Relative Scale Spacetime

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Abstract

Ensuing from the proposals of Plato, Heraclitus and Aristotle, a new theory of spacetime has been suggested. The scope is to reveal the origin of gravity and replace the absolute size of spatial volumes at different length scales by 'relative scale spacetime'.

The next question was - what makes planets go around the sun?
At the time of Kepler some people answered this problem by saying that there were angels behind them beating their wings and pushing the planets around an orbit. As you will see, the answer is not very far from the truth. The only difference is that the angels sit in a different direction and their wings push inward.


What makes changes in spacetime, shown with green and red?
What if the spacetime itself "changes" (Fig. 1), instead of being fixed (Hermann Weyl) as some "block universe" (Ellis, Fig. 4)?

\[ R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R + g_{\mu\nu} \Lambda = \frac{8\pi G}{c^4} T_{\mu\nu} \]

Mass tells spacetime how to curve
Curved spacetime tells mass how to move
See the little red arrow? We only have a name for it: gravity. We cannot suggest an explanation of gravity, only a description, as one could describe 'heat' with hot weather which makes you thirsty and you want to jump in the pool. This is describing 'heat' with something hot, like describing gravity (the little red arrow) with something caused by gravity. It would be like describing heat with some brand new particles, which are very small and terribly hot, say, heatino and its SUSY partner heatinino. An explanation of 'heat' requires reducing it to 'something else', such as kinetic energy, and then demonstrating how kinetic energy produces what we described as 'heat'. But we don't have such explanation, and might as well use "angels" instead of "curvature" to describe gravity, as Richard Feynman remarked. Why? Because "curvature" is not an explanation, and cannot be linked to any other phenomenon, just like you cannot fit heatino and heatinino in the Standard Model.

For if we cannot define the entire spacetime as 'closed system', up to its endpoints at null-and-spacelike infinity (which requires to explain both the localization of the energy density of the gravitational "field" at a topological point and at the "boundary" of that "field" at null-and-spacelike infinity), we cannot claim that one can boil water with gravitational energy (the so-called Bondi news) nor explain the positivity of mass and prove (not assume) the existence of maximal spacelike hypersurface: with gravity, what happens here-and-now depends on the entire spacetime (Ciufolini and Wheeler, p. 270). If you have an electric heater at some location in your living room and wish to understand how it works, you don't need to know 'the entire living room' up to its final endpoints and the gradient of heat at every point, because you will be dealing with a local source of physical (not physicalized) energy and its local effects, and can easily make your living room a 'closed system' by ignoring 'the rest of the universe'.

The conformal speculations of Penrose are wrong (explanation here), so statements like "since no light rays can enter an asymptotically flat spacetime through I+, no boundary data are needed to evolve the interior spacetime" (J. Winicour, p. 1) are sheer wishful thinking. If you replace "no light rays can enter an asymptotically flat spacetime" with 'no light rays can leave an asymptotically flat spacetime', you'll run into another mathematical poetry, called "event horizon". Both cases of "trapped" infinity (C. Norris) cannot be proved for massive particles in FLRW spacetime. No you can't. Forget it.

We cannot explain the little red arrow by reducing it to 'something else', like we explain temperature by reducing it to kinetic energy. We cannot use any physical gravitational field that would be similar to magnetic field. Only the geometry of the entire spacetime, but in GR it cannot be defined as 'closed system' (e.g., Schoen and Yau). As M. Visser explained, "The essence of the problem lies in the fact that the Einstein equations of general relativity are local equations, relating some aspects of the spacetime curvature at a point to the
presence of stress-energy at that point. What general relativity does not do is to provide any natural way of imposing global constraints on the spacetime -- certainly the Einstein equations provide no such nonlocal constraint." Moreover, GR cannot determine the topology of spacetime in the first place, and since the topology depends on matter-energy density, while the academic scholars claim that 95 per cent of the stuff of the world were "dark", their efforts to understand gravity resemble the old joke:

How do we know that Father Christmas has a beard?
We know it, because show falls when he shakes it.

What if the physical universe changes at the fundamental level of 'spacetime', such that every topological point here-and-now is the end product of the negotiations -- one-at-a-time -- between mass and "curved" spacetime? If 'mass tells spacetime how to curve, and curved spacetime tells mass how to move' (see above), we need an atemporal medium (dubbed 'global mode of spacetime') to connect every local topological point 'here-and-now' with 'the entire universe as ONE', like a school of fish (cf. pp. 4-5 here). Stated differently, to explain the little red arrow, we need to reveal what Einstein dubbed "a total field of as yet unknown structure" (Albert Einstein, p. 75), which springs from the "Zen gaps":

The right hand side is a formal condensation of all things whose comprehension in the sense of a field theory is still problematic. Not for a moment did I doubt that this formulation was merely a makeshift in order to give the general principle of relativity a preliminary closed-form expression. For it was essentially no more than a theory of the gravitational field, which was isolated somewhat artificially from a total field of as yet unknown structure.

Let me suggest a hypothesis about the origin of gravity, ensuing from the dynamic causality (dubbed biocausality) along the Arrow of Space (see Fig. 1). The ultimate task is to understand how the physical universe changes during its cosmological evolution, ensuing from the idea that the entire Universe is designed like a human brain: there must be something pertaining to the entire Universe (called 'potential reality', residing in the so-called global mode of spacetime), which remains invariant, thanks to which the physical universe can change. Consider, for example, a concept such as 'corner': it can be physicalized with many languages and hence has different neural correlates in the brains of different people, their brains change as well, etc., yet the concept of 'corner per se' remains invariant (cf. Plato below). The humans self also keeps its identity, despite her/his changing brain and body. This invariant entity resembles a blank colorless canvas (see below), which cannot exist without the colorful painting on it, yet the colorless canvas per se is something ontologically different. Ditto to the physical and perpetually changing universe: the physical content of the universe does change, like changing colors (cf. REIM) cast on blank colorless canvas, yet the ontologically different "colorless canvas" (see below) must keep an invariant 'line element' (Wiki) with which the physical content of the universe is defined 'in spacetime'. This invariant 'line element' is considered 'potential reality' residing in physically unobservable "Zen gaps" -- "a total field of as yet unknown structure" (Einstein).

NB: But what if the potential, "colorless canvas" itself can be shrunk and inflated relative to its macroscopic "size" (Alice)? After all, in the three cases depicted below, the "colorless canvas" shows up in the physical (colorful) spacetime (not shown) only by infinitesimal "changes" dt, but the "sizes" of dt
are indistinguishable, as all different-in-size colorless canvases correspond to undecidable "number" of spacetime points (Cantor). So the facts that we see three different-in-size colorless canvases in the drawing below is correct, yet what we cannot see is one single "colorless" point which is both "that which has no part" (Euclid) and 'that which has no end nor part' (see the explanation at Eq. 1 below).

The potential, "colorless canvas" is both "that which has no part" (Euclid) and 'that which has no end nor part' (cf. Eq. 1 below).

Hence Nature can obtain smaller or larger physical (colorful) spacetime inhabited by matter with smaller or larger size. We postulate that the sole variable of the potential, "colorless canvas" of spacetime is an atemporal "time", denoted with T (explanation below). It is of course 'potential reality' residing in physically unobservable (due to the speed of light) Zen gaps -- "a total field of as yet unknown structure" (Einstein).

In every theory of spacetime, the first off task is to define the rods and clocks. Our theory of Relative Scale (RS) spacetime is based on the proposal of Plato in his work The Republic and the Universals, which we denote as 'potential reality' and interpret as unphysical (yet physicalizable) 'elements of reality' shown as two explications of the Universe, matter and psyche, originating from one common source (Pauli); see 'the eye of the Universe' here. Physicists are very reluctant to acknowledge that 'potential reality' is the cause of Genidentität (Kurt Lewin) and run into insoluble problems. For example, John Wheeler (p. 1215) stressed that "an electron here has the same mass as an electron there is also a triviality or a miracle. (...) No acceptable explanation for the miraculous identity of particles of the same type has ever been put forward. That identity must be regarded, not as a triviality, but as a central mystery of physics." In psychology and Mathematics, we freely operate with 'potential reality'. It is UNSpeakable, like an unphysical "colorless" element of reality, which can be explicated in many (open set) physicalized objects. For example, mathematicians introduce Platonic solids, yet we know that their physical explications come always in some concrete form, like 'this football is a sphere'. It is like using adjectives: if we say 'blue', we must always specify what object is 'blue'. Ditto to 'spacetime', as "bare" spacetime is not physical object but 'potential reality'.

