galilei who in conclusion of

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[22]The truth of the matter is that we always live or sense present with minor delays in our daily lives. This is because information always travels a distance in a certain time to reach our senses and further time is required in our neuro-biological system for the information to be transmitted to the brain for eventual perception.

his insightful work and after hard discussions finally stated that whatever their weights may be all bodies would fall equally fast in a vacuum (1638). For all we know today this implies that the gravitational acceleration is a property of the earth, not of the falling bodies. Later Sir Isaac Newton published his universal equation of the gravitational force (1686) as the reciprocal force of attraction between any two ponderable bodies or, to be more correct, between two centers of gravity of such bodies:

$\mathbf{F_g = Gm_0m_1 \div s^2}$ *where s is the distance between the two centers of gravity, and* $\boldsymbol{m_0}$ *and* $\boldsymbol{m_1}$ *are the two ponderable bodies*

Newton's equation actually verified Galilei's point that the acceleration of the freely falling bodies on earth is invariant and specifically a property of the mass of the earth. This point is demonstrated by the results of the two cases shown below based on Newton's equation.

CASE 1: Considering the gravitational force between two bodies with masses $\mathbf{m_0}$ and $\mathbf{m_1}$:

the force on $\boldsymbol{m_0}$ *is*	$\mathbf{F_g(0) = m_0g_0 = Gm_0m_1 \div s^2}$
and the acceleration is	$\mathbf{g_0 = Gm_1 \div s^2}$
the force on $\boldsymbol{m_1}$ *is*	$\mathbf{F_g(1) = m_1g_1 = Gm_0m_1 \div s^2}$
and the acceleration is	$\mathbf{g_1 = Gm_0 \div s^2}$
but	$\mathbf{F_g(0) = F_g(1)}$ (*by definition*)
therefore	$\mathbf{g_0 \div g_1 = m_0 \div m_1}$
and if	$\mathbf{m_0 \neq m_1}$
then	$\mathbf{g_0 \neq g_1}$

Case 1 shows that although the force of attraction between two bodies is always identical, the acceleration caused by this force on one body is different from the other as long as the bodies have different masses.

CASE 2: Comparing the gravitational forces between bodies $\mathbf{m_0}$ and $\mathbf{m_1}$ and between bodies $\mathbf{m_0}$ and $\mathbf{m_2}$ (where $\mathbf{m_1 \neq m_2}$) :

the force on $\boldsymbol{m_1}$ *is*	$\mathbf{F_g(1) = m_1g_1 = Gm_0m_1 \div s^2}$
and the force on $\boldsymbol{m_2}$ *is*	$\mathbf{F_g(2) = m_2g_2 = Gm_0m_2 \div s^2}$

$$\textit{therefore} \qquad \mathbf{F_g(1) \div F_g(2) = m_1 \div m_2}$$

$$\textit{and} \qquad \mathbf{F_g(1) \neq F_g(2)}$$

$$\textit{whereas} \qquad \mathbf{g_1 = Gm_0 \div s^2}$$

$$\textit{and} \qquad \mathbf{g_2 = Gm_0 \div s^2}$$

$$\textit{therefore} \qquad \mathbf{g_1 = g_2}$$

Case 2 shows that although bodies which have different masses are attracted by different gravitational forces to a certain body ($\mathbf{m_0}$), they experience the same acceleration at same distances from the center of gravity of that body. If $\mathbf{m_0}$ above is assumed to be the mass of the earth, acceleration of all other ponderable bodies in freefall from same altitudes on earth would be identical.

Newton's equation for gravitational force ($\mathbf{F_g}$) or gravitational accelaration ($\mathbf{g}$) expressed in terms of the distance ($\mathbf{s}$) to the c.g. of the "pulling" body is basically an exponential-hyperbolic function where both axes are the asymptotes. The equation is still good and used extensively. But its application is restricted to the cases where the gravitational force is not extremely high and the speed of an object caused by the gravitational force is not near or equal to $\boldsymbol{c}$.

Theoretically the gravitational force between two bodies becomes infinitely large when the distance between their centres of gravity is zero. On the other hand the gravitational force between two bodies is zero only when they are placed infinitely far from each other, which is to say that the gravitational force approaches zero asymptotically in space. What this actually implies is that if hypothetically speaking there were only one body of mass in space, then in moving away from the center of gravity of that mass one could never reach a space region where extrinsic bending would ultimately be zero (where the cosmic radius is at its full magnitude $\mathbf{R_x}$). This does not seem right. It seems more plausible (ignoring atmospheric or all other factors) that whatever the distance is there would in any case be a zero point of altitude (distance) for the freefall of an object ($\mathbf{m_1}$) towards the c.g. of a body of mass ($\mathbf{m_0}$), or putting it the other way around there would be a final distance where the speed of $\mathbf{m_1}$ thrown initially at "escape velocity" vertically upward away from the c.g. of $\mathbf{m_0}$ shall eventually fall down to zero.

Also apart from the normal individual structure of the gravitational field of a body of mass free of other possible gravitational effects, space itself is not infinite. Moreover the gravitational field effects between individual bodies are not quite isolated from the rest of such effects in space. Bodies or groups of bodies which are in motion in space like meteors, satellites, planets, stars or galaxies are pulled to each other by gravitation. Yet such ponderable bodies in space including black holes are not usually observed to be in a process of quick and direct fall on each other. Even though they may be temporary, and temporary on cosmic scale would mean real long spans of time compared to our human standards, dynamic balances among them are evidently at work caused by the counter effects of gravity of different bodies in different positions, the linear and/or rotational (orbital) motions of bodies in space, and even the circumferential out-stretching of space which may exert only a feeble separational tension between any two points in space against gravity. The complex effects of gravitation keep many spatial bodies in dynamic states of equilibrium, while some other bodies are projected off from such states.

Einstein pointed out in General Relativity Theory (**GRT**) that a body with mass ($\mathbf{m_0}$) produces a field around itself and it is this field which acts as gravitation on another body ($\mathbf{m_1}$). Hence the gravitational force of $\mathbf{m_0}$ on $\mathbf{m_1}$ (or vice versa) is not a direct action independent of the "space-time" surrounding $\mathbf{m_0}$. Very briefly expressed, **GRT** defines gravitation as the effect of intrinsic "space-time" curvature formed around all bodies that have mass. Einstein further indicated by his equivalence principle that gravitational mass and the inertial mass in fact are the same thing, which also means that acceleration and gravitational field intensity have identical effects. In the same context if a frame of reference is accelerated, this would have exactly the same effect of a gravitational force inside that frame of reference.

The idea of gravitational field being caused by the bending of space-time on the other hand was not merely a step, but a remarkable breakthrough for the progress of physics. Einstein developed voluminous and complicated field equations in non-linear hyperbolic-elliptic form in order to describe the 4D gravitational bending of the "space-time". But **GRT** has not been fully successful in the extreme cases of gravitation, e.g. the black holes.

The latest on-going debate on gravitation is introduced by the quantum physics. The three fundamental forces outside the gravitational force in the universe are explained canonically by Quantum Mechanics (**QM**) and Quantum Field Theory (**QFT**) by the role of some intermediary or messenger particles. Theoretical particles called "gravitons" are suggested in the same manner in order to explain gravitation. Likewise particles called "dilatons" defined in the scalar field of M-theories which include more than 4 dimensions are also introduced as very highly abstract instruments in the scope of gravitation. But hitherto gravitation seemed not quite congenial with the other fundamental forces and unlike E-M field, gravitational field causes bodies that have mass to move by acceleration. Gravitational field does not produce opposite forces. Attempts to discover physical existence of "gravitons" or "dilatons" so far went in vain and should be expected to remain so on the grounds of the hypothesis of gravitation introduced here by **CMT**.

5.2. Mass: Phrased in simplest terms, mass is the condensation of energy/matter in a 3D volume so as to form an individual body or object in space, which has the distinct quality of bending space (sag) extrinsically when at rest or in motion in the 3 dimensions of space.[23] Mass bends space extrinsically, yet it is not itself changed by space. The quantity of condensed energy/matter and, the size and shape of the spatial form (**V**) in which it is contained are the two essential elements in the making of mass. Magnitude of the mass (energy-matter content) and its ratio to **V** are significant factors in procreating a specific size and form of space bending and the intensity of the gravitational effects of the field structure formed.

Mass determines extrinsic bending of space ($\boldsymbol{\theta}$) by which the maximum radial lag (**d**) and the width or diameter (**l**) of the sag are formed. The distribution of mass in the considered body and the 3D form of the body determine the maximum space bending ($\boldsymbol{\theta_z}$) or the maximum gravitational potential velocity ($\mathbf{v_z}$) anywhere *on the surface* of the body of mass. In other words depending on these factors the density of gravitational field may or may not vary from one point to another on the surface of the body. If mass is uniformly distributed in a spherical form, the radius and the structural parameters of the field on and over the surface of the body is identical all around, in which case anywhere on the surface of the body may be taken as the point of maximum practical gravitation in the field. Newton bypassed the complication by taking or defining each ponderable body or group of bodies simply as a *mass point* at its (or their) center of gravity.

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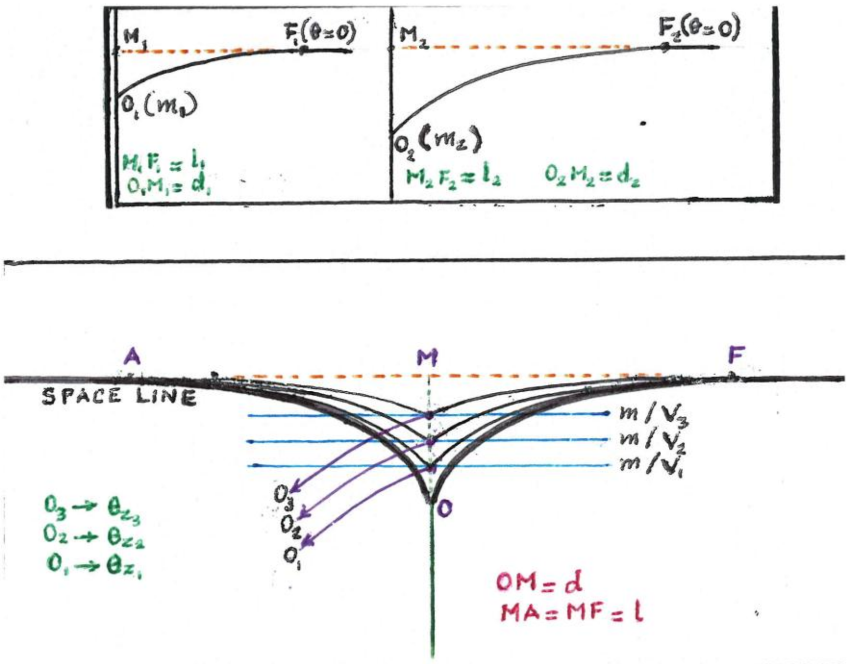
[23] Mass as defined here is assumed to be an exclusive phenomenon of the 3D surface of the universe (space). How exactly 'pure' energy in space starts to condense in the form of matter is a curious and challenging topic of physics.

Assuming a uniform distribution for a body of mass, the same amount of mass in volumes of significantly different sizes, or varying quantities of mass in the same size and form of volume have different effects of extrinsic space bending and gravitation. Theoretical samples of sag formed by different mass quantities and mass/volume of space ratios are shown in 2 dimensions in terms of **l**, **d** and $\boldsymbol{\theta_z}$ in Figure 4 a and b respectively.

There just is not rest for a body or material entity with or without mass in the radial 4th dimension. All bodies as well as space move out one-way in the 4th dimension by the expansion of the universe. Moreover a body or point in space moves at $\mathbf{v_R}$ in the radial 4th dimension unless it is in motion in space[24], in which case it still moves in the 4th dimension but at $\mathbf{v_4}$. A body of mass which is at rest in space cannot move in the 4th dimension (radial) at $\mathbf{v_R}$ without bending space extrinsically further in the form of a sag. A 4D adjustment is made on the space

Figure 4 (a,b)



structure so that the body of mass can move in the radial track of the mainstream motion of the cosmic expansion at $\mathbf{v_R}$. Bodies of mass move at $\mathbf{v_R}$ in the radial 4th dimension only at the

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[24]A uniform spinning of for example a spherical body of mass around an axis through its center is an exception here, because spinning of this sort causes velocity of each point in and on the sphere to be simultaneously cancelled by an equal counter velocity on or in the opposite side. Theoretically, oscillation and spinning of particles at $v_s \cong c$ may also cause complications in this respect.

expense of a radial lag (recession), i.e. in a specific distance **d** behind the apex of the cosmic radius, which in turn is equivalent to a time retardation relative to ***CTF***. The formation of a sag with a specific extrinsic space bending in proportion to the mass it is caused by, can be thought to facilitate the radial motion of the c.g. of the body at $\mathbf{v_R}$ by balancing out the density of matter the mass has, by the lack of space and matter commensurate to the volume of the sag. The sag and the body which causes it are inseparable and they constitute a whole in the space moving at $\mathbf{v_R}$ in the 4th dimension. This is true despite the fact that the motion of a body or space in the 4th dimension inside the sag (between points A-O or F-O in Figure 2) is less than $\mathbf{v_R}$ (see **Section 9**)

If a body of mass moves in the radial 4th dimension at $\mathbf{v_R}$, it means that it is at rest in the 3 dimensions of space. But if it moves in a non-radial direction in the 4th dimension at a $\mathbf{v_4}$ that is less than $\mathbf{v_R}$, than it must be moving also in the 3 dimensions of space. A 3D body of mass can afford to be immobile only relative to the 3 dimensions of space which comprises the expanding surface of the universe.

Mass bends space extrinsically, but so does linear or angular space motion of a body of mass. A body of mass moving in space always bends space more (bigger $\boldsymbol{\theta}$) than it does when it is at rest. If a body of mass is put in motion or if the speed of a moving body is increased, the bending of space for the body will also increase and vice versa. Further bending of space caused by the motion of a body therefore is similar in effect to an increase in the mass of the body. But this is delusive, because what seems like an additional mass which is usually referred to as "the relativistic mass" put on the body by motion is only a temporary phenomenon. It exists as long as the motion lasts at the identical speed. What really changes in motion are the momenta or kinetic energies of the body both in 3D space and in the 4th dimension. The rest mass of a body does not change as the result of being in a gravitational field or in motion. The mass subject to gravitation or to the rest-or-motion state in space is the invariant rest mass. This point and the fact that both mass and motion inevitably bend space is actually the pith of the equivalence principle between gravitational mass and the inertial mass.

5.3. Hypothesis on Gravitation: The 4D sag caused in space by a body of mass is simply the gravitational field of that body. In order to explain gravitation comprehensively we must find out how exactly the topology or gradient of this spatial deformation in the direction of the 4th

dimension define gravitational field intensity, and how such gradient is justifiably translated to gravitational force on the other bodies in this field range.

As a rule already introduced by **GRT,** a material entity with mass bends space and the bent space causes gravitation, But space bending (curvature) is defined to be extrinsic in **CMT**. Bending of space by mass also causes retardation in cosmic time. Material entities with no mass[25]on the other hand do not obey the same rules with respect to gravitation. The elementary concept in understanding gravitation is that an immense cosmic energy or momentum is effective in all radial directions of the universe defined by the constant motion of space points and masses at $\mathbf{v_R}$ (or $\mathbf{v_4}$), as well as the total energy moving radially at $\mathbf{v_R}$ embodied by space and the universe. All material entities in space with or without mass are carried along by this extremely huge momentum. Bodies with mass at rest or in spatial motion however are dragged along only by a lag behind $\mathbf{R_x}$ and ***CTF***, in which case the size of the lag (**d** in Figure 4) depends on the magnitude of the mass per the space volume-form it occupies and its spatial velocity if in motion. All being so we seem to be constantly surfing in our 3D space over an incredibly vast but unseen flow of 'pure' (*non-condensed*) energy in the 4^{th} dimension. Accordingly an individual 3D body with mass ($\mathbf{m_0}$) moves along by cosmic expansion in the radial direction together with the sag it has formed in space at speed $\mathbf{v_R}$, provided that it is neither in a region of bent space (inside another bigger sag) itself nor subjected to some sort of not gravitational force. Thus the momentum ($\boldsymbol{\rho_0}$) of such a body in the radial direction is $\mathbf{m_0 v_R}$.