Think of "bare" spacetime as blank colorless canvas, such that (i) there is no canvas without its physicalized, colorful painting, and (ii) there is no physicalized, colorful painting without its canvas. The second requirement explains the so-called sufficient conditions for spacetime, which are 'global constraints on the spacetime'. Further, in relative scale spacetime we postulate
'potential reality' as fundamental reality, which is explicated, for example, as invariant region of spacetime, such as 300,000,000m viz. 1s time of light. So we suggest, after Plato, that a spacetime region, corresponding to 1s time of light, shows physicalized explications -- one-at-a-time along the Arrow of Space -- of its unphysical "colorless" Platonic source dubbed here 'potential reality', and stress that such physicalized 'line element' (denoted with L, see Addendum 1 below) is not identical to its unphysical, yet-to-be physicalized 'potential reality'. Due to requirement (ii), it is impossible to derive the properties of the "canvas" (introduced with mathematical axioms) from its physicalized, colorful "painting", e.g, derive the time-orientability of the "canvas" from manifolds that are Hausdorff, second countable and C∞ by using only and exclusively only their material (physicalized) content; scroll down to the end of Sec. Topology for specific examples.

NB: Thus, in our theory of relative scale (RS) spacetime we use an unobservable 'time of light' (denoted with T below) as colorless canvas or simply 'potential reality' (the flight time of not-yet-absorbed photon is not physical), and propose its alterations as the origin of gravity: changes of T are changes of the potential reality of 'one second time of light', denoted with D. The latter is physical ("colorful"), while T is its underlying "colorless canvas". Hence the unobservable 'time of light' T matches the "duration" of the invisible, due to the speed of light, Zen gaps. Scroll down to read the FPS analogy and its disambiguation.

The current formulation of GR is still 'work in progress', as we haven't revealed Einstein's "total field of as yet unknown structure". Surely the gravitational energy density is always physicalized at every topological point here-and-now, yet it is not tensorial quantity (MTW, p. 467). Why? Because the localization of positive gravitational energy is quantum-gravitational phenomenon based on 'potential reality': we encounter physicalized explications, which the orthodox theory of gravity (e.g., Wald, 1984) cannot explain. Another example of 'potential reality' is the quantum vacuum -- check out ATM (cash machine) analogy at the end of MST.txt and the "dark puzzle" explained here. The mathematical issues of relative scale spacetime are presented in Sec. Topology. At this moment, we can offer equations only in symbolic form (see Addendum 1 below), because the Mathematics is still uncovered.

Let's get started. We don't know the nature of gravity, which is most likely related to the ultimate puzzle of spacetime (Addendum 1): how finite objects, presented symbolically with number 1 in the right-hand side of the equation below, emerge (Isham and Butterfield) from primordial geometrical points ('the grin of the Cheshire cat without the cat', as observer by Alice) with non-Archimedean topology?

$$0 \times \infty = 1 \quad (\text{Eq. 1}).$$

This symbolic equation shows the ultimate puzzle of the invariant 'one meter' and 'one second' of finite (Sic!) size and duration, obtain by multiplying "that which has no part" (Euclid) by 'that which has no end nor part'. Suppose we place an invariant 'one second' (denoted with D below) in the right-hand side, and interpret the left-hand side as the product of assembling infinitely many (actual infinity) topological points with 0-dimensionality to obtain a 'completed totality' (known as 'set') of topological points with infinite (actual infinity) cardinality and elementary ("that which has no part", Euclid) duration dt. Thanks to Cantor, we know that such 'completed totality' (known as 'set') of temporal points (dt) cannot be defined with Archimedean topology viz. by using
any denumerable value of \( n \), for example, \( n \) frames per second’ (FPS) or "9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium 133 atom" (international second). No physical phenomenon can do the job of assembling denumerable \( n \) to obtain 'one second' of finite duration, with the utmost precision of an invariant 'one second'. No way. Not even with Gedankenexperiment, by setting \( n = 10^{44} \) to assemble (Sic!) an invariant 'one second' from the so-called Planck time. Thus, we have to acknowledge that the phenomenon of assembling the topological dimensions of the physical universe (cf. the Arrow of Space in Fig. 1 here) does not have physical nature, simply because it cannot have physical nature, as we know since the time of Plato (see above). This creative phenomenon is dubbed here 'Aristotelian Connection' (AC), and we postulate that it (not "He") has self-acting nature resembling the human brain.

NB: In our theory of relative scale (RS) spacetime, we shall assume that AC is related (we still don't know how) to the invariant "speed" of light \( c \), with which an invariant spatial region of 360,000km (299,792,458m) is being (present continuous) assembled by AC as '1s time' (denoted with D below) -- once-at-a-time along the Arrow of Space (cf. Fig. 1 here).

To shorten the explanation of RS spacetime, we shall refer to the NB paragraph above with 'light assembles' time viz. spacetime'.

Thanks to the finite value of "speed" of light \( c \), we can define 'spacelike separation' and introduce a metaphysical axiom called 'causality', which we use to define 'cause and effect' (recall that in GR, "acceleration is not an effect (since it is not a generally relativistic vector")", as explained in Wiki). So we know that with Archimedean topology we cannot understand the two sides of Eq. 1, as we cannot set \( n = \infty \) and \( dt = 0 \). Also, \( c \) does not possess Archimedean topology either; for example, in theory of relativity \( 0.8c + 0.7c = c \). If we use Archimedean topology and set \( dt = 10^{-44}s \) (Planck time) and the number of temporal "frames" \( n = 10^{44} \), we would "recover" 'one second of light time', but introduce an absolute length scale of bare 'spacetime per se', which is very bad idea (see below).

This is the ultimate puzzle of spacetime: the non-Archimedean topology of its mind-like source called by Euclid "that which has no part". Sir Arthur Eddington described it as "the aggregation of relations and relata which form the building material for the physical world" (p. 278). It is "ferociously difficult" (Isham and Butterfield) to understand the emerging of Archimedean spacetime as "shadows" (Plato) from 'something else' endowed ab initio with non-Archimedean topology (dubbed here 'potential reality'). We can try to understand it only with the new zero-valent logic YAIN, by interpreting \( dt \) with two complementary properties: both zero and finite. Of course, \( dt \) may be something we cannot comprehend in principle, like an Eskimo who would interpret 'nose' and 'arm' as two complementary presentations of 'trunk'. Ditto to the reciprocal case of 'infinitely large': it may be both infinite and finite, or maybe something entirely different, like 'trunk'.

The moral of this story is that we can use Archimedean topology only to the extent to which the spacetime of physicalized potential reality (called local mode of spacetime) has indeed Archimedean topology (cf. Case II in Addendum 1), knowing very well that the primordial spacetime of potential reality (called global mode of spacetime) has non-Archimedean topology (recall the definition of 'point' by Euclid "that which has no part"). Which is why we cannot introduce an
**absolute** lengths scale viz. determine "absolute" distances pertaining to "large" and "small" regions of spacetime (Case I in Addendum 1), hence eliminate requirement (ii) above ("blank colorless canvas").

What we do know, however, is that gravity cannot be presented as "curvature", so that we could use tensor calculus to handle the so-called curvature and tangent vectors "intrinsically" (Baez and Bunn). Gravity might look like "curvature" (see the first drawing above), but isn't. Why? Because Minkowski spacetime is not like an elastic body or rubber band. To quote from Hyun Seok Yang, "the flat spacetime in general relativity behaves like an elastic body with tension although the flat spacetime itself is the geometry of special relativity. (...) That is, the (flat) spacetime behaves like a metrical elasticity which opposes the curving of space. But this picture rather exhibits a puzzling nature of flat spacetime because the flat spacetime should be a completely empty space without any kind of energy as we remarked above. How is it possible for an empty space of nothing to behave like an elastic body with tension?" The latter is believed to be some "dark" smooth dynamical tension (Carroll), which people consider "dark" because it cannot be traced back to its omnipresent source (explanation here). It would be like you throw a stone up in the air and expect to see it coming down, but the stone suddenly begins to accelerate upwards and disappears in the sky. What would be the source of such "anti gravity"? Wrong question. Gravity has two presentations -- see the centripetal and centrifugal gravitational gradients below.

To understand how 'an empty space of nothing' acquires physicalized (Sic!) energy in the right-hand side of Einstein's equation (the second drawing above), see the ATM analogy at the end of MST.txt and pp. 4-5 here. We need quantum gravity, because GR is not classical local theory. Matter is self-coupled by its own gravity, which leads to self action of matter. This is the crux of the dynamics of gravity "along light cones". To understand why we cannot represent the dynamics of gravity with its final end results -- the time read by your clock -- watch the animation from John Walker below.

The "intermediate" time of "free" photons is not physical. Only its final end results -- one-at-a-time -- are physical, as shown at the instants of "clapping hands" or Escher's drawing hands below.

Gravity is a bootstrapping phenomenon producing a holistic "school of fish" in which every "fish" follows its own quasi-local (Sic!) geodesic. Metaphorically, the school of fish tells every fish where to go in its next instant 'now' by exerting physicalized (see NB below) energy-momentum into its next state, while at the
same instant (Sic!) every fish determines the next global state of the whole school (=spacetime) of fish. This non-linear bi-directional negotiation (resembling Escher's 'drawing hands' below) is the crux of gravity. It requires necessary and sufficient conditions for spacetime (21.09.2008). Due to the "speed" of light, we can observe in the local mode of spacetime only the end result -- one-at-a-time -- from this bi-directional negoation in the global mode of spacetime, between every quasi-local fish and the entire school of fish as ONE.

NB: Hence at every instant of "clapping hands" here-and-now (cf. Fig. 4 here), the bi-directional negotiation has been already (Sic!) completed "within" photon's zeroth world line, which the photon has already completed by traveling "zeroth" (cf. Eq. 1) unit space ds per "zeroth" unit time dt (cf. w axis in Addendum 1).

If you believe can boil water with the so-called Bondi news, try to explain the dynamics of gravity "along light cones". Notice that in GR 'mass tells spacetime how to curve, and curved spacetime tells mass how to move' (see above), but the upper hand can modify the lower hand iff it was already determined in its past light cone by the lower hand, but the lower hand can modify the upper hand iff it was already determined in its past light cone by the upper hand: Catch 22 logical contradiction. The non-linear dynamics of matter-spacetime negotiation requires 'potential reality' in the global mode of spacetime to facilitate such atemporal negotiation -- one-at-a-time (cf. the w axis in Addendum 1.)

Unlike magnetism, gravity is intertwined with rotation: see centripetal and centrifugal gravitational gradients below. The "push and pull" gradients of gravity are of topological origin (cf. pp. 4-5 here), and spacetime is produced by physicalized potential reality. Its localized "flashes" are physicalized energy (and momentum) which either gives to, or takes away 'tangible energy' (Hermann Bondi) from matter and fields placed in the right-hand side of Einstein's field equations. Such physicalized contributions are indistinguishable from the 'tangible energy' shown in the past light cone, i.e., in the right-hand side of Einstein's field equations.
Metaphorically, we observe different physical "gloves" (e.g., proton mass and dressed particles) which facilitate their common "dark hand", but never the "dark hand" itself. Such physicalized energy is always smuggled into the past: the geodesic equation is capable of encoding the effect of external gravitational field on a material particle and - in general - will not lead to any conservation law" (Padmanabhan, p. 213).

NB: If the source of gravity were some classical field (e.g., resembling electromagnetism), its "flashes" will be localizable energy density (MTW, p. 467), which will inevitably comply with Newton's third law, and the inertial mass of an accelerating particle will be a simple "back-reaction to its own gravitational field" (Rindler, p. 22). Bad idea, because the duration of such physical "back-reaction" will be finite, and we would detect some physical force by which the entire spacetime "out there" affects matter and fields locally at a spacetime point "here": "Mass there governs spacetime geometry here" (Ciufolini and Wheeler, p. 270).

No, gravity is not "classical field", because the localization of gravitational energy density is quantum-gravitational phenomenon (cf. pp. 4-5 in sheeple.pdf), which cannot be presented with tensors; the latter can refer to classical objects only (Dan Fleisch, 11:45-12:13). Matter is self-coupled by its gravity and the gravitational "field" is produced by its potential reality. The gravitational waves are produced from bootstrapping the whole spacetime en bloc (see answer Yes), and of course have no topological "boundaries" -- check out the no-boundary proposal in Sec. Topology here.

GR cannot be classical local theory. As Kevin Brown explained, "the field equations of general relativity imply (emphasis mine - D.C.) this conservation, as can be seen by the vanishing of the covariant divergence of the Einstein tensor

\[ C_{\mu\nu} = R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R \]

"The field equations simply equate this to the energy-momentum tensor \( T_{\mu\nu} \), so the covariant divergence of the latter must also vanish, hence energy-momentum is locally conserved, hence particles follow geodesics.

"But the local conservation of mass-energy didn't arise automatically, it was specifically designed into the field equations by the inclusion of the "trace" term (the term with coefficient 1/2) in the Einstein tensor. In fact, one of the early attempts of Einstein and Grossmann to formulate generally relativistic field equations led to the result \( R_{\mu\nu} = T_{\mu\nu} \), but not surprisingly this is unsatisfactory, precisely because the covariant divergence does not vanish. After a great deal of searching (and with the crucial help from Levi-Civita - D.C.), Einstein finally realized that the natural conservation laws - and hence the law of inertia - is recovered if we include the trace term. David Hilbert arrived at this same conclusion almost simultaneously (in November 1915), although his route was much more direct, since he proceeded from a Lagrangian, which automatically leads to conservation laws."

Only we cannot have conservation laws in GR to make particles "follow geodesics". Unlike in special relativity, we cannot ignore the contributions from maximal spacelike hypersurface, and somehow "assume" that the energy-momentum tensor of the system, stretched to spatial infinity, is entirely...
confined in a finite region in 3-D space. You will need well-defined boundary of the integration domain (similar to 'the entire school of fish', see pp. 4-5 here) to make conservation laws (Wyss, p. 304):

6 Equations of motion and conservation laws

The equations of motion are given by demanding that the action Eq. (1) is stationary, i.e. has a critical point under variations where on the boundary of the integration domain \( \delta x^\mu = 0, \delta \phi = 0 \) and \( \delta \phi_\mu = 0 \).

But in the current formulation of GR you cannot make such "boundary" (cf. Penrose and his disciples) exactly at null- and spacelike infinity, because it cannot be defined mathematically. Moreover, you will have to install there a special "mirror" (Rendall) for "gravitational waves" (Schutz). So the only available option is to explore a modified Machian theory of gravity in which the source of energy nonconservation comes from a dual surface placed at null- and spacelike infinity, pertaining to the global mode of spacetime of potential reality. Why dual surface? Because it is installed between every neighboring points of the spacetime continuum as well, like the unphysical Zen gaps.

Hence the spacetime manifold is "quantized" by \( \text{H}_1 \cup \text{O}_1 \) (cf. Sec. Topology) by physically invisible (due to the speed of light) gaps of Zen, and we can recover Einstein's "total field of as yet unknown structure" (see above).