But if a body $\mathbf{m_1}$ is in a bent region of space, then the direction of the 4^{th} dimension which must always be at 90^0 to the tangent of any point in the bent space is no longer coincident with the radial direction. In this case the body keeps moving out in the 4^{th} dimension which diverges from the radial direction by an angle $\boldsymbol{\theta}$ as already indicated in Figure 2. The radial velocity vector $\mathbf{v_R}$ of the local space points and the body is trimmed down to $\mathbf{v_4}$ by this deflection to reflect a relative decrease of expansion velocity in the 4^{th} dimension at a rate

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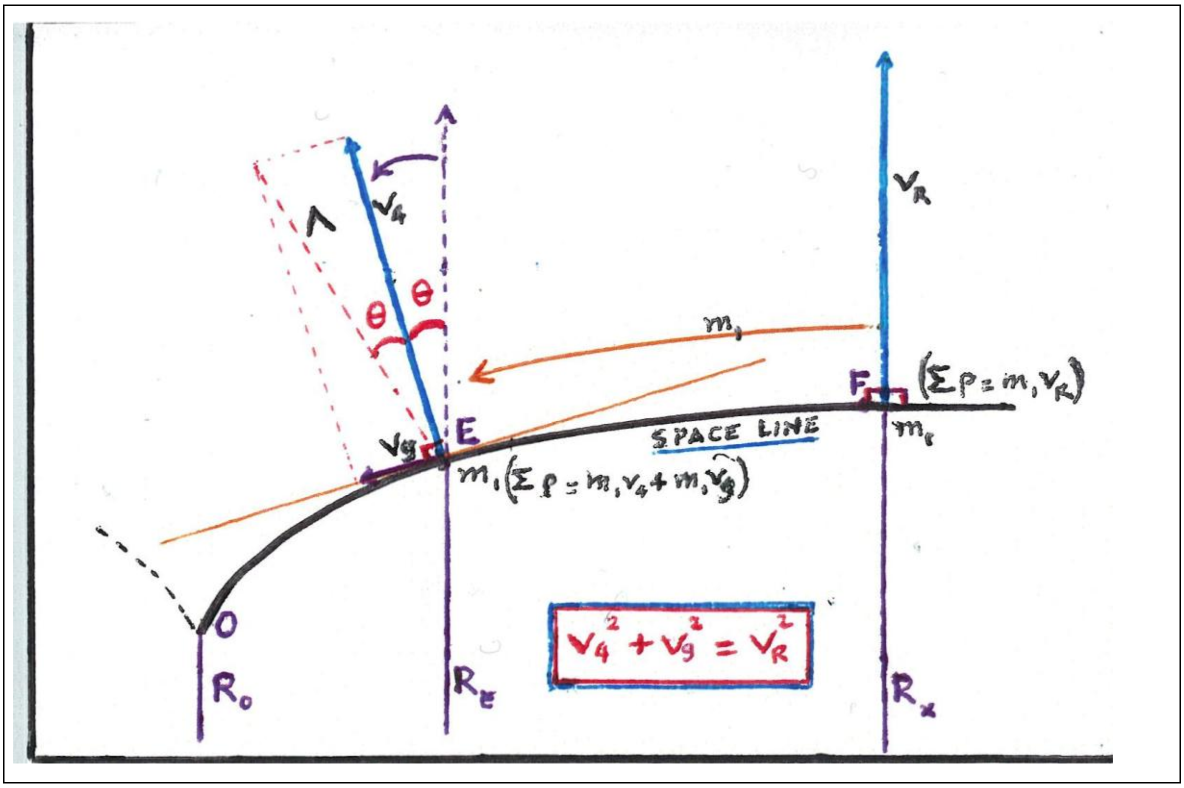
[25] Particles with or without mass not responsive to E-M fields (devoid of electrical charges) for instance would neither be apparently affected by gravitation if they are under the impact of short ranged nuclear forces, whereas electrically or magnetically charged particles with or without mass too are unaffected by gravitation if they are in the range of an E-M field or nuclear forces simply because gravitational effect is out-weighed by stronger nuclear or E-M forces. On the other hand E-M waves or particles with no rest mass which move at speeds close or equal to ***c*** (in vacuum) do not cause any bending in space. Yet they themselves are affected by the space bending of normal gravitational forces as explained in **Section 8** on **Gravitational Field Effects on Moving Bodies of Mass and E-M Waves.**

depending on the magnitude of **θ**, which is bound to be interpreted as a slow-down in the time-flow for $\mathbf{m_1}$ at the relevant point in space as this time-lag will inevitably show in time measuring devices (see also **Section 9** on **Velocity in the 4th Dimension and Time Reconsidered**).

However since there is no reason why the conservation of momentum law of thermodynamics is not equally valid under these conditions, the new velocity of the body in the 4th dimension now poses a problem**:** the momentum of the body is less than the maximum radial momentum ($\mathbf{m_1v_4} < \mathbf{m_1v_R}$). The body does not possibly encounter any material/physical resistance to cause a loss or dissipation of its energy as heat or radiation, and no part of its momentum can be trensferred in collision with a body outside the universe. Consequently the difference or loss of momentum/energy of the body needs somehow to be accounted for. The answer to this discrepancy of momentum also happens to be the crux of the basic hypothesis of **CMT** on gravitation presented here.

Inside a sag where space is extrinsically bent, the velocity vector ($\mathbf{v_R}$) of the body is deflected and consequently broken down into two components, a vector pointing out in the direction of

Figure 5



the 4th dimension ($\mathbf{v_4}$) which no longer coincides with the radial direction, and another potential vector tangent to the point of space where the body is, pointing **always in the direction of bending** of space ($\mathbf{v_g}$) (Figure 5). Therefore the momentum of the body in the 4th dimension ($\boldsymbol{\rho_4}$) now is $\mathbf{m_1v_4}$, and its momentum in 3D space ($\boldsymbol{\rho_g}$) is $\mathbf{m_1v_g}$.

It is important to keep in mind that these momenta are vector components of the original total momentum of the body and the relationships among $\mathbf{v_R}$, $\mathbf{v_4}$ and $\mathbf{v_g}$ can be calculated by trigonometry in terms of the angle $\boldsymbol{\theta}$ or by the Phythagoras' Law. Based on the fact that $\mathbf{v_4}$ is always at right angle to $\mathbf{v_g}$:

$$\sin\theta = v_g \div v_R$$

and: $$\cos\theta = v_4 \div v_R$$

Multiplying equations by $\mathbf{m_1}$:

$$\rho_g = m_1v_g = m_1v_R\sin\theta$$

and: $$\rho_4 = m_1v_4 = m_1v_R\cos\theta$$

Phythagoras' Law which is also valid in 4D geometry can be used to indicate that the sum of the squares of the two vector components is equal to the square of $\mathbf{v_R}$:

$$v_g^2 + v_4^2 = v_R^2$$

Total momentum of $\mathbf{m_1}$ is:

$$\Sigma\rho = m_1v_R = m_1\sqrt{(v_g^2 + v_4^2)}$$

Hence it follows that the missing part of momentum or energy for $\mathbf{m_1}$ is actually compensated by a potential vector of velocity[26] added in space inside the sag. A small part of the cosmic momentum is locally held back inside the sag, which in turn causes an equivalent field tension in the form of a potential momentum or energy to move $\mathbf{m_1}$ in space at $\mathbf{v_g}$.

$$\Delta\Sigma\rho = m_1\sqrt{(v_R^2 - v_4^2)} = m_1v_g = \rho_g$$

In general what all this means is that the origin or source of all motions, as well as all matter and energy in the 3 dimensions of space is the mainstream of motion (at $\mathbf{v_R}$) in the 4th dimension. The two components of $\mathbf{v_R}$, namely $\mathbf{v_g}$ in the 3 dimensions of space and the $\mathbf{v_4}$ in the 4th dimension are connected like two sides of one coin. They define each other.

5.3.1. Topology of Space inside the Sag: The rate of extrinsic bending of space is measured by the magnitude of $\boldsymbol{\theta}$. Greater the magnitude of $\boldsymbol{\theta}$, the more bent is the space. Since:

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[26] The velocity component emerging in space is referred to as being potential in the sense that it is there in the making of an acceleration function effective on a body of mass ($\mathbf{m_1}$) whenever that body is actually inside the field of gravitation where the space is bent.

$$\mathbf{\sin\theta = v_g \div v_R}$$

$$\textit{and}\quad \mathbf{\cos\theta = v_4 \div v_R}$$

it follows that as the magnitude of $\boldsymbol{\theta}$ gets bigger, $\mathbf{v_g}$ also gets bigger while $\mathbf{v_4}$ gets smaller. The potential velocity vector in space ($\mathbf{v_g}$) increases gradually starting from a limit of zero at the points on the surface of the largest sphere of the gravitatiational field or sag (points farthest to the c.g. of the $\mathbf{m_0}$), to its highest magnitude at the points of contact with or on the surface of $\mathbf{m_0}$. In progression from point F to O (or correspondingly from A to O) in Figure 2, $\mathbf{v_4}$ which is equal to $\mathbf{v_R}$ at the start is scaled down to a minimum level in a certain functional pattern, while $\mathbf{v_g}$ in space gets bigger in a way inversely proportional to $\mathbf{v_4}$**.**

The topology of space in the sag from the very beginning of the spatial bending (points A and F in Figure 2) down to its most retarded bottom point in the 4th dimension where the body **(**$\mathbf{m_0}$**)** sits (point O in Figure 2) is very specific in defining the gravitational field and its intensity for that body. The magnitudes and variation pattern of the gravitational acceleration peculiar to any object with mass is described by the 4D gradient against the distance of space from point O of the sag it forms in space.

5.3.2. An Attempt to Derive a Simple 2D Curve for Gravitational Field: The 2D cross sectional line representing the bent space caused by $\mathbf{m_0}$ actually is the shortest path an object ($\mathbf{m_1}$) will follow in a 'freefall' in vacuum from rest state at the zero point of the field/sag (point A or F in Figure 2) until reaching $\mathbf{m_0}$ (point O), all other interfering factors ignored. $\boldsymbol{\theta}$ is a function of $\mathbf{m_0}$ which determines the ultimate shape and size of the sag formed, and the distance **s** from the c.g. or surface of $\mathbf{m_0}$. Any instantaneous $\mathbf{v_g}$ on the bending line of space (A-B-C-O or F-E-D-O in Figure 2) on the other hand is equal to $\mathbf{v_R \sin\theta}$**.** Therefore $\mathbf{v_g}$ is determined by $\mathbf{m_0}$, **s** and the constant $\mathbf{v_R}$. It is important that the magnitudes of all instanteneous $\mathbf{v_g}$ and $\mathbf{v_4}$ defined as such on this curve are the maximum vector parameters of a a body $\mathbf{m_1}$ which moves strictly in freefall starting from rest at the point where the extrinsic bending of space just begins.

We already know by experience that a body $\mathbf{m_1}$ is affected by the gravitational field of $\mathbf{m_0}$ such that as the distance between $\mathbf{m_1}$ and the c.g. of $\mathbf{m_0}$ decreases, not only $\mathbf{v_g}$, but also the acceleration (**g**) of $\mathbf{m_1}$ increases. It is therefore evident that the gravitational force grows bigger toward the c.g. of $\mathbf{m_0}$. The 2D bent space line of the gravitational sag reflecting a gradient of potential velocities continuum in space (A to O or F to O in Figure 2) therefore reminds at first glance a segment of a parabolic curvilinear form. But if we choose the gravitational field effect to become zero at some maximum distance from the c.g. of $\mathbf{m_0}$, then (∂**y**$\div\partial$**x**) or **tan θ** should be zero at that distance and beyond for a function compliant with the bent space line of the field. This is not possible in the case of a parabolic or a hyperbolic function. Instead, a 2D cross sectional view of the sag in curvilinear form is much better described by the appropriate segments of normally an ellipse of high eccentricity[27]**:**

$$(x-h)^2 \div \alpha^2 + y^2 \div \beta^2 = 1 \qquad \textit{where } 0 \le x \le h \ (y \ge 0) \quad \textit{and } \alpha >> \beta$$

Focusing primarily on the elliptic arc in the upper right quadrant of the **x-y** axes (positive **x** and **y** parameters) as the curve representing the right wing of the sag depicted in Figure 2:

$$y(x)^2 = \beta^2 [1 - (x-h)^2 \div \alpha^2]$$

$$\textit{and} \qquad y(x) = \beta\sqrt{[1 - (x-h)^2 \div \alpha^2]}$$

In the equations above α and β determine the size and eccentricity of the ellipse, whereas **h** (equal to ½ of **l** in Figure 4) determines the maximum effective **θ** of the curve (θ_z**).** Of course it is the mass and its volume of space which determine α and β and **h** in the first place. In this course we may make the following assumptions in connection with the elliptic equation above:

$$\beta_i \div \alpha_i = \Omega \qquad \textit{where } \Omega \textit{ is a constant valid always for all bodies of mass}$$

$$\textit{and} \quad h_i \div \alpha_i = \Psi_i m_i \qquad \textit{where } \Psi \textit{ is constant for specific bodies of mass } (m_i) \textit{ only}$$

The curve best fit for the 2D view of the gravitational field line (**O-F** in Figure 2) in space is shown in Figure 6 by two partially overlapped identical ellipses. The effective curve for the space line of the gravitational field is represented by the relevant segment in the upper right quadrant of the ellipse at right (the effective curve for the reciprocal left handside space line may also be indicated as the relevant segment in the ellipse at left). Sinus of θ_z at point **O** in Figure 6 is defined here as $\mathbf{v_z}$ which is the final maximum $\mathbf{v_g}$ in the freefall of an object across the gravitational field of $\mathbf{m_0}$ from zero gravitational level until the surface of $\mathbf{m_0}$[28].

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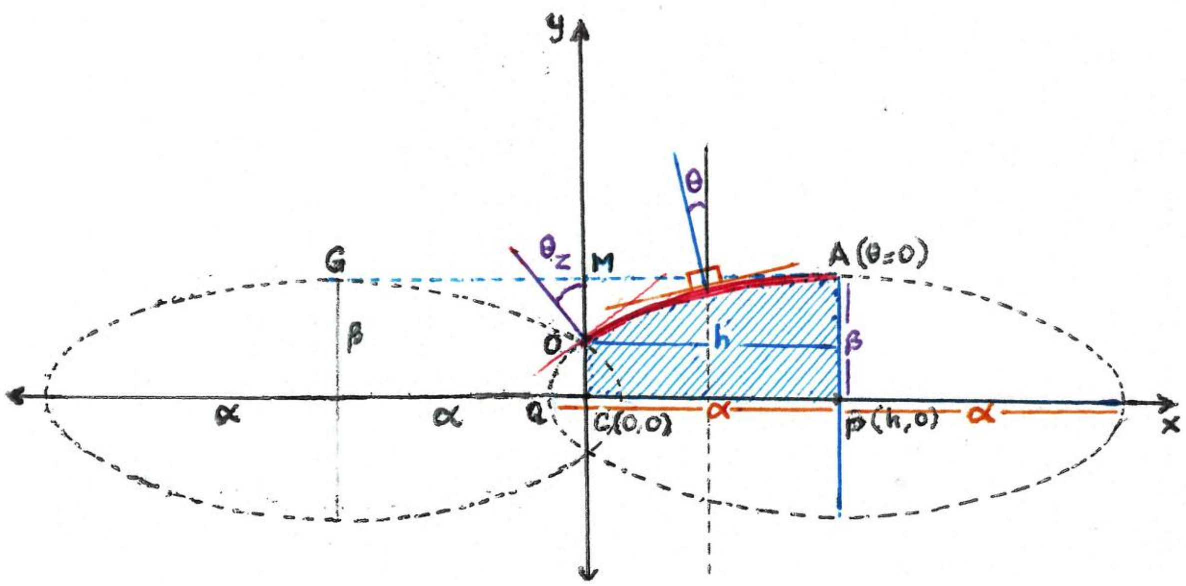
[27]The ellipse considered is very flat, because normally the masses in space, including the stars that are much bigger than our sun do not bend space very largely, unless the escape velocity from the body is a significant percent of the speed of light (***c***)
[28] The 2D gravitational field curve y(x) is the integration of the points $\mathbf{x_i}$ from **zero** to **h** along the y-axis which represents the radial 4th dimension. 3D and 4D curves may also be derived from this curve. In the derivation of a 3D curve, points of $\mathbf{x_i}$ of the 2D curve that have their specific $\mathbf{v_g}$ or $\mathbf{v_4}$ or **θ** form circles of $\mathbf{x^2 + y^2 = R^2}$ where **R** takes the values of $\mathbf{x_i}$ and the function of the circles is integrated along an additional **z**-axis to represent the 4th dimension at 90^0 to x-y plane. In the case of a 4D curve, points of $\mathbf{x_i}$ of the 2D curve form spheres of $\mathbf{x^2 + y^2 + z^2 = R^2}$ where again **R** takes the values of $\mathbf{x_i}$ and the function of spheres is integrated along an additional **w**-axis at 90^0 to x,y and z. Integration range of $\mathbf{R(x_i)}$ in both cases are from **0** to **h**.