In general, my interpretation of Einstein's Equivalence Principle includes both (i) energy conservation and (ii) energy nonconservation. Case (i) corresponds to a newly re-created achronal "slice" of the Universe, used to assemble the local mode of spacetime: see option Nein here, and Fig. 1 and NB in Addendum 2 here. Case (ii) corresponds to the binding and rendering (cf. Addendum 1 below) of such "slices" by the Arrow of Space, which assembles the topological dimensions (Sicl!) of the local mode of spacetime from 'something else'. Sure enough, if we examine such assembled chain of 4-D slices 'now' (local mode of spacetime), energy cannot and must not be conserved, and we encounter the law of energy nonconservation as well. With my interpretation of Einstein's Equivalence Principle, we can 'have our cake and eat it'.

Notice that the issue of conservation vs. non-conservation of energy can be formulated only and exclusively only in classical physics, in which we have 'objective reality out there' (e.g., the state of the Sun when nobody is looking at it; see Heisenberg). To use the ATM (cash machine) analogy explained at the end of MST.txt, if I withdraw more money than the amount in my bank account, I will have additional money on "credit", which will be like "negative of money" (Dirac). In Quantum Theory, however, we don't have 'objective reality out there'. Recall Erwin Schrödinger:

In general, a variable has no definite value before I measure it; then measuring it does not mean ascertaining the value that it has.

So if we consider a physical system grounded on the vacuum, we cannot even formulate the question whether energy has or has not been "conserved". All speculations about negative energy in GR (Horowitz) and negative energy densities for gravity (Helfer) and quantum field theory (Ford) are based on the wrong presumption that GR refers to a classical theory. No, in quantum gravity the issue of energy "conservation" viz. "non-conservation" makes no sense. To
use again the ATM analogy at the end of MST.txt, if I withdraw less money from the total amount stored in my bank account, or more money and run into "negative of money", the "remaining" amount of money in the entire bank will not change at all. Why? Because the absolute or total amount of money (viz. the total energy density of the vacuum) is undecidable -- any denumerable amount of money viz. any energy difference (Baez, Sec. 4) is irrelevant. This is the nature of the vacuum and its non-Archimedean topology. The case of "credit" or "negative of money" corresponds to emission of gravitational "radiation" in which the potential, not-yet physicalized energy is not bounded (Horowitz) and is manifested, for example, as GRBs ("5 solar masses emitted in under 60 seconds in the form of X-rays and gamma rays"). Thus, "negative energy" comes always in virtual negative-positive mass pairs (Belletête and Paranjape, pp. 6-7), called here 'potential reality': see Eq. 1 on p. 35 here. There can be no "conservation" of mass-energy in the Creation of the Universe. And if the physical system grounded on the vacuum is a human brain, we should be able to channel "negative energy" from the vacuum into macroscopic systems, and there will be no need to burn coal nor build nuclear power plants. This was the idea of my proposal sent to U.S. Department of Energy in March 1994.

Going back to Einstein's "glücklichste Gedanke meines Lebens" depicted with a hypothetical 'closed system' in the drawing below ("closed room"), notice that at every instant 'now' from the duration of such "fee fall" (Cavino) we have the case (i) above -- one-at-a-time, as re-created achronal 'slice' of the Universe, which does not possess anything that would be pulling the "closed room" in any spatial direction from the assembled local mode of spacetime. Why? Because gravity is not a force that can be shown with a vector, as with the bold red arrow below -- gravity does not obey Newton's third law. The case (ii) produces omnidirectional displacement of the whole 'closed room' ("shoal of fish") in the assembled local mode of spacetime, which we call 'time as read with a clock' (see Addendum 1 below). Due to the speed of light, we cannot detect the global referential "dark room", which Hermann Weyl dubbed 'the eternal repose of Father Æther'.

But how Mother Nature makes gravitational motion? Let's examine the rotation of the Moon around Earth.
See the little red arrow in Fig. 1.1? We call it gravitational centripetal gradient, which produces 'gravity as attraction', including "dark matter" (Wittman). The geodesic motion of the Moon is the result of dynamic equilibrium between gravitational centripetal gradient and the opposite centrifugal gradient due to rotation. The case of 'gravity as repulsion' is produced by gravitational centrifugal gradient, which is in dynamic equilibrium with 'gravity as attraction'. Perhaps the two gradients of gravity can be explored with REIM (see Addendum 1 below and p. 8 in sheeple.pdf).

**NB:** This hypothesis is based on the interpretation of 'rotation' (as well as 'spin') as global topological property of spacetime. The phenomenon of 'rotation' is present at all length scales, from elementary particles to the so-called "axis of evil" in the cosmic microwave background. The origin of 'rotation' is the dual topology of the elementary temporal and spatial displacement, dt and ds, along the Arrow of Space (cf. Fig. 1 here). Firstly, the joint "displacement" dt & ds does not have referential system, like the two river banks at absolute rest with respect to the flowing water in the river of Heraclitus. And secondly, this dynamic causality (called biocausality) includes two transitions with complementary topology: both along an infinite line (1-D Euclidean space) and along a completed (Sic!) circle. The remnant from the latter is observed as 'rotation', as it introduces angular momentum to the temporal and spatial displacement dt and ds. The "true" topology of spacetime cannot be comprehended by humans, because it is like a "trunk". And if we combine this dual topology of spacetime (see again the no-boundary proposal in Sec. Topology), observed as 'rotation & elementary tick of time', with Relative Scale (RS) theory of spacetime, we have RS theory of gravity based on alteration of the spacetime metric (see Addendum 1 below). No "curvature" is needed. No "dark matter" or "dark energy" either.

It is crucially important to understand that the joint phenomenon gravity & rotation does not have material source located in the past light cone, but is a global topological phenomenon. It is "blank canvas" (see above), like 'the grin of the Cheshire cat without the cat', as observer by Alice (see Addendum 1). We certainly observe 'rotation' and, unlike the case of quantum spin, can imagine an axis of rotation, but the gravitational rotation does not have any physical engine which could be placed at some axis in 3-D space. No physical field is "pushing" planets, stars, galaxies, and the whole visible universe (cosmic equator) to rotate. This phenomenon may be "counter intuitive", but is a fact of Nature.

Quantum gravity shows that something physical can be added to the physical world (e.g., proton mass and dressed particles), and the source of this additional
physical stuff comes from 'the universe as ONE BRAIN' (potential reality) and cannot entirely be traced back to any physical stuff in the past. If you nevertheless try to think of such effects as produced exclusively by some physical stuff in the past, you’ll have to pronounce the source of such effect "dark" (source here). For example, "positive pressure does not promote the expansion [of the universe]; therefore, one must have a high negative pressure!", says Yakov Zeldovich, but "negative pressure" is a misnomer. Briefly, gravity & rotation cause physical effects on matter, but the source of such physical effects cannot be derived exclusively from matter in the past -- the source resides in the potential future as well -- which is why quantum-gravitational matter looks "alive", like self-acting "brain".

In the case of 'gravity as attraction' shown with geodesic motion of the Moon, the very rotation and gravitational centrifugal gradient are produced by "shrinking" (see Addendum 1 below) the spacetime metric, caused by the inertial mass of Earth. In the case of 'gravity as repulsion', the whole universe (cf. 'school of fish' above) acts on itself by "inflating" (Addendum 1) the distances between spacetime points, and the "inflating" increases proportionally to the distance between all points of a "large" (see $B_1$ in Addendum 1) spatial domain -- a larger domain will be endowed with greater gravitational centrifugal gradient (Hubble's law). Hence some people gathered the idea of "dark energy" (source here). Again, the difference between the two presentations of gravity is that attractive gravity is local phenomenon related to distribution of inertial mass in $B_1$ (see Addendum 1), while repulsive gravity is global phenomenon of the entire universe. Their dynamic equilibrium is essential for the formation of galaxies and the precise fine-tuning of the topology of the universe.