Figure 6



The area outlined by the points G-M-A-O on the two ellipses above is identical to the 2D dimensional sag described in Figure 2. Here it is focused on the upper right quadrant of the ellipse at right where the bent space line is shown as the segment of the ellipse in red. α is the total distance between **Q** and **P**. β which is the maximum reading of **y** is equal to P-A. θ is zero at A. It reaches at its maximum level θ_z at O. Based on parameters of α, $\beta$and **h** the size and eccentricity of the ellipse may differ depending on the magnitude of mass. Or v_z at point O may differ in proportion to **h** depending on the space-volume occupied by the mass which is derived in the graph above by shifting the ellipse to the right or left on the x-axis. If th**e** ellipse is shifted to the right (shifting P away from C) the maximum space bending θ_z or v_z is bigger and vice vensa. Note that if the reciprocal left wing of the field (upper left quadrant of the ellipse at left) were to be focused on, then x, α and h would take minus values and the relevant curve segment would be G-O $[(-x+h)^2 \div(-\alpha)^2 + y^2\div\beta^2 = 1$ *where* $y \geq 0,\ 0 \geq x \geq (-h)$ *and* $\alpha^2 >> \beta^2]$

5.3.2.1. Gravitational Velocities in Space and in the 4th Dimension: From the basic equation **y(x)**, we may now proceed to find v_4 and v_g as follows:

Since **y(x)** is given as:

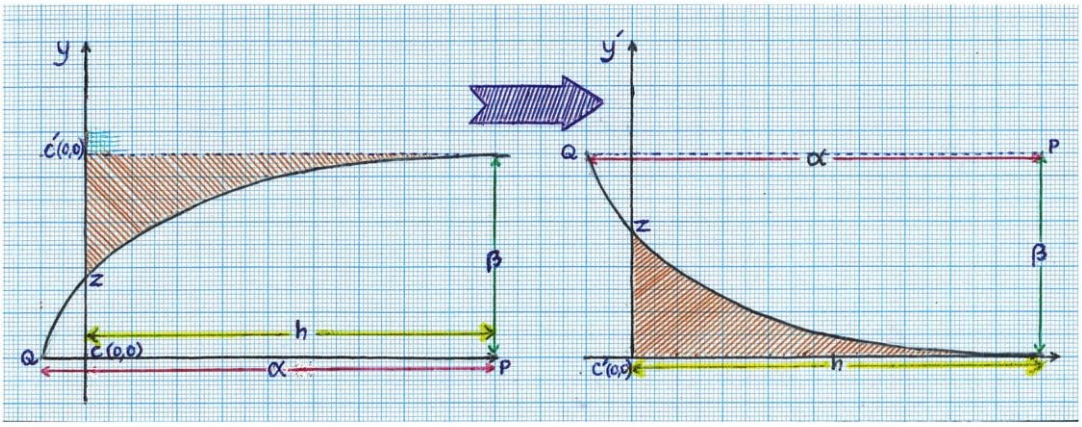
$$y(x) = \beta\sqrt{[1 - (x-h)^2\div\alpha^2]}$$

let **y'(x)** be: $\quad y'(x) = \beta - y(x)$ (*the graph of y and y' are shown in* ***Figure 7***)

and:

$$y(x)\div\beta = v_4(x)\div v_R = \cos\theta(x)$$

Figure 7



therefore:

$$\mathbf{v_4(x)^2 = v_R^2\ y(x)^2 \div \beta^2}$$

$$\mathbf{v_4(x)^2 = v_R^2\beta^2\ [1 - (x-h)^2 \div \alpha^2] \div \beta^2 = v_R^2\ [1 - (x-h)^2 \div \alpha^2]}$$

$$\mathbf{v_4(x) = v_R\sqrt{[1 - (x-h)^2 \div \alpha^2]}}$$

and $$\mathbf{v_g(x)^2 = v_R^2\ y'(x)^2 \div \beta^2}$$

$$\mathbf{v_g(x)^2 = v_R^2\beta^2(x-h)^2 \div \alpha^2 \div \beta^2 = v_R^2(x-h)^2 \div \alpha^2}$$

$$\mathbf{v_g(x) = -\ v_R(x-h) \div \alpha}$$

Using the equations for **Ω** and **Ψ**:

$$\mathbf{v_4(x)^2 = v_R^2\ [1 - \Omega^2(x-h)^2 \div \beta^2]}$$

$$\mathbf{v_4(x) = v_R \sqrt{[1 - \Omega^2(x-h)^2 \div \beta^2]}}$$

and $$\mathbf{v_g(x)^2 = v_R^2\Psi^2 m^2(x \div h - 1)^2}$$

$$\mathbf{v_g(x) = v_R\Psi m(x \div h - 1) = (v_R\Psi m x \div h) - (v_R\Psi m)}$$

The magnitues of $\mathbf{v_g}$ and $\mathbf{v_4}$ in the cases when **x** is equal to **h** and **0** are as follows:

● *When* ***x = h*** *[Point* ***A(h, β)*** *in Fig. 6]:*

θ = 0, y = β, and **sin θ = 0**, **cosθ = 1**

$$\mathbf{v_4(x)\ =\ v_R\ \cos\theta(x) = v_R}$$

or $$\mathbf{v_4(x)\ =\ v_R\sqrt{[1 - (x-h)^2 \div \alpha^2]} = v_R \sqrt{[1 - \Omega^2(x-h)^2 \div \beta^2]}}$$

$$\mathbf{v_4(x)\ =\ v_R\sqrt{[1 - (h-h)^2 \div \alpha^2]} = v_R \sqrt{[1 - \Omega^2(h-h)^2 \div \beta^2]}}$$

$\therefore\quad \mathbf{v_4(x) = v_R}$

and $\mathbf{v_g(x) = v_R \sin \theta(x) = 0}$

or $\mathbf{v_g(x) = v_R (x\text{-}h)\div\alpha = v_R\Psi m(x\div h - 1)}$

$\mathbf{v_g(x) = v_R (h\text{-}h)\div\alpha = v_R\Psi m(h\div h - 1)}$

$\therefore\quad \mathbf{v_g(x) = 0}$

● *When* ***x = 0*** *[Point* ***O(0,C-O)*** *in Fig. 6]:*

$\boldsymbol{\theta = \theta_z}$

$\mathbf{v_4(x) = v_R \cos \theta_z(x)}$

or $\mathbf{v_4(x) = v_R\sqrt{[1 - (x\text{-}h)^2\div\alpha^2\,]} = v_R \sqrt{[1 - \Omega^2(x\text{-}h)^2\div\beta^2]}}$

$\therefore\quad \mathbf{v_4(x) = v_R\sqrt{[1+h^2\div\alpha^2]} = v_R \sqrt{[1 - \Omega^2 h^2\div\beta^2]}}$

and $\mathbf{v_g(x) = v_R.\sin \theta_z(x)}$

or $\mathbf{v_g(x) = v_R (x\text{-}h)\div\alpha = v_R\Psi m(x\div h - 1)}$

$\therefore\quad \mathbf{v_g(x) = v_z = -v_R\, h\div\alpha = -v_R\Psi m}$

Now instead of **x** the $\mathbf{v_g}$ curve may be defined as a function of **s** which is the integral length of the curve itself at any point on the $\mathbf{v_4}$ or $\mathbf{v_g}$ curve:

since $\mathbf{\partial s^2 = \partial x^2 + \partial y'^2}$

$\mathbf{\partial s^2 \div\partial x^2 = 1 + \partial y'^2 \div\partial x^2}$

$\therefore\quad \mathbf{s(x) = \int \sqrt{(1 + dy'^2\div dx^2)}\,.\,dx}$ *(integrated from* ***x=0*** *to* x_i*)*

but $\mathbf{y'(x) = \beta(x\text{-}h)\div\alpha}$

and $\mathbf{dy'\div dx = \beta\div\alpha = \Omega}$

$\mathbf{dy'^2\div dx^2 = \Omega^2}$

$\mathbf{s(x) = \int \sqrt{[1 + \Omega^2]}\,.\,dx = x_i \sqrt{[1 + \Omega^2]}}$

$\therefore\quad \mathbf{x = s \div\sqrt{[1 + \Omega^2]}}$

Accordingly the $\mathbf{v_g(s)}$ curve is:

$\mathbf{v_g(x) = v_R\Psi m(x\div h - 1)}$

or $\mathbf{v_g(x) = v_R\Psi mx\div h - v_R\Psi m}$

$\mathbf{v_g(s) = v_R\Psi ms\div h\sqrt{(1 + \Omega^2)} - v_R\Psi m}$

or $\mathbf{v_g(s) = v_R\Psi m[s\div h\sqrt{(1 + \Omega^2)} - 1]}$

and of course when **s=0**, then:

$$v_g(s) = v_z = -v_R\Psi m$$

5.3.2.2. Acceleration and Force Caused by a Gravitational Field on a Body of Mass: The potential space velocities (**v_g**) effective in continuity throughout **S_0** which is the maximum gravitational distance of **m_0** represented by A-O or O-F in two dimensional cross-sectional view of the field, cause the emergence of **F_g** on all bodies of mass in the gravitational field of **m_0**. But gravitational acceleration **g** is not uniform across the field of gravitation; it increases like **v_g** as the distance (**s**) gets smaller between the c.g.s of the two bodies of mass in gravitational interaction. Since variable **t** is missed in **$v_g(s)$**, **g(s)** can be found by using the chain rule [$g = (\partial v_g \div \partial s)(\partial s \div \partial t)$]:

$$g_i(s) = (\partial v_g \div \partial s)\, v_g(s) = v_R^2\Psi_i^2 m_i^2 s \div h_i^2(1 + \Omega^2) - v_R^2\Psi_i^2 m_i^2 \div h_i\sqrt{(1 + \Omega^2)}$$

Acceleration functions of **m_0** and **m_1** fields are:

$$g_0(s) = (\partial v_g \div \partial s)\, v_g(s) = v_R^2\Psi_0^2 m_0^2 s \div h_0^2(1 + \Omega^2) - v_R^2\Psi_0^2 m_0^2 \div h_0\sqrt{(1 + \Omega^2)}$$

$$g_1(s) = (\partial v_g \div \partial s)\, v_g(s) = v_R^2\Psi_1^2 m_1^2 s \div h_1^2(1 + \Omega^2) - v_R^2\Psi_1^2 m_1^2 \div h_1\sqrt{(1 + \Omega^2)}$$

The gravitational force on **m_1** in the field of **m_0** (where **$m_1<m_0$**) is**:**

$$F_{g1}(s) = m_1 g_0 = m_1[v_R^2\Psi_0^2 m_0^2 s \div h_0^2(1 + \Omega^2) - v_R^2\Psi_0^2 m_0^2 \div h_0\sqrt{(1 + \Omega^2)}]$$ *($F_{g1}(x)$: gravitational force in **s** on **m_1** in the field of **m_0**)*[29]

The gradient of the **F_g** curve above show that **F_g** is not uniform (**$\partial F_g \div \partial s > 0$**). In general when **x** or **$s \div \sqrt{[1 + \Omega^2]}$** gets smaller in relation to **h, F_g** gets increased and vice versa.

It is worthwhile to point out again that the gravitational **v_g** as defined above is a potential velocity vector and a component of **v_R** which is constant. The gravitational **v_g** being equal to **$v_R \sin\theta$** indicates the maximum instantaneous parameters of **v_g** all along the 2D line (**A-O** or **O-F** in Figure 2) of the field strictly in freefall from rest at the point where space bending just starts (**A** or **F** in Figure 2). Thus, the gravitational acceleration and force on **m_1** in freefall from rest are found or derived directly from the potential velocity vector **v_g** which is invariant at all points across the field (**A-O** or **O-F** in Fig. 2).

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[29]In the notation used on Newtonian Gravity, the gravitational force on **m_1** in the field of **m_0** was defined as **m_1g_1**. But since we know that **g** is specific solely to the **m_0** field the same force is now denoted as **m_1g_0**

5.3.2.3. Total Gravitational Force between Two Bodies of Mass: As explained in the previous section the 3D space bent around a mass is a gravitational field that carries a gradient of potential velocities which integrally manifest an acceleration on an increasing scale toward the c.g. of that mass. Therefore a body of mass like $\mathbf{m_1}$ in the field of a body of mass like $\mathbf{m_0}$ becomes subject to an increasing force, namely the force of gravity in the said direction.. But what is explained so far concerning the velocity and acceleration experienced by a body of mass in the gravitational field of another body of mass is only a part of the story. The other part of the story is that $\mathbf{m_1}$ affected by the gravitational field of $\mathbf{m_0}$ too has its own gravitational field which exerts a certain gravitational force through a distance on $\mathbf{m_0}$ in return.

The total gravitational force between two bodies of mass is not thoroughly mutual unless the bodies are identical. Theoretically the total force of gravity between the two bodies is thesum of the force of gravity on $\mathbf{m_1}$ ($\mathbf{F_{g1}}$) in the field of $\mathbf{m_0}$, and the force of gravity on $\mathbf{m_0}$ ($\mathbf{F_{g0}}$) in the field of $\mathbf{m_1}$.

The maximum displacement (**x**) or distance (**s**) of gravity for $\mathbf{m_0}$ is:

$$\mathbf{S_0(x) = h_0}$$

$$\textit{or} \quad \mathbf{S_0(s) = h_0\sqrt{[1 + \Omega^2]}}$$

and the maximum displacement or distance of gravity for $\mathbf{m_1}$ is:

$$\mathbf{S_1(x) = h_1}$$

$$\textit{or} \quad \mathbf{S_1(s) = h_1\sqrt{[1 + \Omega^2]}}$$

The following relationship between $\mathbf{S_0}$ and $\mathbf{S_1}$ is always valid provided that $\mathbf{m_1}$ is defined to be the smaller body when $\mathbf{m_0}$ and $\mathbf{m_1}$ are unequal ($\alpha_0 > \alpha_1$ and $\beta_0 > \beta_1$)**:**

$$\mathbf{S_1 \leq S_0}$$

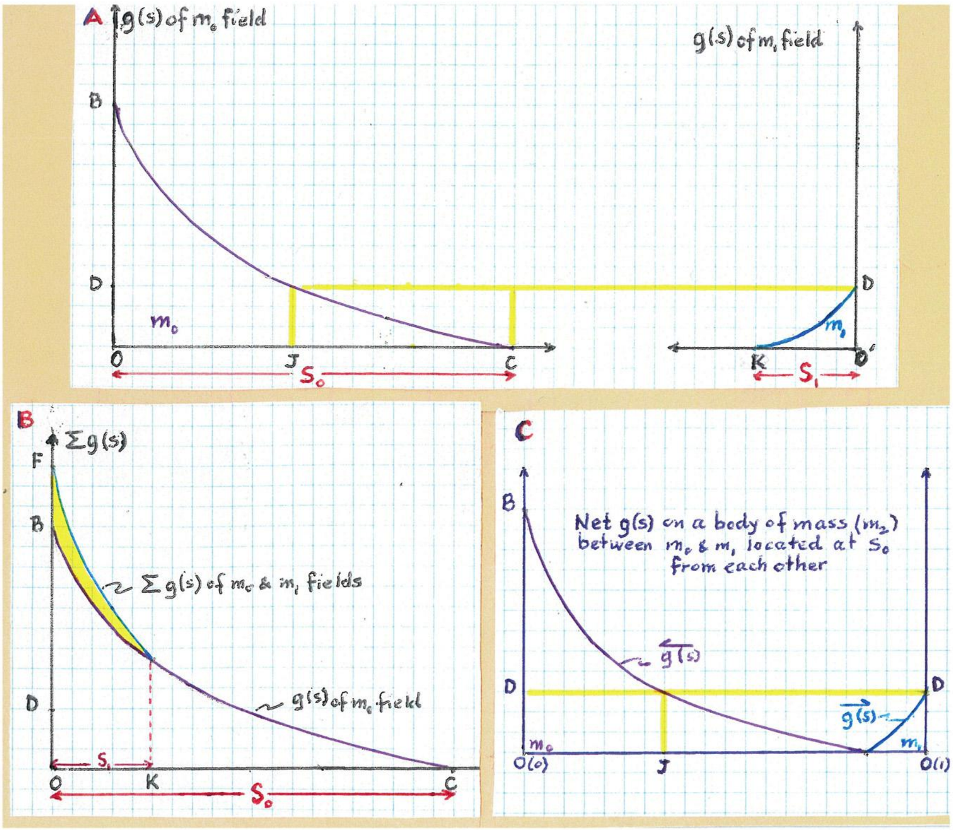
Consequently the total distance of gravitational interaction between the two bodies is always $\mathbf{S_0}$. The force of gravity between $\mathbf{m_0}$ and $\mathbf{m_1}$ beyond $\mathbf{S_0}$ is zero. The gravitational force by $\mathbf{m_1}$ on $\mathbf{m_0}$ takes effect only in the range from the surface of $\mathbf{m_0}$ to a maximum of $\mathbf{S_1}$, where total combined force is mutual.

Smaller bodies of mass too exert a gravitational effect on the bigger bodies of mass even if on a limited scale. Where $\mathbf{S_1}$ and $\mathbf{S_0}$ overlap, force vectors of opposite directions are added to find the total force of gravity between two bodies of mass. In fact the space bending angles of $\mathbf{m_0}$

and $\mathbf{m_1}$ facing each other are always in opposite directions throughout $\mathbf{S_0}$. In fact this is what causes mutuality in the gravitational interaction between $\mathbf{m_0}$ and $\mathbf{m_1}$. Therefore no matter how unequal $\mathbf{m_0}$ and $\mathbf{m_1}$ are, addition of their gravitational forces holds as long as the body of bigger mass is also in the field of the body of smaller mass.

The gravitational acceleration between $\mathbf{m_0}$ and $\mathbf{m_1}$, is shown by means of graphical illustration in Figure 8 where gravitational accelerations caused by the fields of $\mathbf{m_0}$ and $\mathbf{m_1}$ shown in Figure 8A are added to reach the total combined gravitational acceleration [$\mathbf{\Sigma g(s)}$] of the two bodies in interaction in Figure 8B. The net gravitational acceleration between $\mathbf{m_0}$ and $\mathbf{m_1}$ produced in respect to a third body of mass $\mathbf{m_2}$ by the overlapment of $\mathbf{g_0}$ and $\mathbf{g_1}$ in $\mathbf{S_0}$ is shown in Figure 8C where $\mathbf{g_0}$ and $\mathbf{g_1}$ vectors are subtracted in contrast to the $\mathbf{\Sigma g(s)}$ between $\mathbf{m_0}$ and $\mathbf{m_1}$.

Figure 8 A, B & C



Total force of gravity $\mathbf{F_g(s)}$ between $\mathbf{m_0}$ and $\mathbf{m_1}$ is:

$$\mathbf{F_g(s)=m_1v_R{}^2[\Psi_0{}^2m_0{}^2s\div h_0{}^2(1+\Omega^2)-\Psi_0{}^2m_0{}^2\div h_0\surd(1+\Omega^2)]+m_0v_R{}^2[\Psi_1{}^2m_1{}^2s\div h_1{}^2(1+\Omega^2)\ \Psi_1{}^2m_1{}^2\div h_1\surd(1+\Omega^2)]}$$

or:

$$\mathbf{F_g(s) = m_1v_R{}^2\Psi_0{}^2m_0{}^2\div h_0\surd(1+\Omega^2)\ [s\div h_0\surd(1+\Omega^2) -1]\ +\ m_0v_R{}^2\Psi_1{}^2m_1{}^2\div h_1\surd(1+\Omega^2)\ [s\div h_1\surd(1+\Omega^2) -1]}$$

$\mathbf{F_{g0}}$ and $\mathbf{F_{g1}}$ are congruently defined as:

$$\mathbf{F_{g0} = F_g - F_{g1}}$$

$$\textit{and}\quad \mathbf{F_{g1} = F_g - F_{g0}}$$

In case $\mathbf{m_0}$ and $\mathbf{m_1}$ are totally identical: $\mathbf{F_g = 2F_{g0} = 2F_{g1}}$

Inverse square law reflects primarily the weakening of a 3D radiational effect in spherical surface areas receding by distance **r** from a point source. Newton established his equation of gravitation based on this principle like Coulomb's Law. But we must keep in mind that when $\mathbf{m_0 > m_1}$ the total gravitational force on $\mathbf{m_1}$ is effective throughout $\mathbf{S_0}$, whereas there is no gravitational force on $\mathbf{m_0}$ between $\mathbf{S_0}$ and $\mathbf{S_1}$. In Newton's Equation for mutual gravitational force the parameters like $\boldsymbol{\alpha}$, $\boldsymbol{\beta}$, $\mathbf{v_R}$, $\boldsymbol{\theta}$ and/or $\boldsymbol{\Omega}$ and $\boldsymbol{\Psi}$ are to an extent implied in the universal constant **G** while maximum distances of gravity (**h** or **S**) for the relevant bodies of mass is totally missing.

5.3.2.4. Freefall not Starting from Zero Gravitation: Under condition $\mathbf{m_0 > m_1}$, at any point $\mathbf{s_i}$ in the field of $\mathbf{m_0}$, $\mathbf{m_1}$ may be held stationary by a force just equal to $\mathbf{F_{g1}}$. This is like making a car moving at an accelerating speed stop by an external counter force which is equal to:

-F = (**mass of the car**) x (**instantaneous acceleration of the car**)

When $\mathbf{m_1}$ is held stationary by an external counter force however, $\mathbf{v_4}$ of $\mathbf{m_1}$ is restored to $\mathbf{v_R}$ despite the fact that it is still behind ***CTF.*** The time lag then as previously stated is determined by the radial distance between $\mathbf{m_1}$ and $\mathbf{R_x}$. $\mathbf{v_4}$ is elevated to $\mathbf{v_R}$ because the counter force that interrupts the gravitational motion of $\mathbf{m_1}$ eliminates the space bending ($\boldsymbol{\theta}$ becomes zero) whereby the 4th dimension for $\mathbf{m_1}$ is brought back to coincide with the radial direction.

If a body of mass ($\mathbf{m_1}$) is let fall freely from rest at some intermediate point $\mathbf{s_i}$ inside the gravitational field of $\mathbf{m_0}$, it moves toward $\mathbf{m_0}$ by $\mathbf{F_{g1}}$. The initial $\mathbf{F_{g1}}$ at $\mathbf{s_i}$ is certainly bigger than zero and it subsequently increases as in the equation derived in **Section 5.3.2.3**. What happens in this case is not any different than a stationary object put in motion by an initial force equal to $\mathbf{F_{g1}}$ at $\mathbf{s_i}$ that is subject to further increase.

6. INERTIA AND 3+1D KINETICS

Inertia has been one of the major mysteries in physics. Yet it may be understood to satisfaction as another manifestation of the same principle which underlies gravitation, and together with Newton's First Law of Motion (**F = ma**) it can be explained in the scope of **CMT**.

The heart of the hypothesis concerning gravitation above was that the extrinsic bending of space by a mass ($\mathbf{m_0}$) causes a field around that mass, wherein any other object with mass ($\mathbf{m_1}$) would move slower (from $\mathbf{v_R}$ to some $\mathbf{v_4}$) in the 4th dimension which diverges from the radial direction of the universe by a deflection angle $\boldsymbol{\theta}$. **The slow-down of $\mathbf{v_R}$ in the gravitational field is compensated by an emergent continuum of potential velocity vectors ($\mathbf{v_g}$) in 3D space which causes gravitational force.** It should also be kept in mind that both $\mathbf{v_4}$ and $\mathbf{v_g}$ are components of the original $\mathbf{v_R}$. The net resultant vector of $\mathbf{v_4}$ and $\mathbf{v_g}$ in 4 dimensions is now a new vector in direction which is different than the original radial 4th dimensional direction of $\mathbf{v_R}$. The new resultant vector of $\mathbf{v_g}$ and $\mathbf{v_4}$ components denoted here as $\boldsymbol{\Lambda}$ is virtual and has the same speed with $\mathbf{v_R}$, but points to a totally different direction. In the preceding section where the main concern was gravitation, what really mattered were $\mathbf{v_4}$**,** and $\mathbf{v_g}$ in the emergent field of gravitation, and there was no particular need to recount $\boldsymbol{\Lambda}$.[30] Nevertheless it is important to see that any object with mass which is subject to gravitation or in motion in space is bound to follow a virtual 3+1D trajectory defined by the direction of $\boldsymbol{\Lambda}$**.** This point relates to 4D kinetics of matter in the universe which is instrumental in shedding light on the issues in physics not understood well enough in terms of the 3D kinetics.

In reference to 3+1D kinetics a body of mass in space may have the following single or simultaneous multi-dimensional motion states ($\mathbf{v_s}$ defined as velocity in space):

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[30]Although the sum of the squares of $\mathbf{v_4}$ and $\mathbf{v_g}$ in the case of gravitation is equal to the square of the speed of $\boldsymbol{\Lambda}$ it is directionally different than $\mathbf{v_R}$

1) 0_s + 1_4 D motion: ($\mathbf{v_s} = \mathbf{0}$) + $\mathbf{v_R}$
2) 1_s + 1_4 D motion: ($\mathbf{v_s} = \mathbf{x/t}$) + $\mathbf{v_4}$
3) 2_s + 1_4 D motion: ($\mathbf{v_s} = \mathbf{x/t} + \mathbf{y/t}$) + $\mathbf{v_4}$
4) 3_s + 1_4 D motion: ($\mathbf{v_s} = \mathbf{x/t} + \mathbf{y/t+z/t}$) + $\mathbf{v_4}$

In the kinetic combinations above, the spatial motions which are possible in 3 dimensions (**x,y,z**) of the body are shown by a subnotation of **s** and the motion in the single 4th dimension is shown by a subnotation of **4**. Examples of 3+1D motions shown above would be:

1) A body ($\mathbf{m_0}$) not moving (at rest) in space
2) A body ($\mathbf{m_0}$) moving in a 'straight' * linear path in space
3) A body ($\mathbf{m_0}$) moving in a curvilinear path in space
4) A body ($\mathbf{m_0}$) moving in a helical path in space, or the 3D motion of E-M waves in space

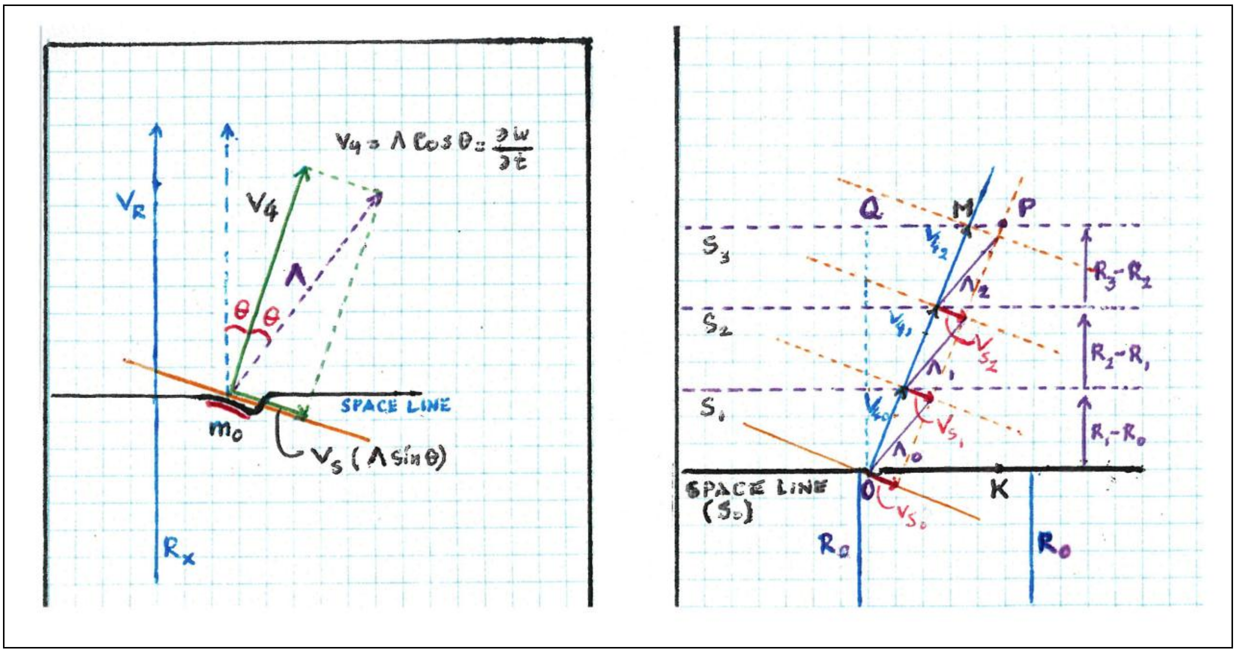
(*not necessarily a Euclidian straight line)

$\mathbf{m_0}$ in the first case above moves only in the 4th dimension with a momentum of $\mathbf{m_0 v_R}$. The direction of the motion is along the radius of the universe. But in all other cases $\mathbf{m_0}$ is in spatial motion in addition to the constant motion in the 4th dimension. We know that in 3D space, application of force on $\mathbf{m_0}$ always leads to some change in its spatial velocity ($\mathbf{v_s}$) including the case where starting from rest it will be brought to a moving state at $\mathbf{v_s}$ or vice versa. Consistent with the vector concept, force applied on $\mathbf{m_0}$ does not only change its speed in the range from zero up to any speed under the limit of $\mathbf{v_R}$ in space, but it may also change the direction of $\mathbf{m_0}$ already in motion. The momentum of $\mathbf{m_0}$ in the 4th dimension whenever it is in spatial motion ($\mathbf{v_s}$) is $\mathbf{m_0 v_4}$, where $\mathbf{0 < v_4 < v_R}$. However the consequence of the applied force or change of spatial velocity exclusively on $\mathbf{\Lambda}$ of $\mathbf{m_0}$ is traced only as a change of direction. Any change of state of a body from rest to motion or from motion to rest or from one velocity to another which may involve speed or directional change by force in space in turn causes a change in the direction of its 3+1D $\mathbf{\Lambda}$ trajectory. Therefore force (in space) is required to produce a change in the direction of $\mathbf{\Lambda}$ of a body or space point, or expressed alternately, direction of $\mathbf{\Lambda}$ of a body is changed whenever a net force is applied on that body.

The reason why application of force causes a change in $\mathbf{v_s}$ of $\mathbf{m_0}$ is because it bends space by a specific deflection angle $\boldsymbol{\theta}$ corresponding to each resultant $\mathbf{v_s}$ of $\mathbf{m_0}$, in exactly the same way as it is in gravitation, i.e. the bigger is **θ**, the bigger is $\mathbf{v_s}$.[31] The deflection angle **θ** here is the angle between the radial direction and the direction of the 4th dimension of $\mathbf{m_0}$, The angle between $\mathbf{v_4}$ and **Λ** is also equal to **θ**. Therefore the angle between radial direction and $\mathbf{v_4}$ is **2θ**. In Figure 9(a) in a 2D cross-sectional view of the expanding universe, the instantaneous $\mathbf{v_4}$, $\mathbf{v_s}$ and **Λ** of an object $\mathbf{m_0}$ moving at speed $\mathbf{v_s}$ which bends space or surface of the universe by angle **θ** are shown. $\mathbf{v_R}$ in the figure is simply the expansion velocity of the unbent space in the 4th dimension. If a further force in the same direction of $\mathbf{v_s}$ is applied uniformly on $\mathbf{m_0}$, space bending **(θ)** and $\mathbf{v_s}$ will keep increasing uniformly. In general the effective force on $\mathbf{m_0}$ may be a single direct force or the net resultant force of various possible forces of different magnitudes and directions, which may accelerate or decelarate $\mathbf{m_0}$ (may bring it to a stop or start moving it in the opposite direction) and/or change its direction. In Figure 9(b) the successive positions of $\mathbf{m_0}$ and the distances or trajectories it travels in space and in the 4th dimension are shown in terms of the corresponding $\mathbf{v_s}$ (**sin θ.Λ**), $\mathbf{v_4}$ and **Λ** at each $\mathbf{R_x}$ or ***CTF*** levels ($\mathbf{v_4}$ and $\mathbf{v_s}$ times are equally retarded relative to $\mathbf{v_R}$) where speeds, and therefore the

Figure 9

(a) **(b)**



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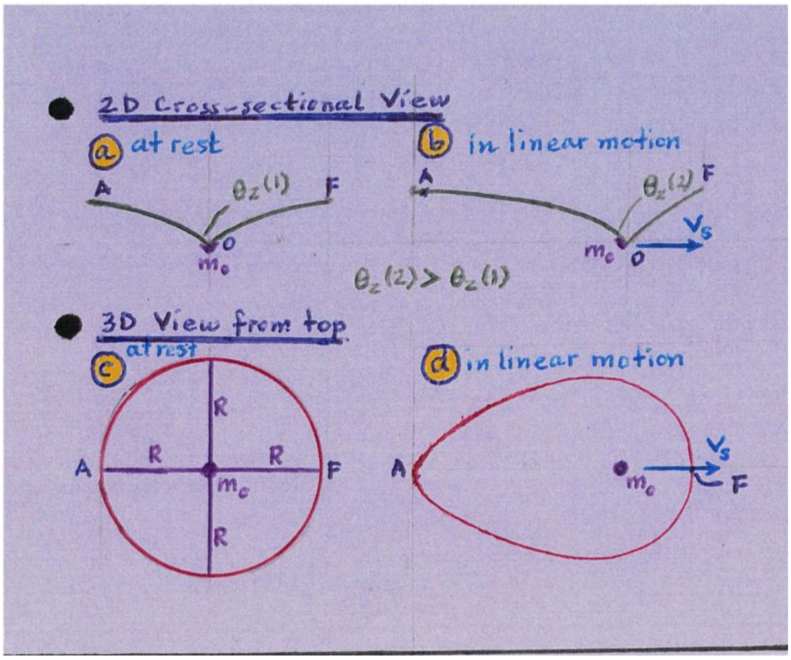
[31]Space is already bent by an object depending on the size of its mass, but motion has its own plus or minus bending effect on space by the object, which imitates mass changes (relativistic mass).

distances covered by $\mathbf{v_R}$ and $\mathbf{\Lambda}$ are identical. Another point of significance here is that time-flow is continuously delayed when $\mathbf{m_0}$ moves constantly at a uniform $\mathbf{v_s}$. This is in fact identical to the case of $\mathbf{m_1}$ falling continuously at some uniform velocity in the gravitatonal field of $\mathbf{m_0}$ (the twin paradox of relativity is verified also by **CMT**).