To understand RS gravity and the "inflating" and "shrinking" of spacetime metric, consider an invariant (also indistinguishable) flow of time 'one second ($D$) per second ($D$)' as produced by the "speed" of time ($R$) with which light assembles 'one second ($D$)' by integrating the successive elementary "durations" of time ($T$): even a miniscule decrease of the "duration" $T$ will cause huge "shrinking" of the invariant 'one meter' and 'one second' with which the separation between two spacetime events is defined, hence will cause gravitational centrifugal gradient viz. 'gravity as attraction'. The opposite increase of the "duration" of $T$ will produce "inflating" of the invariant 'one meter' and 'one second' with which the separation between two spacetime events is defined, hence will cause gravitational centrifugal gradient viz. 'gravity as repulsion', known as Hubble's law. Yet at all length scales the invariant 'one meter' and 'one second' will remain indistinguishable (not identical, see Addendum 1), because in Relative Scale (RS) spacetime the "size" of all spacetime domains is defined with variable (Sic!) 'one meter' and 'one second', while all clocks run with an indistinguishable (not identical) flow of time 'one second per second', at all relative-length scales.

The initial idea is borrowed from the distance equation, speed ($R$) multiplied by time ($T$) equals distance ($D$), but here $D$ means the temporal "distance" of 'one second time of light', which is used to express (not define) the flow of time as 'time runs as one second $D$ per second $D$'. As is known from the distance equation for light, 360,000km separation between two spacetime points/events corresponds to 'one second time of light' ($D$), hence different "durations" of the unphysical atemporal $T$ will cause different values of the physical 'one second time of light' $D$, which in turn will render different-in-size spacetime regions (Addendum 1 below).

Notice that the two unobservable variables have different nature: the "duration"
of unobservable time $T$ is flexible, while the unobservable speed (rate) of time $(R)$ is fixed. These two variables are physically unobservable, because one cannot detect an emitted photon "during" its flight (watch John Walker above), before it is absorbed (see the 'clapping hands' at $dt$).

NB: To avoid misunderstandings of the flexible "duration" $T$ "during" the Zen gaps, read again the explanation at NB above, and keep in mind that $dt$ itself is not flexible, because $dt$ obtains numerical value as a 'limit' (cf. Sec. Topology here!). What is flexible is the duration $T$ of assembling atemporal unphysical and unobservable $dt$-s of not-yet-absorbed photon, spanned over physically unobservable atemporal $T$ of not-yet-absorbed photon "during" its flight. In a way, we zoom "inside" time/time scales are different (Small), yet indistinguishable (not identical) to suggest flexible durations $T$ of assembling 'one second' before the photon is absorbed, which leads to different -- yet indistinguishable -- durations of physical 'one second' of already-assembled time $(D)$ at the instant of 'clapping hands' at $dt$. Shortly, the flexible $T$ is the time of $D$, while the unobservable "dynamics" of $T$, denoted with $R$ (from 'rate'), remains fixed.

Perhaps the best way to explain $T$ and $R$ is with analogy from recording one-second video with two different rates $(R)$ called 'frames per second' (FPS), say, 30 FPS $(A)$ and 90 FPS $(B_L$, cf. Addendum 1 below). In the cases of 1s video recorded with 30 FPS, we denote 1 frame duration with $T$, which defines its duration $T = 1/30s$ and rate $R = 30$ FPS. However, in the second case of 90 FPS we denote 1 frame with $T'$, stressing that in RS spacetime the flexible duration $T'$ is 3x increased relative to $T$, as if it were spanned over 3 frames from the first video. Hence with the increased duration $T'$, the second 1s video will be assembled with the same fixed rate of 30 (albeit undetectably larger) FPS and will be indistinguishable from the first one. Likewise if we consider a third one-second video recorded with 10 FPS (cf. $B_s$ below), and set its duration of 1 frame $T''$ to be 3x smaller relative to $T$ in the first video -- the third 1s video will be assembled with the same fixed rate of 30 (albeit undetectably smaller) FPS and will be indistinguishable from the first one.

We shall refer to the variable $T$ as 'gravity differential', after Wilbur B. Smith (cf. Addendum 1). Notice that the "value" of $T$ is scale-dependent and cannot be determined with observation or experiment. $T$ valid for case $A$ is indistinguishable from (not identical to) $T'$ valid for case $B_L$ (Addendum 1). Ditto to $T''$. There is no absolute scale with which we could detect any change of the "duration" $T$. There is no absolute frame nor rate of 'absolute frames per absolute second' (FPS) in Nature. Otherwise the ether (cf. Einstein in Addendum 1 here) will be physically detectable.

Hence the crux of relative scale (RS) spacetime: 'one meter' and 'one second' are made by the Aristotelian Connection AC (see Eq. 1 above) to be indistinguishable (not identical) between all length scales, $T = T' = T''$ (Case I). Yet different length scales are different for themselves, as different "values" of $T$ lead to assembling different durations $D$ viz. different-in-size spacetime regions (Case II, see Addendum 1 below). In symbolic form, the equation of the first case (Case I) is $RT = 1$ (e.g., $30x1/30 = 90x1/90 = 10x1/10 = 1$). The equation of the second case (Case II) is $RT = D$, and different "values" of $T$ lead to different durations of $D$ viz. different-in-size spacetime regions. In all three cases, $T$ (Alice, see below), $T'$ (Large), and $T''$ (Small), $dt$ can and will obtain point-like numerical values as a 'limit' (cf. Sec. Topology here), yet $dt$ will pertain to different-in-size regions of spacetime, which are being assembled by different "values" of $T$. 

Surely one cannot measure some proper values (if any) of $T$ and $R$ -- we cannot detect some "river banks" of Heraclitus river at absolute rest to measure the flow of time ($D$) as 'one second per second' -- yet the minimal timelike displacement, $dt$, is an instantaneous frozen "flash" of the underlying light-in-motion: Panta rei conditio sine qua non est.

Similar phenomenon of "flashes" is known since 1911, thanks to Charles Wilson: see the most widely known public secret in theoretical physics here, and keep in mind that the same underlying light-in-motion is an unobservable atemporal quantum reality (global mode of spacetime) from which different numerical values of $dt$, as read with a macroscopic clock as water droplets (see below), are observed upon quantum measurements. Yet the intact quantum reality 'out there' is not directly observable: read again Plato and Erwin Schrödinger above.

Addendum 1

According to Relative Scale theory of spacetime (hereafter RS spacetime), the length scale in Nature, shown in the Gedankenexperiment Powers of Ten (watch the video below), is not absolute but relational. The assembling of spacetime by the Aristotelian Connection (AC) along the Arrow of Space (cf. Fig. 1 here) produces finite regions of spacetime, which are interpreted with two complementary cases. In Case I, two regions, denoted with $A$ and $B_L$, are in
fact indistinguishable in "size". In Case II, the second region $B_L$ is in fact larger in "size". Cases I and II are also applicable to the opposite case of Small, denoted below with $B_S$; just replace 'larger' with 'smaller' to obtain Case II and $T'$ (see above). I hope the explanation is obvious and will be omitted for brevity. No experiment or observation can determine whether Case I or Case II is wrong or correct, because the two factual cases are complementary.

Powers of Ten™ (1977)

According the the girl shown above (let's call her Alice, denoted with $A$), she is in the middle ("visible dot") between the Small and the Large (see the drawing below). Correct. But if make another Gedankenexperiment by instructing her partner (let's call him Bob, denoted with $B$) to move along the two opposite directions of the axis (watch Powers of Ten above), toward the Small and the Large, Alice (dotted line in the drawing below) will conclude that Bob is getting "small" viz. "large".

Correct, according to Alice. But not according to Bob, because he will be always assembled or rather rendered by the Arrow of Space (Fig. 1 in Sec. Topology here) as an invariant spacetime region possessing the same size (Case I) of Alice (dotted line). Hence the two rendered (see explanation below) spacetime regions, belonging to Alice and Bob, are in fact different (Case II), yet are in fact indistinguishable (Case I) as well.
How could this happen? By altering the physically unobservable and flexible variable $T$ (see above) which determines the physical '1s time of light' ($D$) in all finite spacetime regions. How? At the level (Sic!) of the potential reality of $D$, denoted above with $T$.