The long standing problem of inertia involving the question as to why a body of mass brought to motion at a uniform velocity is inclined to sustain its velocity unless a counter force is applied, or as to what causes a body of mass to resist to move (requires force) when at rest or to a change of velocity when moving is plausibly solved by **CMT** in the following way: motion or resting of a material entity in space and its motion in the 4th dimension are simultaneous. Belonging to the same body these moving or resting states are integral vector components of the same maximum velocity $\mathbf{\Lambda}$ (speed of $\mathbf{\Lambda}$ is exactly equal to $\mathbf{v_R}$) which is constant and valid for the entire universe. In other words the motion or rest state of a body in 3 dimensions in space is a component of the mainstream cosmic flow motion which causes universe to expand constantly in the 4th dimension. Without an intervening force the body will keep its state as long as $\mathbf{\Lambda}$ or rather $\mathbf{v_R}$ lasts. Additional force is required to have a change in motion or rest state of mass, and this condition is consequently reflected as the inertia of the mass. On the other hand it is well known that in the real world a constant uniform $\mathbf{v_s}$ of an object is never endless because of inevitable frictional forces and probable collisions.

We already know that a body of mass ($\mathbf{m_0}$) at rest causes a specific sag of space with a specific $\boldsymbol{\theta_z}$ or $\mathbf{v_z}$ around $\mathbf{m_0}$, and that this sag is perfectly symmetrical if $\mathbf{m_0}$ is a perfect spherical body. But when $\mathbf{m_0}$ moves in space the sag (gravitational field) is inevitably re-shaped. Two major changes should occur in this respect proportional to the magnitude of $\mathbf{v_s}$**:** first the extrinsic bending of space in the field is further increased reflected by a larger $\mathbf{v_z}$ and secondly the $\mathbf{S_0}$ between the surface of $\mathbf{m_0}$ and the outmost point of its field *in the direction of* $\mathbf{v_s}$ would be shortened while the spherical sag basin would become flattened all around and elongated ($\mathbf{S_0}$ is increased) in the opposite direction. By pure reasoning it may be expected that at the upper limit of the speed of $\mathbf{v_s}$ which happens to be ***c***, $\mathbf{S_0}$ in the direction of $\mathbf{v_s}$ would approach zero. 2D cross-sectional and 3D top views of the perfectly symmetrical (spherical) sag of $\mathbf{m_0}$ at rest are shown in (a) and (c) in Figure 10. The distorted 2D cross-sectional and 3D top views of the sag of $\mathbf{m_0}$ in motion at $\mathbf{v_s}$ on the other hand would probably look somewhat like the sketches in (b) and (d) in Figure 10. But at low speeds compared to ***c*** like the speed of the earth around the sun, the distortion of the field may not be significant.

Figure 10



E-M waves are specifically surface (space) waves of the universe. E-M waves and particles with no rest mass are independent of inertia because they do not bend space. When free of E-M and/or gravitational fields, screens or nuclear forces, they move at ***c*** in space (vacuum) and move at $\mathbf{v_R}$ in the 4th dimension at the same time. E-M wave velocity in space is changed by the properties of the medium they travel through. But velocity of the E-M waves as in the case of light for example is also changed directionally by gravitational field as explained in the forthcoming **Section 8** on **Gravitational Field Effects on Moving Bodies of Mass and E-M Waves.**

7. ESCAPE VELOCITY AND BLACK HOLES:

7.1. Escape velocity: Launching $\mathbf{m_1}$ by an initial escape velocity ($\mathbf{v_e}$) at point $\mathbf{s_i}$ in the gravitational field of $\mathbf{m_0}$ straight away from the c.g. of $\mathbf{m_0}$ against all successive $\mathbf{v_g}$ until it is just off the limits of the gravitational field of $\mathbf{m_0}$ is a reversed process of progression of the maximum $\mathbf{v_g}$ values of $\mathbf{m_1}$ in a freefall from the start of the space bending where gravitational energy and force are zero, toward the c.g. (or the surface) of $\mathbf{m_0}$.

We already know that the potential $\mathbf{v_{g0}(s)}$ in the field of $\mathbf{m_0}$ is independent of $\mathbf{m_1}$ or any other body of mass. It happens to be a property of the $\mathbf{m_0}$ field and it is invariant unless the rest or motional state of $\mathbf{m_0}$ changes.This is also true for the field of the reciprocal body of mass defined as $\mathbf{m_1}$. The escape velocity at any point from the c.g. of $\mathbf{m_0}$ is invariant like $\mathbf{v_g}$. But the total force or energy required to launch $\mathbf{m_1}$ at $\mathbf{v_e}$ is naturally also dependent on the magnitude of $\mathbf{m_1}$. $\mathbf{v_e(s)}$ at the surface of $\mathbf{m_0}$ where $\mathbf{s=0}$ is found in the following way:

$$\mathbf{V_g.dv = g.ds}$$

Kinetic Energy: $\mathbf{E_k(m_1) = m_1\int v_g dv}$ (*integrated from* $v_g = 0$ *to* $v_g = v_t$ *where* v_t *is the final total velocity of* m_1)

$$\mathbf{E_k(m_1) = -\tfrac{1}{2}m_1v_t^2} \quad (\textit{where } \mathbf{-v_t = v_e})$$

Potential Energy: $\mathbf{E_p(m_1) = m_1\int g ds = \int F g ds}$ (*integrated from* $s = 0$ *to* $s = h_0\sqrt{(1+\Omega^2)}$)

$$\mathbf{E_p(m_1) = \left\| m_1v_R^2\Psi_0^2m_0^2 s \div h_0\sqrt{(1+\Omega^2)}[s \div h_0\sqrt{(1+\Omega^2)}-1] + m_0v_R^2\Psi_1^2m_1^2 s \div h_1\sqrt{(1+\Omega^2)}[s \div h_1\sqrt{(1+\Omega^2)}-1] \right\|}$$

$$\mathbf{E_p(m) = \tfrac{1}{2}\,(m_1v_R^2\Psi_0^2m_0^2 + m_0v_R^2\Psi_1^2m_1)}$$

$$\textit{but} \quad \mathbf{E_k(m_1) + E_p(m_1) = 0}$$

$$\therefore \mathbf{\tfrac{1}{2}m_1v_e^2 = \tfrac{1}{2}\,(m_1v_R^2\Psi_0^2m_0^2 + m_0v_R^2\Psi_1^2m_1)}$$

$$\textit{and} \quad \mathbf{v_e = v_R\sqrt{(\Psi_0^2m_0^2 + \Psi_1^2m_1^2)}} \quad (\textit{contribution of } m_1 \textit{ field effect included})$$

If on the other hand $\mathbf{m_1}$ is much too smaller than $\mathbf{m_0}$ then:

$$\mathbf{v_e \approx v_R\Psi_0m_0 = v_z}$$

It should be noted that there is no "relativistic mass" mounted on a freely falling body of mass in a gravitational field. The body merely follows the space velocity potential produced by the already bent space.

7.2. Black Holes: There just is not potential space velocity of gravitation ($\mathbf{v_g}$) where space is not bent at all;

$$\mathbf{\theta = 0}$$

$$\mathbf{\sin\theta = 0}$$

$$\therefore \quad \mathbf{v_g = v_R \sin\theta = 0}$$

Again where there is no bending of space;

$$v_4^2 = v_R^2 - v_g^2$$

$$v_g = 0$$

$$\therefore \quad v_4 = v_R$$

Or using θ ;

$$v_4 = v_R \cos\theta$$

$$\theta = 0$$

$$\therefore \quad \cos\theta = 1$$

$$\textit{and} \quad v_4 = v_R$$

But what happens in the opposite case where θ_z is very big and v_g goes up to excessively high levels? The highest possible level or theoretical limit of θ is clearly 90^0 (where $h = \alpha$) in which case v_z would be equal to v_R, and v_4 would drop to zero. A striking theoretical effect here is that, time as we deem it would stop since time measurement devices (clocks) would not move or work where v_4 is zero. What this means is that v_4 would be approaching a limit of **zero** while v_g approaches the limit of v_R in the case of the gravitational fields of extra ordinary big masses very densely packed in extremely small volume forms of space (**Section 5.2** on **Mass**), which would produce extremely huge gravitational force. The upper limit for gravitational force is:

$$F_{gmax.} = m(v_R) \div t = Energy \div s$$

The extreme case where light can not escape the gravitational field of an extremely huge mass has been known as "black hole" in astrophysics. The black holes are generated by very big and dense masses which may be spinning and/or moving.

Light may be moving into the gravitational field of a body of mass or it may be radiating away from the body itself. In either case light would move either along the radial direction or by an angle to the radial direction in the field. If the escape velocity is equal to the speed of light (*c*) at some point in the field then light can never leave the field in any way. To meet the condition of light not being able to escape the gravitational force where for example **s=0**, the speed of v_e must be equal to *c*:

$$v_e(s) = v_R \Psi_0 m_0 = c$$

But in the case when light moves in an angle (ϕ) to the radial direction in the gravitational field of the body ($\mathbf{m_0}$), it may still be trapped inside the field rotating around $\mathbf{m_0}$ in which case the gravitational speed effective on the light may be less than the speed of light. Gravitational force in this case is presumed to play the role of the centripetal force which holds the rotating light in an orbit around $\mathbf{m_0}$ at the uniform speed $\boldsymbol{c}$. The velocity of light ($\mathbf{v_c}$) is made up of the virtual components $\mathbf{v_{cg}}$ in the $\mathbf{v_g}$ direction and $\mathbf{v_{cs}}$ at 90^0 to both $\mathbf{v_{cg}}$ and $\mathbf{v_g}$, at distance $\mathbf{s}$ from $\mathbf{m_0}$. The initial parameter of $\mathbf{v_{cg}}$ on the other hand is combined with $\mathbf{v_g}$ of the $\mathbf{m_0}$ field in the radial/gravitational direction, while velocity of light in the 4th direction is decreased, because of the bending of space ($\boldsymbol{\theta}$) at $\mathbf{s}$. Hence $\mathbf{v_{cs}}$ is decreased to balance out the increase in $\mathbf{v_{cg}}$ so that only the direction of the resultant spatial velocity of light changes, i.e. bending inwards around $\mathbf{m_0}$ at $\mathbf{s}$ (see also **8.2** on **E-M Waves**):

$$\mathbf{v_c^2 = (v_{cg} \pm v_g)^2 + v_{cs}'^2} \quad \left(\textit{v_{cg} and v_g are added when light moves toward m_0 and subtracted when it recedes from m_0}\right)$$

where:

$$\mathbf{v_g = \sin\theta} c$$

$$\mathbf{v_{cg} = \cos\phi} c$$

$$\mathbf{v_{cs}' = \sin\phi} c$$

and

$$\mathbf{F_g \div m_0 = v_g\, \partial v_g \div \partial s}$$

$$\mathbf{F_c \div m_0 = v_s^2 \div s} \quad (\textit{where } \mathbf{s} \textit{ is the radius of the orbit})$$

$$\therefore\ \mathbf{v_g\, \partial v_g \div \partial s = v_s^2 \div s}$$

$$\mathbf{v_g\, (\partial v_g \div \partial s) = v_g\, v_R \Psi_0 m_0 \div h_0 \surd(1+\Omega^2) = v_s^2 \div s}$$

$$\mathbf{v_g = v_s^2 h_0 \surd(1+\Omega^2) \div v_R \Psi_0 m_0 s}$$

or

$$\mathbf{v_g = v_s^2 \alpha_0 \surd(1+\Omega^2) \div v_R s}$$

$$\mathbf{v_g \div v_R = v_s^2 \alpha \surd(1+\Omega^2) \div v_R^2\, s}$$

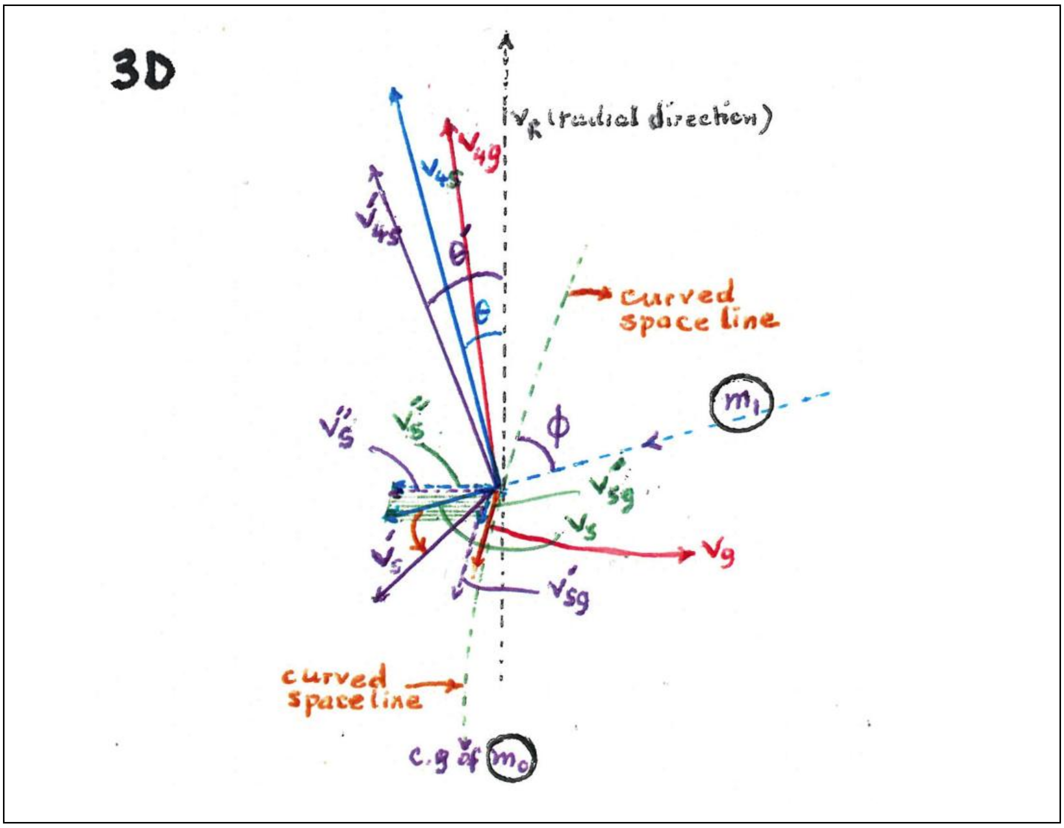
In consideration of the postulates of **CMT** set out in the beginning sections it should be noted that no 3D body of mass can survive in a so called Einstein-Rosen Bridge or Schwartzchild wormhole which, as doubtful as it may be is thought to connect two blackholes in space through the inner part of the universe under the outer surface which is defined as the entire space by **CMT**.