In the drawing above, Alice is denoted with $A$, 'Bob in the Large' with $B_L (T')$, and 'Bob in the Small' with $B_S (T'')$. The axis connecting the Small, Alice, and the Large is an achronal "slice" of the Universe, shown in Fig. 1 here. The alteration of the physical '1s time of light' ($D$) produces different (Case II) rendered regions of spacetime, which are "stacked" on the spacetime axis in Powers of Ten above, yet these rendered regions of spacetime are indistinguishable (not identical) as well (Case I).

To understand how the spacetime metric is altered ("curved" spacetime is a very misleading metaphor) in RS spacetime, keep in mind that the meter itself - the invariant length -- is "shrinking" toward the Small and "stretching" toward the Large, as shown in the drawings below. Hence the alteration of spacetime metric at the level of 'potential reality' ($T$) is "directly related to the energy and momentum of whatever matter and radiation are present" (Wiki), but there's no "curvature" in RS gravity. Why? Because the physicalized presentations of 'potential reality', which produce the local (physical) mode of spacetime (shadows in Plato's cave), are embedded in the atemporal global mode of spacetime -- not in some fictional higher-dimensional manifold -- and cannot be "curved". It's that simple.

Here I will be very brief, and will be happy to elaborate upon request. Suppose this is an invariant 'one meter', according to Alice:

Below is also an invariant 'one meter', somewhere along the road toward the Small:
Relative to Alice, it is indeed "smaller" (Case II), but according to 'Bob in the Small' $B_s$, it is indistinguishable from the first invariant length denoted as 'one meter' (Case I).

And this is also an invariant 'one meter', somewhere along the road toward the Large:

![Graph showing invariant lengths](image)

Relative to Alice, it is indeed "larger" (Case II), but according to 'Bob in the Large' $B_L$, it is indistinguishable from the first invariant length denoted as 'one meter' (Case I).

**NB:** The alteration of the invariant 'one meter' (see NB above) is made in the potential reality: see Sec. Topology.

Who has 'the right meter'? **Nobody.** See the analogy with recording and rendering one-second movie with different frames per second (FPS) above. Besides, the Small and the Large are separable only at point $A$. Once Bob moves toward the "small" (relative to Alice), he will be moving toward the "large" (relative to Alice) as well, because the "small" and the "large" interpenetrate and produce entanglement of spacetime (see below). So the size of a proton and the size of a galaxy have "the same" indistinguishable length (Case I). Yet relative to Alice at point $A$, the two have indeed different and opposite sizes (Case II), being in fact Small and Large as well.

Of course, Alice is right. So is Bob ($B_s$ & $B_L$), because there is no absolute 'one meter' nor 'one second' -- at all length scales they are being rendered by the Arrow of Space (see Fig. 1 here) from 'one and the same' continuum of non-Archimedean topological points (cf. Eq. 1 above and Sec. Topology). Why 'one and the same', instead of some "number"? Because of Cantor's discovery.

Suppose Alice, who stays always at the length scale of tables and chairs, examines a spherical region of her spacetime, assembled with her value $T$ (see above) to obtain diameter of app. 300,000km, which corresponds to app. 1s time or light ($D$) to trespass it. Let's denote this spatial size with $L$ and its characteristic light-time (1s) with $D$; their ratio is the "speed" of light, $L/D = c$ [km/s]. Suppose also that Bob's spacetime in the Large ($B_L$) is enlarged by coefficient $K$, that is, $B_L$ has been rendered with $T' = KT$. With respect to Alice, 'Bob in the Large' ($B_L$) is $K$-times larger compared to her (Case II). But in RS spacetime, Bob's $T'$ of rendering his physical 1s ($D$) viz. spacetime region ($B_L$) will be $K$-times larger to her $T$ -- not to his $T'$. Relative to Alice, Bob's physical 'one second' ($D$) will be $K$-times inflated, rendering $K$-times larger ($L' = KL$) spacetime region ($B_L$). Relative to whom? Only to Alice, of course. Relative to Bob, his $B_L$ will in fact be exactly as "large" as Alice's $L$ ($L' = L$): see FPS analogy and its disambiguation in the main section above.

**NB:** If Bob is rendering Alice's one-second $D$ with $K$-times inflated (with respect to Alice) $T'$; he will consume $K$-times more time $T$, thus Alice (not Bob) will observe (with Hubble Space Telescope) $B_L$ in "slow motion", just as she (and three other people) would observe a bouncing droplet in slow motion. The "slower motion" of light (Sic!) will produce the effect called by Alice (and those three people) "redshifted light" (yes, I am also running for Nobel Prize).
One could claim that Bob's physical one-second (D) might have been assembled with K-times "larger" T', but the relative-scale "size" of T makes no difference: see again FPS analogy and its disambiguation in the main section above. Besides, in the continuum of topological points any denumerable number of points (dt) makes no difference. If Alice and Bob had a common background Newtonian spacetime to act as some fixed grid endowed with absolute metric, they could prove Case I wrong and introduce Archimedean topology as fundamental fact of Nature, hence obliterate the theory of relativity by introducing an ether (cf. Einstein in Addendum 1 here).

Let's talk about the flow of time as rate of assembling "frames" dt, separated by Zen gaps. In the drawing below, \( dt = AB \) (see Fig. 4 here).

Fiber-bundle structure where each moment in time, dt, pertains to its own re-created 3-D "slice" of the Universe: space is erased and redefined "within" each instant \( AB = dt \), corresponding to photon's zeroth world line along w below.

Notice that the propagation of light, which assembles its relative-scale 'one second' (D) to obtain the topological dimensions of the local (physical) mode of spacetime, cannot have reference frame: "due to Lorentz invariance, an electromagnetic wave cannot be at rest with respect to any inertial observer; therefore, we do not need to specify a reference system for the propagation of light, i.e. its movement is completely independent of the motion of inertial observers and it can thus be considered as absolute" (Lichtenegger and Mashhoon, p. 14).

Why absolute reference frame? Because the rendering of spacetime is atemporal, as it is "happening" on null surfaces. With respect to your clock, the unphysical time of light T is an atemporal global mode of time -- exactly the same atemporal global mode of time pertaining to the human brain. It is physicalized only as 'clapping hands' with "duration" \( AB = dt \). Yet the invariant time interval is assembled from infinitely many (actual infinity, not 9,192,631,770) dt to produce the local (physical) mode of spacetime endowed with Archimedean topology (cf. the explanation of Eq. 1 above) -- once-at-a-time along the Arrow of Space (cf. Fig. 1 in Sec. Topology here). This atemporal process on null surfaces (see the animation below) is called rendering of spacetime; see again NB above.
The atemporal rendering of spacetime along the \( w \) axis (see below), performed with the self action of Aristotelian Connection (AC), is being nullified -- once-at-a-time, denoted with \( dt \) -- to seal off the "Zen gaps" of the perfect continuum called local (physical) mode of spacetime.

In RS spacetime, changes of the values of \( T \) will produce at all length scales indistinguishable temporal distances \( D \) of 'one second', and indistinguishable flow of time as 'one second per second' (Case I), yet different values of \( T \) will render different values of 'light-time 1s' \( D \), yielding Large (\( B_L \)) and Small (\( B_S \)) regions of spacetime (Case II). Namely, K-times inflated \( T \) will correspond to K-times increased \( D \) (see Case II below) viz. K-times inflated spacetime region \( L \) with indistinguishable "speed" of light \( c \), \( L/D = c \) [km/s]. Here's a brief summary:

Case I: \( RT = 1 \) (Eq. 1.1), so if we multiply \( T \) by \( K \), \( R \) will be multiplied by \( K^{-1} \), and all relative-length spacetime regions, \( A \) and \( B_S \) & \( B_L \), will be indistinguishable (not identical). Alice (\( A \)) remains in the middle between \( B_S \) and \( B_L \), with "30 FPS": see FPS analogy and its disambiguation in the main section above.