8. GRAVITATIONAL FIELD EFFECTS ON MOVING BODIES OF MASS AND E-M WAVES:

8.1. Bodies of Mass: In the case where a body of mass ($\mathbf{m_1}$) enters the gravitational field of another body of mass ($\mathbf{m_0}$) under the condition $\mathbf{m_0>m_1}$ by a certain uniform velocity ($\mathbf{v_s}$) in space, the instantaneous velocity vectors at each level of $\mathbf{s_i}$ (distance from the c.g. of $\mathbf{m_0}$) through or inside the field, add up to define the resultant velocity vector in a way that takes the combined effect of space bending already there by the gravitational field of $\mathbf{m_0}$ and the additional space bending caused by $\mathbf{v_s}$ into account. Let the uniform velocity $\mathbf{v_s}$ of $\mathbf{m_1}$ make an angle ϕ with $\mathbf{v_g}$ (potential space velocity of gravitation) where $\mathbf{0^0} \leq \phi \leq \mathbf{90^0}$ at any point inside the gravitational field of $\mathbf{m_0}$. $\mathbf{v_s}$ making such an angle with $\mathbf{v_g}$ may be thought to consist of two virtual components, a component denoted $\mathbf{v_{sg}'}$ in the direction of $\mathbf{v_g}$ and another denoted $\mathbf{v_s'}$ at $\mathbf{90^0}$ to $\mathbf{v_g}$ and $\mathbf{v_{sg}'}$ but in the 3 dimensions of space**.** In this format $\mathbf{v_g}$ and $\mathbf{v_{sg}'}$ are added up to make a new vectoral component to determine together by $\mathbf{v_s'}$ the resultant space velocity vector**.** If the angle between $\mathbf{v_s}$ and $\mathbf{v_g}$ is zero, then without further need for any component of $\mathbf{v_s}$, $\mathbf{v_s}$ and $\mathbf{v_g}$ are added up to determine the resultant space velocity vector. If however the angle between the two vectors is $\mathbf{90^0}$, then again without further need for any component of $\mathbf{v_s}$, the resultant space vector is determined by vectoral addition to be equal to $\sqrt{\mathbf{v_s}^2 + \mathbf{v_g}^2}$. The $\mathbf{v_4}$ vector is determined by the resultant space velocity ($\mathbf{v_4}^2 = \mathbf{v_R}^2 - \mathbf{v_s'}^2$).

If, for instance, a moving body of mass $\mathbf{m_1}$ assumed to be significantly smaller than $\mathbf{m_0}$ enters the gravitational field of $\mathbf{m_0}$, the eventual course and destiny of its motion may be a collision with or a constant rotation around $\mathbf{m_0}$, or it may leave the $\mathbf{m_0}$ field totally with its track bent toward the c.g. of $\mathbf{m_0}$. Given the basic properties of the $\mathbf{m_0}$ gravitational field, what exactly happens is determined mainly by the angle with respect to the direction of the c.g. of $\mathbf{m_0}$ and the speed of $\mathbf{m_1}$ at entering the gravitational field of $\mathbf{m_0}$. From the moment $\mathbf{m_1}$ enters the field of $\mathbf{m_0}$ there are basically four velocity vectors at each point and level of the field that are effective on $\mathbf{m_1}$, namely the uniform space velocity it already has ($\mathbf{v_s}$), the potential space velocity of gravitation ($\mathbf{v_g}$) that varies by $\mathbf{s}$ but always in the direction of the c.g. of $\mathbf{m_0}$, $\mathbf{v_{4s}}$ combined to $\mathbf{v_s}$, and $\mathbf{v_{4g}}$ combined to $\mathbf{v_g}$ **.** $\mathbf{v_{4s}}$ and $\mathbf{v_{4g}}$ of course are always at $\mathbf{90^0}$ to $\mathbf{v_s}$ and $\mathbf{v_g}$ respectively. The actual path of $\mathbf{m_1}$ in space is clearly determined by the net resultant space vector of the two simultaneous space velocities $\mathbf{v_g}$ and $\mathbf{v_s}$ at each point in the $\mathbf{m_0}$ field. Examplary vector additions for $\mathbf{v_s}$, $\mathbf{v_g}$, $\mathbf{v_{4s}}$ and $\mathbf{v_{4g}}$ of $\mathbf{m_1}$ through or inside the gravitational field of $\mathbf{m_0}$ are shown in Figure 11.

Figure 11



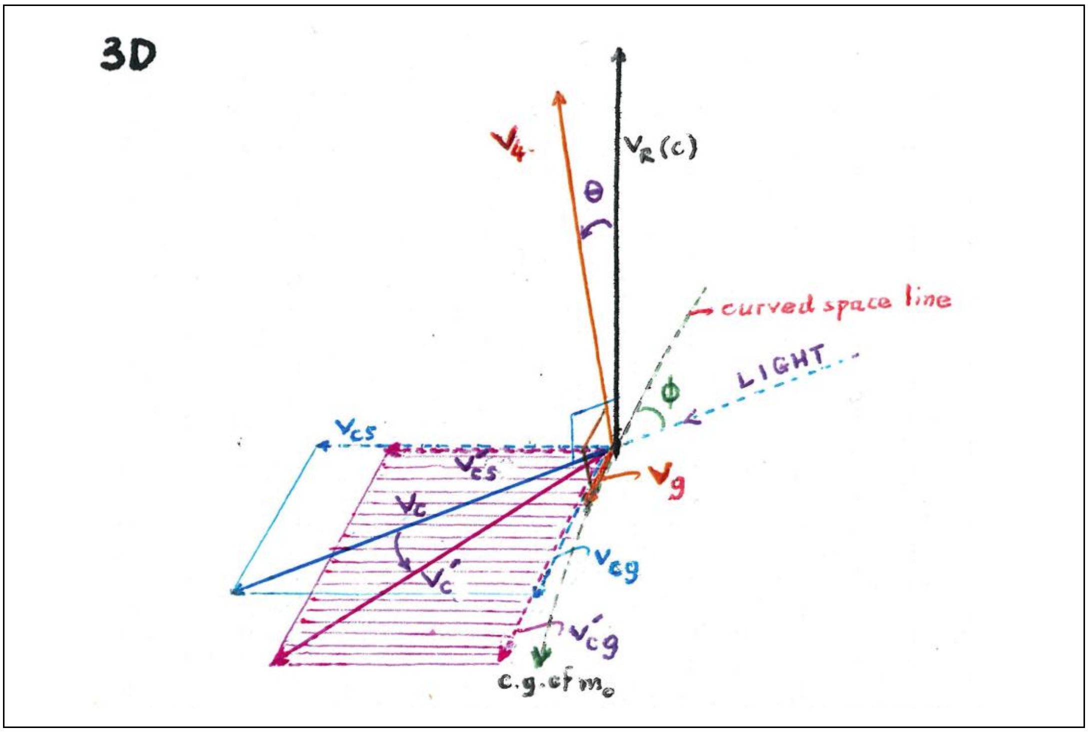
8.2. E-M Waves: Light which is an E-M wave has no mass and it does not bend space. The speed of light (or E-M waves in general) ***c*** in space is uniformly constant. Movement of light is not subject to inertia and for that reason $\mathbf{v_4}$ of light is not diminished, it remains equal to $\mathbf{v_R}$ as long as it is not inside an already bent space. In a bent space the speed of light is still equal to the speed of $\mathbf{v_R}$, while its direction changes.

Light enters (or leaves) a field of gravitation by $\mathbf{v_c}$ (at speed ***c***). But as in the case of the bodies of mass, $\mathbf{v_R}$ of light at some point $\mathbf{s_i}$ in the field is also broken down to two components, namely $\mathbf{v_g}$ and $\mathbf{v_4}$, the parameters or intensities of which are determined by the properties of $\mathbf{m_0}$ and distance $\mathbf{s_i}$ from the c.g. of $\mathbf{m_0}$. Moreover in case $\mathbf{v_c}$ enters a gravitational field at an angle ϕ_c ($\mathbf{0^0 \leq \phi_c \leq 90^0}$) to $\mathbf{v_g}$, then $\mathbf{v_4}$ of light too is slightly diminished because of the bending of space and, $\mathbf{v_c}$ is virtually broken down to two components, one being $\mathbf{v_{cg}}$ in the direction of $\mathbf{v_g}$ and the other one being $\mathbf{v_{cs}}$ at $\mathbf{90^0}$ to $\mathbf{v_g}$ and $\mathbf{v_{cg}}$ all in 3 dimensions of space. The $\mathbf{v_g}$ and $\mathbf{v_{cg}}$ are added to find the total gravitational space velocity $\mathbf{v'_{cg}}$ component of light always pointing toward the c.g. of $\mathbf{m_0}$. This total gravitational component and the other virtual component $\mathbf{v'_{cs}}$ which is diminished as pointed out then determine the final resultant space velocity of light always at speed ***c***. In this process the breakdown of the space velocity ($\mathbf{v_c}$) of light merely serves in the bending of light by the gravitational field of a body like $\mathbf{m_0}$. In other words the speed of light does not vary while its direction does. If on the other hand light is headed directly toward the c.g. of $\mathbf{m_0}$ ($\mathbf{v_g}$ and $\mathbf{v_c}$ in the same direction), the decreasing $\mathbf{v_4}$ is determined by $\mathbf{s_i}$ or $\boldsymbol{\theta}$ and $\mathbf{v_R}$, and light moves invariantly at $\boldsymbol{c}$ without breaking down to components. In this case light is bound to hit $\mathbf{m_0}$ directly without bending around it.

In the case where light enters the gravitational field of $\mathbf{m_0}$ at a certain angle with respect to the c.g. of $\mathbf{m_0}$, it is compelled to bend (curvilinear change of direction) at a rate determined by the angle of light, $\mathbf{s_i}$ and field structural properties of $\mathbf{m_0}$. So a beam of light may be bent by some degree around a body of mass and then either kept rotating around it or released off its field, or it may hit it and the part of it not absorbed by the body bounces back outside the gravitational field of the body. But in the extreme case where light reaches the surface of a body of enormously huge mass where $\mathbf{v_g}$ ($\mathbf{v_R}.\mathbf{sin}\boldsymbol{\theta}_\mathbf{x}$) becomes equal to $\boldsymbol{c}$ then no part of light can escape the gravitational field of that body.

The rate of bending of light around a star at a certain distance from its center for example tells us an important story about the mass/field or the space bending ($\boldsymbol{\theta}$) of that star. The ultimate track of light is determined by the result of the $\mathbf{v_c}$, $\mathbf{v_g}$, $\mathbf{v_{cg}}'$, $\mathbf{v_c}'$ and $\mathbf{v_4}$. Movement of light in a gravitational field on vectoral basis is shown in Figure 12.

Figure 12



9. VELOCITY IN THE 4^{th} DIMENSION AND TIME RECONSIDERED

It is now in place to inquire further on time-flow in a gravitational field in the light of the hypothesis on gravitation and inertia introduced with the following in mind:

$$\mathbf{v_4} = \mathbf{w \div t_4} = \mathbf{v_R \cos\theta} \quad \text{and} \quad \mathbf{v_R} = \mathbf{R \div t_R}$$

$$\textit{or} \quad \mathbf{v_4 \div v_R = \cos\theta} \qquad \textit{where} \quad \mathbf{0 < v_4 \leq v_R}$$

R: *the distance covered in the 4^{th} dimension along the radial direction*

w: *the distance covered in the 4^{th} dimension, but not in radial direction*

t_4: *time elapsed in motion in the 4^{th} dimension at $\boldsymbol{v_4}$ (below $\boldsymbol{v_R}$)*

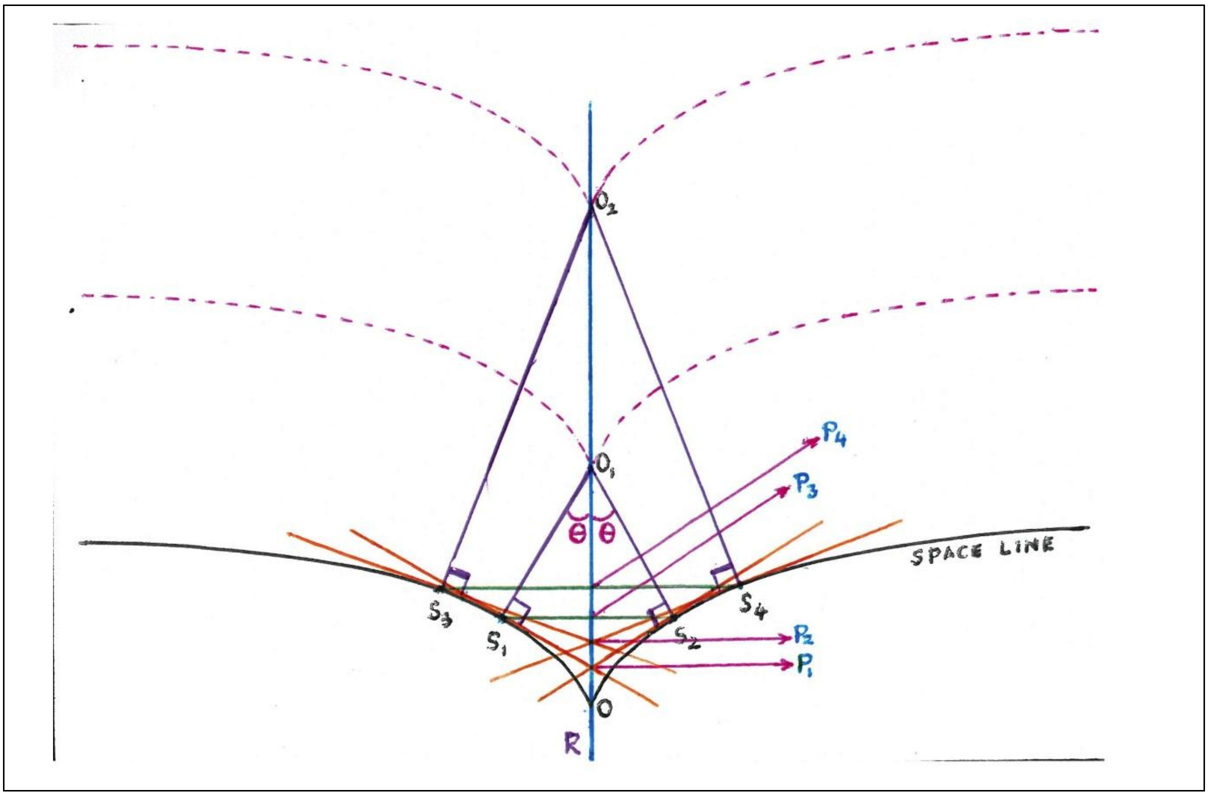
t_R: *time elapsed in motion in the 4^{th} dimension at $\boldsymbol{v_R}$*

Referring back to Figure 2, $\mathbf{v_4}$ is valid only between O and F (or O and A). Velocity of the space points or bodies in the 4^{th} dimension at A or F or at further points where space is defined to be not bent is indisputably $\mathbf{v_R}$. Point **O** on the other hand is the very bottom point of the sag caused by $\mathbf{m_0}$, and it is where the c.g. of $\mathbf{m_0}$ is located. The 4^{th} dimensional direction of expansion at point **O** is once again coincident with the radial direction. But point **O** where the bottom ends of the sag (represented 2 dimensionally by O-A and O-F in Figure 2) meet does not actually move in any direction in the cosmic expansion. What happens is that all corresponding points along O-A and O-F at equal distances from the radial O-M line proceed moving in the 4^{th} dimension until they meet at the midline O-M consecutively from bottom to top. The corresponding points between O-A and O-F move toward the midline in the 4^{th} dimension at different but constant uniform $\mathbf{v_4}$'s. Thus point **O** is progressively re-built in the radial direction as the side points of the sag meet in the said order. Therefore point **O** in effect is shifted constantly upward in the radial direction (even though $\mathbf{\Delta w}$ or $\mathbf{\Delta R}$ is in fact zero there) and we have to find out how the vertical speed of this shift compares with $\mathbf{v_R}$ or the $\mathbf{v_4}$ set between O-A or O-F.