Case II: \( RT = D \) (Eq. 1.2), so if we multiply \( T \) by \( K \), will obtain K-times larger 'light-time 1s' (\( D \)), which is rendered as K-times larger spacetime \( B_L \), but only
with respect to Alice. As explained in NB above, the light coming to Alice from a larger (to her) spacetime region \( B_L \) will be "redshifted" (no scattering of light is involved), yet no absolute "metric expansion of space", valid for Alice and for 'Bob in the Large' \( B_L \), will be needed (three people were lucky to get Nobel prize by employing alternative hypotheses based on some "dark" you-name-it).

Thus, the unphysical \( T \) takes values in an open interval \((0, \infty)\), yielding Large and Small physical 'one second' \( D \) viz. Large and Small regions of spacetime. In fact (Case I), there is only one 'Bob', \( B_S \) & \( B_L \), thanks to which we have entanglement of space (cf. Eq. 2 in Addendum 6 here). Yet in fact \( B_S \) and \( B_L \) are different as well (Case II), as \( B_S \) is rendered with \( K \in (0, 1) \) and \( B_L \) is rendered with \( K \in (1, \infty) \). Alice (A) remains in the vicinity of \( K = 1 \).

NB: Notice that \( K = 0 \) is indistinguishable from \( K = \infty \), as they pertain to (Luke 17:21) -- see Eq. 3 below.

Also, the entire spacetime, \( A & B_S & B_L \), is rendered from \( K = 1 \) in two opposite "directions", simultaneously toward \( B_S \) & \( B_L \). The largest physical region of spacetime, rendered as \( B_L \), will be an asymptotic region of \( K --> \infty \), which can never be completed exactly up to 'infinity' by massive particles (bradyons), because their flow of time will stop, like photon's proper time traveling on zeroth world line. However, in RS spacetime we introduce a new axis, denoted with \( w \) (from wunderbar, after Theodor Kaluza), which is orthogonal to photon’s zeroth world line (see the drawing below), and is being (present continuous) nullified at every instant (topological point) here-and-now from the local (physical) mode of spacetime. This atemporal nullification -- one-at-a-time -- is made in the global mode of spacetime (cf. the Arrow of Space in Fig. 1 here) along the \( w \) axis.

The physicalizable "mass" at \( P_i \) is potential reality (Macavity), which is rendered as positive mass at \( P \) endowed with inertia. Elevating \( P \) at \( P_i \) is considered reversible process (REIM). The red point from \( w \) axis shows the elementary transition \( AB = dt \) in Fig. 4, which has zero "dimensions": photon's world.
line, which every *inanimate* clock reads as *already* completed. The *human brain* and all quantum-gravitational objects read it as *atemporal* global mode of spacetime -- *potential reality*.

The first off task in the so-called Virtual Geodesic Path formulation of GR (2 October 2010) is to get rid of tensors defined on a *dead fixed manifold*, and invent new imaginary numbers (called *hyperimaginary numbers*, denoted with \(w\) from *wunderbar*), so that the squared moduli of the wave amplitudes of potential-reality waves will be *always zero* \((w^2 = 0)\), matching a flat line due to *destructive interference*. Notice that \(\sqrt{w}\) is *not* zero, just like \(\sqrt{i}\) is neither negative nor positive.

The two imaginary degrees of freedom, \(+i\) and \(-i\), facilitate the *atemporal offer and confirmation* waves of potential reality "outside the train" (September 2011), like the two 'drawing hands' of Escher above. The *atemporal offer and confirmation* waves of potential reality should eliminate 'all but one' of the potential states of the Universe, yielding one *physicalized (virtual)* state at the *interface* 'now' in Fig. 4, while keeping the rest of non-physicalized *potential* states stored in the atemporal vacuum, ready for negotiating the *next* interface 'now'. Hence the red point from \(w\) axis (see above) also denotes the *physicalized* presentation of \(w\) cast on its *real* basis viz. the *structure* of every topological point defined with the no-boundary proposal (see Sec. Topology).

In general, we propose that the physical world is made from "*retarded" light-and-cognition (John 1:1) with equation of state

\[1 \times 1 = 1\ (\text{Eq. 3}).\]

In RS spacetime the *physicalized* explications of 'the Universe as ONE' are produced by *atemporal* conversions -- one-at-a-time -- between Eq. 3 and Eq. 1 above, yielding *dual cosmological age* of the "retarded" physical world: once created by God (John 1:1), the physical universe is *already* (Sic!) eternal, as it can never actually reach its Beginning-and-End (Luke 17:21).

Watch the video explanation below, and keep in mind that nobody knows
whether $\sqrt{0}$ is indeed "zero". It may refer to an atemporal light-like null surface, called here 'global mode of spacetime' (cf. Fig. 4 here). The latter is governed by actual infinity as ONE entity, as it does not have physical metric viz. 'parts' (Euclid).

0.47 - 0.52: "Relative to the platform, time on the train completely stops." Yet with hyperimaginary numbers $w$, $\sqrt{w}$ is not zero. Only $w^2 = 0$ (see below), hence $(t' = tw)$ pertains to the null surface (global mode of spacetime) at which all tachyons will be "frozen" at absolute rest.

This is Relative Scale theory of spacetime. At the end of the day, we hope to offer new interpretation of the three kind of masses (positive, negative, and imaginary) shown below, from Terletsky (1966), Ch. VI, § 25.

Notice that the unphysical variables $T$ and $R$ are "absolute structures" (Giulini, p. 11; Anderson, p. 73 and p. 339). If they were physically observable, we will have physical presence of 'Father Æther' and an absolute "reference fluid" (also called 'individuating field'), which can identify the points of space and the
instants of time, like in the Newtonian spacetime (see above). Bad idea, because
the spacetime will have Archimedean topology at fundamental level, and the
erther (cf. Einstein, 5 May 1920, in Addendum 1 here) will become physical
observable at absolute rest, like the two river banks at absolute rest with
respect to the flowing water in the river of Heraclitus.

Now let's move to RS gravity by introducing the alterations of spacetime metric
in RS spacetime as the origin of gravity. To obtain $B_s$, set $K < 1$ in the open
interval $(0, 1)$. To obtain $B_L$, set $K > 1$ in the open interval $(1, \infty)$. Keep in mind
that in RS gravity the centripetal and centrifugal gravitational gradients (see
above) are due to $K < 1$ (attractive gravity) and $K > 1$ (repulsive gravity). That
is, gravity "shrinks" the metric of physical spacetime without any "dark matter"
or "supermassive black holes", and "expands" the metric to produce the
repulsive presentation of gravity: no need for any "dark energy" of (whatever).

Another application of RS gravity: if you fly with a jet plane (see below) with,
say, 600 km/h in Alice's spacetime (dotted line in the drawing above), you will
pass 167m/s, but if you switch to the spacetime of 'Bob in the Large' and use $K
= 3$, you will fly with $3 \times$ speed, and with enormous acceleration. With respect to
whom? Only to Alice, of course. You won't notice in your REIM drive any sudden
acceleration (watch 0:49 - 0:51) of your relative-scale speed.

To fly like an Alien Visiting Craft (AVC), you may have to alter (cf. p. 8 in
sheep.pdf) the gravity differential $dt$ (cf. Wilbur B. Smith below) of your REIM
drive by $K > 1$. This will be bona fide spacetime engineering. Tough challenge.

Wilbur B. Smith (3:00 - 3:10): "... to produce the gravity differential,
the time field differentials which were necessary to operate the ship."