In Figure 13 A-O-F represents a 2D cross-sectional view of a sag (gravitational field) identical to the sag in Figure 2. The sag is constantly "zipped up" in the cosmic expansion such that its shape and size is preserved while moving up (expansion). The corresponding points $\mathbf{s_1}$ and $\mathbf{s_2}$ will meet at point $\mathbf{O_1}$, whereas points $\mathbf{s_3}$ and $\mathbf{s_4}$ in the same way will meet at point $\mathbf{O_2}$. Both $\mathbf{O_1}$ and $\mathbf{O_2}$ take place on the radial line O-M. Just at the moment when $\mathbf{s_1}$ and $\mathbf{s_2}$ meet at $\mathbf{O_1}$, it can be seen that point $\mathbf{O_1}$ becomes the new bottom point (**O**) of the sag which in effect has moved up as a whole in the cosmic expansion. Therefore $\mathbf{s_1}$, $\mathbf{s_2}$ and point **O** meet at $\mathbf{O_1}$ at the same cosmic instant. On the other hand the distance covered by $\mathbf{s_1}$ in the 4^{th} dimension ($\Delta\mathbf{w}$) is the straight line between $\mathbf{s_1}$ and $\mathbf{O_1}$**,** whereas the effective displacement of point **O** ($\Delta\mathbf{R}$) in the same period of time is equal to the segment ($\mathbf{O}$-$\mathbf{O_1}$) on the radial O-M line. It is clearly seen in the diagram that while the time elapsed in both displacements are same, $\Delta\mathbf{R}$ is definitely bigger than $\Delta\mathbf{w}$. Hence the velocity of point **O** is bigger than $\mathbf{v_4}$ of $\mathbf{s_1}$.

It is now possible by the aid of the diagram in Figure 13 to show that $\mathbf{v_R}$ of point **O** is the same with the $\mathbf{v_R}$ at point **F** (or A), and to make a comparison between the time-flows of $\mathbf{v_R}$ and $\mathbf{v_4}$. First, it can be shown that the displacement of any point $\mathbf{s_i}$ between O and F (or O and A) until it reaches the radial midline O-M at $\mathbf{O_i}$ is always less than the displacement of **O** until $\mathbf{O_i}$. But since displacements $\mathbf{s_i}$-$\mathbf{O_i}$ and $\mathbf{O}$-$\mathbf{O_i}$ are always covered in the same time ($\Delta\mathbf{t_i}$) it can be concluded that the speed of any point ($\mathbf{s_i}$) between O and F (or O and A) in the 4^{th} dimension (pointing to changing non-radial directions) is always below the speed of point **O** in the radial direction. This can be verified by the same method on for example points $\mathbf{s_4}$ (or $\mathbf{s_3}$), $\mathbf{O_2}$ and **O**.

Figure 13



What is also evident is that $\mathbf{v_4}$, which is equal to $\mathbf{v_R\cos\theta}$ increases gradually from O to F (or from O to A) until it finally becomes equal to $\mathbf{v_R}$ at F (or A). Therefore the velocity in the 4th dimension of **O** is equal to $\mathbf{v_R}$ in the unbent space.

The truth of the matter is that $\mathbf{v_4}$ is but a velocity representing motion in the 4th dimension. It states that a distance of **w** is covered in time $\mathbf{t_4}$ in the 4th dimension. Thus as it gets smaller, $\mathbf{t_4}$ gets bigger or faster in contrast to **t** of space. Referring back to Figure 13 it can be shown that any $\mathbf{t_4}$ of $\mathbf{v_4}$ is smaller than $\mathbf{t_R}$ of $\mathbf{v_R}$ where of course $\mathbf{v_4 < v_R}$:

$$\mathbf{v_4 \div v_R = (w \div t_4) \div (R \div t_R) = (w \div R) \div (t_R \div t_4)}$$

$$\therefore\ \mathbf{t_4 \div t_R = (v_4 \div v_R) \div (w \div R)}$$

$$\textit{but}\quad \mathbf{v_4 \div v_R = \cos\theta = (s_2\text{-}O_1) \div (P_1\text{-}O_1)}$$

$$\textit{and}\quad \mathbf{\Delta w \div \Delta R = (s_2\text{-}O_1) \div (O\text{-}O_1)}$$

$$\mathbf{t_4 \div t_R = (P_1\text{-}O_1) \div (O\text{-}O_1)}$$

$$\textit{since}\quad \mathbf{(O\text{-}O_1) > (P_1\text{-}O_1)}$$

$$\therefore\ \mathbf{t_4 \div t_R < 1}$$

It can be shown in the same way by Figure 13 that $\mathbf{t_4'}$ of $\mathbf{v_4'}$ is always smaller than $\mathbf{t_4}$ of $\mathbf{v_4}$ where $\mathbf{v_4 > v_4'}$.

$\mathbf{t_4}$ being inversely related to **t** poses a temporal dichotomy on the cosmic scale. Nevertheless, time is defined in conformity with the canonical understanding of physics as the time observed and measured in space (**t**), and its pace is accepted here to be identical to $\mathbf{v_4}$:

$$\mathbf{t \equiv v_4}$$

The speed of time in a totally unbent space where $\mathbf{v_{s/g} = 0}$ is $\mathbf{v_R}$ which is a universal constant. The magnitude of the **t** of a reference frame in space is at its maximum magnitude (fastest speed of time-flow) when that reference frame moves at $\mathbf{v_R}$ in the 4th dimension ($\mathbf{v_{s/g}=0}$). Time of a reference frame in space at any $\mathbf{v_4}$ below $\mathbf{v_R}$ in the 4th dimension is always less than the mentioned maximum time. $\mathbf{v_R}$ is scaled down to $\mathbf{v_4}$ in a bent space, and whenever space is bent further (bigger $\boldsymbol{\theta}$) by the increase of $\mathbf{v_s}$ and/or $\mathbf{v_g}$, then $\mathbf{v_4}$, and for that matter **t** of the referenece frame in space gets smaller (slower **t)**.

Description of time (**t**) in relativity as being dilated when it runs slower (or vice versa) may reasonably be associated with or comparable to measuring time on a flexible scale of spatial coordinates. There happens to be two ways by which a change of speed may be obtained on a graph where time and spatial displacement are shown on the abscissa (vertical coordinate or axis) and the ordinate (horizontal coordinate or axis). One way is to alter the gradient/slope of say a straight linear function (uniform) **v** leaving the abscissa and the ordinate unchanged, while the other is to change the scale (gradation) of time and/or displacement by stretching out or shrinking the abscissa or the ordinate, or both evenly. Extension or shrinking of the scales evenly causes equal changes in the units by which **t** or **s** (or **L**) is measured. Changes on the abscissa or the ordinate however can not take place regressively as no change is permitted in the past. As already said when **t** in a reference frame in space for example is shown to be smaller it means that time flows slower in that reference frame as defined or determined by its $\mathbf{v_4}$. But slower **t** may also be obtained and shown by an equivalent even extension in the coordinate scale of **t.** The dilation of time of relativity for instance is equivalent to stretching out the time coordinate scale evenly so that time (**t**) will be measured smaller (i.e. time-flow is slower) in the larger units of the extended time scale. Similarly the contraction of length (space) is equivalent to shrinking of the space coordinate scale evenly so that **L** is measured larger in smaller space units.

10. THE RADIAL EXPANSION SPEED ($\mathbf{v_R}$) :

It is a matter of fact that the speed of $\mathbf{v_g}$ or $\mathbf{v_s}$ for the material entities with mass may change only within a range starting from **zero** up to a limit of the speed of $\mathbf{v_R}$. All intermediate values of $\mathbf{v_g}$ or $\mathbf{v_s}$ take place where $\mathbf{0 < \theta < 90^0}$. The space is bent at maximum when $\boldsymbol{\theta}$ is equal to $\mathbf{90^0}$**.** At this limit all clocks stop running and the expansion of space in the 4^{th} dimension is no more possible, and $\mathbf{v_4}$ approaches the limit of zero while $\mathbf{v_{g/s}}$ reaches its maximum speed (theoretically a case where $\mathbf{v_R}$ is totally transferred to $\mathbf{v_g}$ or $\mathbf{v_s}$). But the maximum speed of $\mathbf{v_s}$ for the material entities with mass in 3D space is already known. It is the speed of light (***c***)! Therefore the following equality should be valid:

$$\textbf{speed of } \mathbf{v_R} = \textbf{speed of } \boldsymbol{\Lambda} = \boldsymbol{c}$$

By substituting ***c*** for $\mathbf{v_R}$ some basic equations introduced by **CMT** hitherto are read as follows:

$$\mathbf{R \div t_R = \boldsymbol{c}} \qquad \textbf{(1)}$$

$$\check{T}_i = R_i \div c \quad and \quad CTF = R_x \div c \tag{2}$$

$$v_s = c \sin\theta \quad or \quad v_g = c \sin\theta \tag{3}$$

$$v_4 = c \cos\theta \tag{4}$$

$$c^2 = v_4^2 + v_s^2 \quad or \quad c^2 = v_4^2 + v_g^2 \tag{5}$$

$$v_{s/g}^2 = c^2 - v_4^2 \quad or \quad v_4^2 = c^2 - v_{s/g}^2$$

$$v_4^2 \div c^2 = 1 - v_s^2 \div c^2 \quad or \quad c \div v_4 = 1 \div \sqrt{1 - v_s^2 \div c^2} \quad (\textit{Lorentz Factor } (\gamma)) \tag{6}$$

$$v_4(s) = c\sqrt{[1 - \Psi^2 m^2 [s \div h\sqrt{(1+\Omega^2)} - 1]^2]} \tag{7}$$

$$v_g(s) = c\,\Psi m[s \div h\sqrt{(1+\Omega^2)} - 1] \tag{8}$$

when $s = h\sqrt{(1+\Omega^2)}$ and $\theta=0$:

$$v_4 = c$$

$$v_g = 0$$

when $s = 0$:

$$v_4 = c\cos\theta_z = c\sqrt{(1-\Psi^2 m^2)}$$

$$v_g = v_z = c\sin\theta_z = c\,\Psi m$$

Total maximum gravitational distance **S(s)** of **m** (**A-O** *or* **O-F** *in Figure 2*) :

$$S(s) = h\sqrt{[1+\Omega^2]} \tag{9}$$

Total Gravitational Force between m_0 and m_1:

$$F_g(s) = m_1 c^2 \Psi_0^2 m_0^2 \div h_0\sqrt{(1+\Omega^2)}[s \div h_0\sqrt{(1+\Omega^2)} 1] + m_0 c^2 \Psi_1^2 m_1^2 \div h_1\sqrt{(1+\Omega^2)}[s \div h_1\sqrt{(1+\Omega^2)} - 1] \tag{10}$$

Escape velocity v_e on the surface of m_0 is:

$$v_e = c\sqrt{(\Psi_0^2 m_0^2 + \Psi_1^2 m_1^2)} \tag{11a}$$

or if $m_1 << m_0$:

$$v_e \approx c\,\Psi_0 m_0 = ch \div \alpha \tag{11b}$$

and in the case of light when $v_e = c$:

$$v_e = c = c\,\Psi_0 m_0 \tag{12a}$$

$$\Psi_0 m_0 = h \div \alpha = 1 \tag{12b}$$

For rotation of light around m_0:

$$v_g = v_s^2 \alpha_0 \sqrt{(1+\Omega^2)} \div cs \tag{13a}$$

$$v_g \div c = v_s^2 \alpha \sqrt{(1+\Omega^2)} \div c^2 s \tag{13b}$$

Astonishingly the fact that $\partial \mathbf{R} \div \mathbf{t_R}$ is equal to ***c*** leads to the fact that the radial expansion speed of the universe or space is theoretically the same as the speed of light (***c***). It is even more astounding that if the radial expansion speed of space is ***c***, then the circumferential out-stretching speed of 3D space (denoted here as $\mathbf{v_C}$) is $\mathbf{2\pi c}$, because the circumference of a 4D sphere of radius **R** (not any different than a 3D sphere) is :

$$\mathbf{C = 2\pi R}$$

$$\textit{and}: \ \mathbf{\Delta C = 2\pi \Delta R}$$

therefore the circumferential out-stretching speed ($\mathbf{v_C}$) of 3D space or 4D universe is:

$$\mathbf{\Delta C \div \Delta t = 2\pi.\Delta R \div \Delta t_R}$$

$$\textit{or}: \ \mathbf{v_C = 2\pi c}$$

But it is very important to keep in mind that, although there may be particles without mass or waves that move at speeds over ***c***, $\mathbf{v_C}$ is an extremely high speed which must be exclusive for space itself and it ought not cover material entities like objects, particles and waves that are in this substratum which owe their existence specifically to the 3 dimensionality. Equally important is the fact that a circumferential out-stretching speed of space as high as $\mathbf{2\pi c}$ is only theoretical and would hold only for space totally free of huge masses such as galaxies and their gravitational effects. Therefore it is more plausible to assume that in reality $\mathbf{v_C}$ while varying a good deal depending on the degree of bending of space ($\mathbf{0 < v_C \leq 2\pi c}$), must in overall average be much lower than $\mathbf{2\pi c}$.[32] As present observations indicate however, inside galaxies and/or not too far intergalactic space regions where gravitational effect is strong, the much lower speed by which the distant stars and galaxies move away from each other would nevertheless be accelerating, due to the fact that gravitation decreases at a faster rate as the distance increases among the concerned bodies of mass and, lessened gravity as such means accelerated speed of out-stretcing of distances in space, i.e. redshift distances of space.

When usual masses of objects in daily life on earth or bodies of mass in space like planets and modestly sized stars like our sun are considered, the basic equations of **CMT** above show that the actual angles of usual extrinsic space bending are so very petty that they would point to extremely tiny fractions of a degree. This is not much of a surprise in regard of the fact that force of gravity, space velocity and respective bending of space by $\boldsymbol{\theta}$ are all measured in reference to the speed of light (***c***). However the theory also foresees much greater angles of space bending in the case of huge stars or objects of very dense masses, and black hole phenomena.

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[32] Dense matter like planets, stars and galaxies in space are found in groups, and the strong interactive gravitational effects at work in and around these groups of dense matter are preponderant to the stretching tension on the local space. By the same token it can be argued that the speed of spatial distention by "red-shift" would be measured much less than what it really is in and among stellar and galactic gatherings

The idea of a circumferential out-stretching speed of space higher than ***c*** is of course prone to have extraordinary consequences in physics, particularly in regard to the explanation of some critical issues on waves and particles in Quantum Mechanics and Quantum Field Theory.

11. ENERGY

11.1. Total Energy and Components: All motion in 3D space stems from and is sustained by the mainstream motion, namely the cosmic expansion in the 4th dimension. Likewise all the matter or energy observed in the 3 dimensions of the surface of the universe owe their existence to the same mainstream energy in the 4th dimension. Thus a certain object with mass ($\mathbf{m_0}$) at rest is only in motion in the 4th dimension dragged by this mainstream at the speed of ***c***. The 3+1D total momentum of an object with $\mathbf{m_0}$ in this case is simply $\mathbf{m_0}\boldsymbol{c}$, whereas its 3+1D total energy is $\mathbf{m_0}\boldsymbol{c}^2$:

$$\sum \rho = \mathbf{m_0}\boldsymbol{c}$$

$$\sum \mathbf{E} = \mathbf{m_0}\boldsymbol{c}^2$$

But whenever $\mathbf{m_0}$ is in motion in any one or two or three of the x, y and z dimensions of space in addition to its constant motion in the 4th dimension, then both its momentum and energy are broken down into 2 components:

$$\sum \rho = \mathbf{m_0}\boldsymbol{c} = \rho_4 + \rho_s = \mathbf{m_0 v_4} + \mathbf{m_0 v_s}$$

$$\sum \mathbf{E} = \mathbf{m_0}\boldsymbol{c}^2 = \mathbf{E_4} + \mathbf{E_k} \ \textbf{(kinetic energy)}$$

Assuming the initial velocity of $\mathbf{v_s}$ of $\mathbf{m_0}$ to be $\mathbf{v_{s0}}$ and its terminal velocity to be $\mathbf{v_{sn}}$, where $\mathbf{v_{s0}}$ may be **zero** meaning $\mathbf{m_0}$ is initially at rest, the kinetic energy of $\mathbf{m_0}$ in a certain displacement (**s**) is as shown previously:

$$\mathbf{E_k} = \int \mathbf{v_s} \ \ (\textit{integrated from } \boldsymbol{v_{s0}} \textit{ to } \boldsymbol{v_{sn}})$$

If $\mathbf{v_{s0}}$ is **zero**, then assuming a uniform accelaration**:**

$$\mathbf{E_k} = \tfrac{1}{2}\mathbf{m_0 v_{sn}}^2$$

$$\therefore \quad \sum \mathbf{E} = \mathbf{m_0 v_4}^2 + \tfrac{1}{2}\mathbf{m_0 v_{sn}}^2 = \mathbf{m_0}(\mathbf{v_4}^2 + \tfrac{1}{2}\mathbf{v_{sn}}^2)$$

In general terms the ratio of energy of $\mathbf{m_0}$ in the 4th dimension to the total energy of $\mathbf{m_0}$ is:

$$\mathbf{m_0 v_4}^2 \div \mathbf{m_0}\boldsymbol{c}^2 = \mathbf{v_4}^2 \div \boldsymbol{c}^2 = \mathbf{1 - v_s}^2 \div \boldsymbol{c}^2$$

and:

$$\boldsymbol{\rho_4 \div \Sigma\rho = v_4 \div c = \sqrt{(1 - v_s^2 \div c^2)}}$$

11.2. Thermodynamics: As far as thermodynamics is concerned, the Cosmic Mechanics Theory presented here is unquestionably based on the conservation of energy principle from the domain of the 4th dimension to the domain of 3D space and thus it is thoroughly consistent with the 1st Law of Thermodynamics. This is clearly indicated in the hypothesis on gravitation and the preceding section on energy.

CMT is not in any discord or inconsistency with the 2nd Law of Thermodynamics either. The 2nd Law states that 'entropy' as the measure of disorder indicates the decrease in the quality or capacity of total available energy in a closed or isolated system to do work, although the total quantity of the energy remains unchanged. Very briefly the differences of energy concentrations in a system which enable conversions between energy kinds or to do work is lessened by entropy. Degradation of energy in this context is an irreversible process. Changes are reversible only when change in entropy is zero. The phenomenon of entropy as such stems from the reality of constant motion in the 4th dimension including motion that may or may not be in space and the consequential changes in the microscale universe to which all physical processes are subjected irreversibly. The phenomenon of irreversibility of changes based on the microphysical background of entropy is congruent with the cosmic process leading to the concept of asymmetric or one-way time-flow (*arrow of time*) stated in **Section 4** on **Time**.

The topic of entropy can be considered basically on three main levels, namely the level of a partial or regional system (isolated, closed or open) in space, or the level of total 3D space or the entire 4D universe. The planet earth in space is not an isolated or completely closed system. There is a constant bombardment of energy radiation to earth from the sun and space in general, even though its solid material resources are not subject to augmentation from outside. But life, and in particular the human life which entails high levels of counter entropic activity on earth exploits energy at excessively high rates.

The absolute zero temperature which is more a subject of the 3rd Law of Thermodynamics is also a useful concept in approaching space and the universe from the viewpoint of the 2nd Law of Thermodynamics. It must be noted that temperature is a measure of the concentration of energy and shows the uneven distribution of the heat energy. Temperature is higher in a system or region if movement of particles there are faster than the environment. Therefore the difference of temperature in space indicates conversion of energy or work. Any temperature over the absolute zero is caused by work or kinetic energy in space. The absolute zero (**0^0K** or **-270^0C**), as stated by the 3^{rd} Law of Thermodynamics, can not be fully reached in space as long as there is effective gradient of energy concentration or motion, including organic processes of the living bodies like ourselves in 3 dimensions of space. That is to say, beside the existence of differences of absolute temperature, the average absolute temperature in overall space must always be somewhat over the absolute zero temperature so long as convertible energy or work survives in space. This seems exactly the case with our space. The ratio of the excess of absolute temperature over the absolute zero in the overall average is an indication of the total kinetic energy in 3D space against the energy-flow in the 4^{th} dimension. At absolute zero temperature prevalent at every point in space there is no way for a kinetic process or any action to take place in space.

A critical distinction is introduced by **CMT** between the 3D space and the 4D spherical universe. Space can be described as one huge closed dissipative, but not an isolated[33] system in that it is open to energy transfer from the mainstream of the 4^{th} dimension. Under the 2^{nd} Law of Thermodynamics space would require fresh energy supply in order to keep or control its overall average of temperature or to constrain its increasing entropy. As the expanding 3D surface of the universe space indeed receives energy from the mainstream of cosmic expansion in the 4^{th} dimension, but not 3D matter or mass which are postulated to survive only in the 3D surface of the universe. The momenta and kinetic energy transferred in space are always componential to and thus sustained by the mainstream energy flow in the 4^{th} dimension. The universe seems to act like a vast energy and space supply machine or generator. The spherical volume of space increases at a very high uniform speed (***c***). Yet, existence of absolute temperatures over the absolute zero in space is still an irrefutable fact, although the overall average absolute temperature in space may be approaching the absolute zero at an unnoticably slow rate after all.

Another phenomenal aspect of the universe pertains to the impossibility of perfect isolation of

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[33] An "isolated"system has no sharing of any matter or energy with its surrondings. It is not mentioned here, because although it is quite possible to have a system in space which can be isolated from its environment in regard to transactions of matter, such isolation would never be valid for any system in regard to the energy transactions.

a system in space. There can indeed never be a thoroughly protective isolation in 3D space, because the 3D system always has an invisible opening to the 4^{th} dimensional energy flow, and even the micro particles and waves that make physical bodies in a 3D closed system have different paces of time in regard to their velocities in the 4^{th} dimension. This fact plus the variable space-stretch effects on matter would lead to inevitable differentiation in the energy format of an "isolated" spatial system content.

So far as the total 4D universe is concerned, it is not known at this stage whether it is an isolated or closed or an open system (not in the geometrical sense to describe closed or open/flat universe). Nor is it known if the total quantity of the mainstream cosmic energy is fixed. Our current knowledge of the universe is not adequate for reaching a reliable conclusion on a possible "heat death" or perpetuity of the universe.

12. COSMIC MECHANICS AND RELATIVITY

As laid out in Sections 3 and 4, the understanding of space and time structure in **CMT** in essence is rather different than the space-time continuum concept of **SRT**. When two points, namely A and B are defined in space, no matter how infinitesimally small it may be, there is by definition a distance of space between these points. However a distance in this sense does not only mean a difference or separation of placement in space, but also a difference of time between the two points. That is to say, even if an infinitesimally small distance between A and B is covered by speed $\boldsymbol{c}$ or by a speed higher than $\boldsymbol{c}$, still an infinitesimally short time is spent. This intermingled quality of space and time is always valid until the limit where A and B are the same single point. The definition of space-time continuum of **SRT** everywhere in the universe is seen to be based on this fact. But as explained hitherto the basic understanding of **CMT** on space and time not only allows for the same fact, but it also confirms the one-way or asymmetric flow of time, which remains unaccounted for in **SRT**.

The theory of relativity in general is not necessarily concerned over the consequences of $\mathbf{v_4}$ of an individual reference frame in space on the parameters of that reference frame as observed or measured in space, when it is at rest or in motion at a specific velocity, or inside or outside a gravitational field. The conclusions of the theory is based mainly on the speed of light as a universal constant in all reference frames, and the premise that all reference frames are equally valid for the laws of physics. The Lorentz transformation principle stands in the background of **SRT.** The Lorentz factor that underlies **SRT** is also derived basically by reference to the constant speed of light propagation in 3 dimensions of space.

In **SRT**, the Lorentz factor defines relative pace of time, length or distance, mass, momentum and energy in different reference frames in space. While **CMT** definition of the energy of the rest mass is directly equal to the derivation of **SRT, CMT** is not compatible with the idea of variation of the rest mass and therefore the relativistic momentum and energy. Relativistic conclusions on time and spatial length between different reference frames in space however are equally valid in **CMT**. The derivation of time dilation or length contraction based on the Lorentz transformation between two reference frames of different motion states or gravitational fields in space do not in anyway infringe **CMT**.

CMT postulates that $\mathbf{v_s}$ always bends space (the bigger the $\mathbf{v_s}$, the more bent is space) extrinsically and that the pace of time of a reference frame or body in space at some $\mathbf{v_s}$ is always determined by the specific $\mathbf{v_4}$ of that reference frame or body. Furthermore it is very important that according to **CMT** the speed of the radial or the maximum cosmic expansion is equal to the speed of light. Invariance of the speed of light is a solid fact and happens to be the crux matter of **SRT**. But it must be noted that according to **CMT** the speed of the cosmic expansion ($\mathbf{v}_4$) which is equal to $\boldsymbol{c}$ at maximum does vary in bent space depending on the degree of bending . In fact, if there were no bending of space at all, there would not be any time differences among different reference frames in space. What is missing in relativity from the viewpoint of **CMT** is the factor of $\mathbf{v_4}$, the speed of which is equal to $\boldsymbol{c}$ when $\mathbf{v_{s/g}}$ or space bending is equal to zero. The extrinsic bending of space is not taken into account by **SRT**.

What does the Lorentz factor mean in **CMT**? Actually this factor is derived in **CMT** as follows:

$$\mathbf{v_4}^2 = c^2 - \mathbf{v_s}^2$$

$$\textit{and} \quad \mathbf{v_4}^2 \div c^2 = 1 - \mathbf{v_s}^2 \div c^2$$

$$\therefore \quad c^2 \div \mathbf{v_4}^2 = 1 \div 1 - \mathbf{v_s}^2 \div c^2$$

$$\textit{and} \quad c \div \mathbf{v_4} = 1 \div \sqrt{(1 - \mathbf{v_s}^2 \div c^2)}$$

$$\textit{or} \quad c \div \mathbf{v_4} = c \div c.\cos\theta = 1 \div \cos\theta$$

Lorentz Factor = $\gamma = c \div v_4 = 1 \div \cos\theta$

The Lorentz factor is the ratio between the maximum speed of cosmic expansion (c) which corresponds to the maximum pace of time in space, and the diminished speed of the cosmic expansion (v_4) where space is bent. As shown above it is also expressed in terms of the rate of bending of space ($1 \div \cos\theta$).

In **SRT** if time **t'** in reference frame **F'** is dilated in comparison to **t** in reference frame **F**, then the pace of time-flow in **F'** is slower than the pace of time-flow in **F** ($t \div t' > 1$). All time measurement devices (clocks, atomic watches etc.) are expected to run slower in a reference frame where time is dilated. In **CMT,** increase of $v_{s/g}$ of a reference frame (or object) always corresponds to an increase of space bending (θ) and to a decrease of v_4 for that reference frame and vice versa. In congruence with the postulate that the pace of time of a reference frame in space is identical to its v_4, time-flow in space is slower when θ and $v_{s/g}$ increase while v_4 decreases, and faster when θ and $v_{s/g}$ decrease while v_4 increases. Following the **SRT** notation if **t** is the time-flow of a reference frame in space which moves in the 4th dimension at c ($v_s = 0$), and **t'** is the time of another reference frame in space which moves in the 4th dimension at v_4 ($v_s > 0$), then $t \div t'$ is exactly equal to the time-dilation derivation of **SRT:**

$$t \equiv c$$

$$t' \equiv v_4$$

$$t \div t' = c \div v_4$$

$$\textit{but} \quad c \div v_4 = 1 \div \sqrt{(1 - v_s^2 \div c^2)} = \gamma$$

$$\therefore \quad t \div t' = \gamma$$

As far as the length contraction is concerned this has been shown to happen by Lorentz transformation only in the spatial direction of the velocity at which the reference frame or the body moves. The length **L** is defined in **SRT** as the distance between two points on a space dimension coincident with the direction of v_s of the reference frame. Defining **L** as Δs in that direction, when v_s or θ of a reference frame is increased Δs increases (which is equivalent to contraction of **s** coordinate), while as can be figured out by Figure 13, Δw decreases (which is equivalent to dilation of **w** coordinate), and vice versa. This relationship of space is the inverse of time dilation, in conformity with the length contraction of **SRT**.

In **CMT** the total energy of a body is directly found by its rest mass times its speed of motion in the radial 4th dimension $\mathbf{v_R}$ which is equal to $\boldsymbol{c}$. The total energy of a body **m** therefore is $\mathbf{m}\boldsymbol{c}^{\mathbf{2}}$. It is important from the viewpoint of **CMT** that the mass of a body at rest (in space) is actually a given parameter independent of any velocity it may have in space varying from **0** (rest position) to $\boldsymbol{c}$. The rest mass remains invariant through this whole range of speed in space.

The total energy of $\mathbf{m_0}$ at rest position is identical both in **CMT** and relativity: $\mathbf{m_0}\boldsymbol{c}^{\mathbf{2}}$. But when $\mathbf{m_0}$ is moved from rest position ($\mathbf{v_s = 0}$) to $\mathbf{v_{st}}$, it is obvious that this is achieved totally by an external force, and that the resultant kinetic energy of $\mathbf{m_0}$ is $\mathbf{½m_0v_{st}^2}$. The basic difference between **CMT** and relativity here is on the energy balance accounting of $\mathbf{m_0}$ before and after the considered change. Relativity asserts that the total energy of $\mathbf{m_0}$ moving at $\mathbf{v_s}$ is its relativistic mass ($\mathbf{m_0c^2\gamma}$) plus its kinetic energy ($\mathbf{½m_0v_s^2}$). The total energy change under relativity therefore is:

$$\Delta\mathbf{E} = \mathbf{m_0}\boldsymbol{c}^{\mathbf{2}} \div \sqrt{\mathbf{(1- v_s^2 \div c^2)}} + \mathbf{E_k} - \mathbf{m_0c^2}$$

$$\textit{or} \quad \Delta\mathbf{E} = \mathbf{m_0}\boldsymbol{c}^{\mathbf{2}}\mathbf{[1 \div \sqrt{(1- v_s^2 \div c^2\ )} - 1]} + \mathbf{E_k}$$

CMT on the other hand holds that the total energy of $\mathbf{m_0}$ is not really altered by any change of its spatial velocity ($\mathbf{0 \le v_s < c}$). What happens instead is that a part of the total energy $\mathbf{m_0}\boldsymbol{c}^{\mathbf{2}}$ is transferred into kinetic energy by exertion of (in exchange for) a certain amount of force, whereupon the energy accounting is simple and in balance:

$$\mathbf{m_0c^2 = m_0v_4^2 + E_k}$$

Even if the kinetic energy were assumed to be an addition to the energy of $\mathbf{m_0}$ (added mass) at rest, a condition which is not acceptable by **CMT,** the further addition of relativistic energy difference $\mathbf{m_0c^2[1 \div \sqrt{(1- v_s^2 \div c^2)} - 1]}$ in relativity seems unnecessary and unaccounted for in the general energy balance of $\mathbf{m_0}$. The same reasoning is also valid when the speed of a body is increased from a non-zero velocity to a higher terminal speed**.**

Question of variance of mass poses another point of disagreement between **CMT** and **SRT**. In **CMT** it is not really the mass but its momentum and kinetic energy which change by the change in $\mathbf{v_s}$, and therefore the relativistic mass $\mathbf{m\gamma}$ is not valid. Although space is bent more by increasing $\mathbf{v_s}$, this is still a phenomenon that would last only as long as $\mathbf{v_s}$ lasts at that same magnitude. When $\mathbf{v_s}$ decreases however, so does the bending of space ($\boldsymbol{\theta}$), and when the body or the reference frame is brought to a standstill, both $\mathbf{v_s}$ and $\boldsymbol{\theta}$ become zero. It is true that the force required to increase the speed of a body of mass becomes much bigger as the speed of the body gets higher until the limit ***c*** for which an infinite force is required. But increasingly higher force in this case is not required because of the growing mass of the body (or the reference frame), but for bending space further in order to convert more of the energy of the body from the 4th dimension to kinetic energy in space. It gets increasingly harder and much bigger forces are required to reach higher spatial speeds which necessitate increased space bending. Much more energy is transferred into space at higher $\boldsymbol{\theta}$ values. Bending and unbending of space at an identical degree ($\boldsymbol{\theta}$) requires *ceteris paribus* the same amount of external force.

Accelerated reference frames are covered in the scope of **GRT**. **CMT** clearly shares the premise that space is bent by mass, but extrinsically. **CMT** also holds that space is bent further by $\mathbf{v_s}$ of a body of mass. The most distinctive and fundamental difference between **CMT** and relativity is marked by the hypothesis of **CMT** which states that the cosmic radial velocity of a body or reference frame is broken down to two main components, namely the $\mathbf{v_s}$ and $\mathbf{v_4}$ in a bent space. Inertia is shown by **CMT** to stem from the fact that the rest or mobile state of a body or reference frame in space is directly and inseparably connected to its stem of constant cosmic motion or momentum in the 4th dimension.

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