Alice will see you "accelerating" from her with enormous speed (watch 0:49 -
0:51), and will think that you've been propelled by "dark energy" (explanation
here). So imagine the following experiment. Alice and Bob are in Munich, and
have synchronized their atomic clocks with highest possible precision at
09.00AM. Alice is walking her dog, while Bob jumps in his private jet plane and
flies to Hamburg and back ($2 \times 600$km) with average speed 600km/h with respect
to Alice, so she expects to see him back at around 11.00AM. But at a safe
altitude of 11km, Bob switches to $K = 3$ and makes his jet a REIM drive.
Relative to his spacetime, his speed remains 600 km/h and can never exceed his
Three questions come to mind. Will Bob see at $K = 3$ the space "moving" toward him, like in sci fiction movies? In the case of Alcubierre Warp Drive, Brendan McMonigal explained: "Strictly speaking, the ship is stationary in space, rather it is the space that is distorted around the ship. This is why it is different to, say, a plane flying through space." Secondly, when Bob and Alice rejoin in Munich, will their atomic clocks show difference in reading their times? And thirdly, if there is a difference, whose clock will be "lagging" at 09:40AM? I bet on Bob's clock. Here's why.

If Bob was flying the distance $L = 1200$ km (2x600km) like Alice ($K = 1$) but with 1800 km/h, we can calculate a miniscule value of its relativistic time dilation with respect to Alice's clock at 09:40AM. If we denote the reading of Alice's clock at 09:40AM with $M$, and the reading of Bob's clock ($K = 1$) with $N$, the time dilation will be $M - N > 0$. But since Bob is flying with an altered gravity differential $T'$ ($K = 3$), it will 3x inflate $(M - N)$, so if we denote the reading of his (also perfectly accurate) clock at $M$ with $N'$, we claim that $(M - N') = 3x (M - N)$, because his relativistic time dilation will be 3x increased.

I bet all air traffic controllers and "the good guys" monitoring Bob's jet with spying satellites (Süddeutsche Zeitung, 6. Dezember 2013) will immediately detect the jet flying with their 1800 km/h (990 knots, 2:10 - 2:24). But what may happen if Bob uses $K = 3000$ and fly with 500 km/s relative to Alice? I suppose $(M - N)$ will be inflated by 3.10$^3$, yet the relativistic time dilation will be still too small to detect with atomic clocks. Now, the diameter of Milky Way is approx. 120,000 light-years, which makes 378,684x10$^7$ light-seconds, so an AVC would need to fly with $K = 378,684x10^7$ in order to pass through our galaxy (we stay with Alice) for 1s. If our guests were flying here on Earth like Bob with $K = 3$ or 1800 km/h relative to Alice, with the value of $K$ above they will navigate through Alice's spacetime with 5.7x10$^5c$ relative to Alice. Yet their speed in their altered spacetime will never surpass their relative-scale "speed" of light, because $(M - N)$ can never be inflated backwards to eliminate the initial 40min. Such "miracle" can be attributed only to some transcendental tachyon which is already absolutely everywhere at 'time zero' at the beginning at 09.00AM.

Trouble is, the engine of AVCs is total mystery to me, because it should use the centrifugal (to accelerate with $K > 1$) and centripetal (to de-accelerate with $K < 1$) gravitational gradients without 'rotation', and should be de facto unconstrained by inertia (REIM). Perhaps such engine can produce gamma-ray photons ("a bright flare"; see the flash at 0:54-0:56 here), but will it produce unbounded amount of positive energy (Horowitz) by "runaway reaction" (Chase)?

Perhaps the so-called hyperimaginary numbers (see photon's zeroth world line above) can be explained with superposition of three kinds of masses: (i) imaginary mass of tachyons (cf. Addendum 2), in which case their $(m)^2$ is negative (Chase), (ii) massless particles such as photons ($E^2 - p^2 = 0$), and (iii) particles with real positive/negative mass (see "negative of money" above), in which case their $(+/-m)^2$ is positive, so case (i) exactly cancels case (iii), and we obtain a perfect vacuum of energy, $w^2 = 0$. But how can we start and stop $K$? With polarization of the light vacuum, $w^2 = 0$, producing virtual positive/negative pairs from (iii), which could eliminate (REIM) the inertia of $(+m)$? We need the engine of AVCs, we can't fly only with our brains!
Of course, I could be wrong. Perhaps we can, but by using the **Brain of the Universe**. As Christopher Columbus once noticed, if we didn't go directly west to seek new route to India, how could have we discovered America?

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I am grateful to my daughter **Kalina Chakalov** for bringing my attention to the **Powers of Ten™** (1977), and to my sons **Andy Chakalov** and **Nikola Chakalov** for providing many insights and creative ideas.

Surely the future belongs to youth, as explained by **Geheimrat Max Planck** (*Philosophy of Physics*, Norton and Company, New York, 1936, p. 97):

An important scientific innovation rarely makes its way by gradually winning over and converting its opponents: it rarely happens that Saul becomes Paul. What does happen is that its opponents gradually die out and that the growing generation is familiarized with the idea from the beginning: another instance of the fact that the future lies with youth.

D. Chakalov
October 29, 2014

**Addendum 2**

A few days ago, I wrote to my good old friend **Erasmo Recami**, informing him that after thirty years of studying tachyons (see also **Gerald Feinberg**), only now I can suggest something conclusive about their **puzzling nature**. First, check out the Quantum of Time (chronon), introduced by Erasmo Recami and Ruy Farias in 1997, and keep in mind that, "unlike any known particle, tachyons do **not** interact in any way and can never be detected or observed" ([Wiki](http://example.com)). To quote again from Wiki (emphasis mine), "after a tachyon has passed nearby, we would be able to see two images of it, appearing and departing in opposite directions"; see the drawing below (source [here](http://example.com)).

"Because the **object** arrives **before the light**, the observer sees **nothing until** (Sic! - D.C.) the sphere starts to pass the observer, **after** which the image-as-seen-by-the-observer splits into two -- one of the arriving sphere (to the right) and one of the departing sphere (to the left)."

To understand the meaning of "the observer sees **nothing until** (Sic! - D.C.) the sphere starts to pass the observer", notice that **before the light**' is depicted with the new axis **w** above, which is erected toward the atemporal potential reality at photon's **zeroth** world line, "over" **one** topological point 'here-and-now' from the spacetime continuum. We postulate two atemporal topological
waves, propagating in the atemporal potential reality, to explain the emergence of the instant 'here-and-now', denoted with AB in Fig. 4 here. Obviously, one cannot "expand" the atemporal Zen gaps to observe the "flashes" of physicalized world with their "proper" duration dt. This is why the atemporal "duration" T (see above) is unphysical.

The light vacuum $w^2$ (see above) is by default perfectly neutral, as it does not interact "in any way and can never be detected or observed" (Wiki). Stated differently, the light vacuum is the omnipresent light-in-motion: *Panta rei conditio sine qua non est*. Its symbolic 'equation of state' (resembling the Pythagorean theorem) requires the so-called hyperimaginary numbers (see the exact cancellation of case (i) with case (iii) at the end of Addendum 1 above),

$$w^2 = (m_i)^2 + (+/-m)^2 \quad (\text{Eq. 4}).$$

Notice that $\sqrt{w}$ is not zero. Only $w^2 = 0$.

Hopefully, if we tweak Eq. 4, we may obtain retarded light in the form of always positive (Macavity) mass and energy, which can be observed only post factum, only in your past light cone. But "before" you do that, you will see "nothing", as Wiki eloquently explained above. Then the (charged) tachyon instantaneously splits (not once but infinitely times) into two massive particles with equal mass $(+m)$ but opposite charges. The two particles with non-negative mass literally emerge from one single point here-and-now, at the exact same time and exact same place, causing annihilation (e.g., "a bright flare", see also the flash at 0:54-0:56 here), not Cherenkov radiation. In electron-positron annihilation, two gamma rays will emerge, moving in opposite directions, and one of the rays will accelerate you like an AVC (see above). Actually, one of the rays will be the AVC itself. Of course, "energy is given off" as well.

Hence with just one tachyon one could reproduce the release of energy corresponding to five solar masses emitted in under 60 seconds in the form of X-rays and gamma rays. Is this a new route to India?

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