

Relative Scale Spacetime

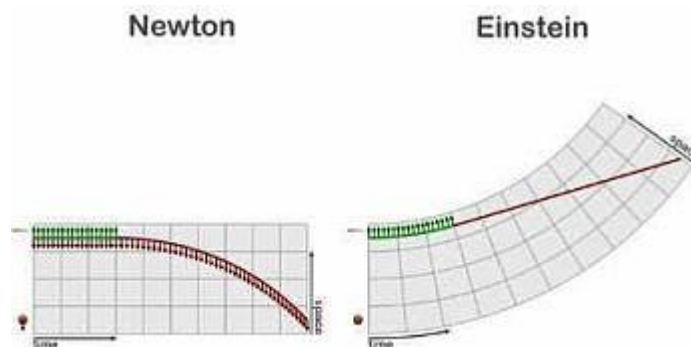
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Abstract

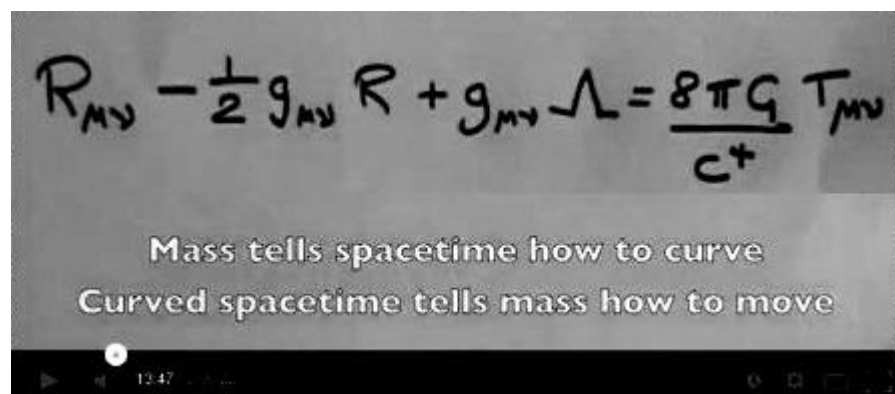
Ensuing from the proposals of Plato, Heraclitus and Aristotle, a new theory of spacetime has been suggested. The scope is to reveal the origin of gravity and replace the absolute size of spatial volumes at different length scales by 'relative scale spacetime'.

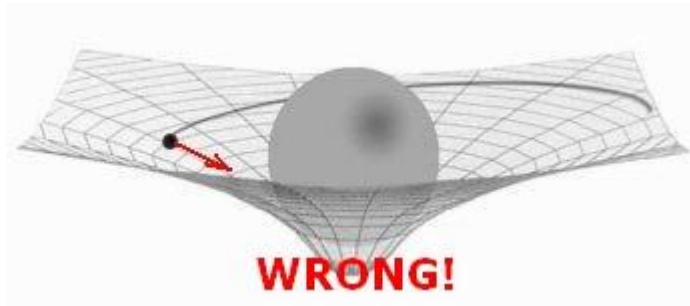
The next question was - what makes planets go around the sun?
At the time of Kepler some people answered this problem by saying that there were angels behind them beating their wings and pushing the planets around an orbit. As you will see, the answer is not very far from the truth. The only difference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

Richard Feynman, *The Character Of Physical Law*, 1967



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)?





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, resembling "**event horizon**". Regardless of how you would "confine" infinity, it cannot be proved for **massive particles** in **FLRW spacetime**. No you can't (C. Norris). 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 snow 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"](#):

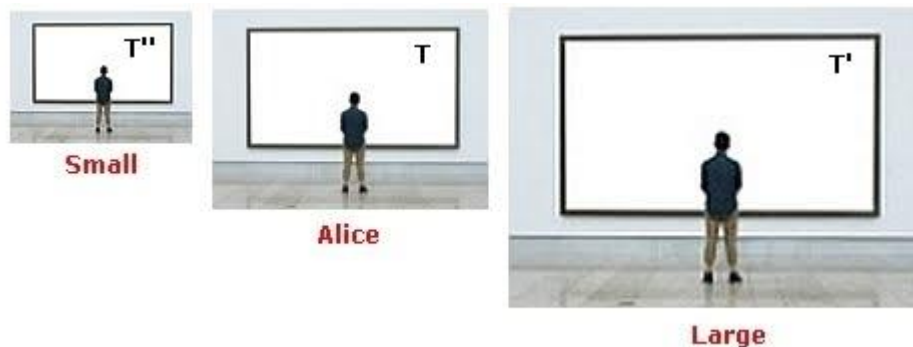
The right hand side is a formal condensation of all things whose comprehension in the sense of a field theory is still problematic. Not for a moment did I doubt that this formulation was merely a makeshift in order to give the general principle of relativity a preliminary closed-form expression. For 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 *in time*, as measured with a clock. 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 human self also keeps its **identity**, despite its perpetually changing brain. 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 "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" could be traced to the *physical* or "colorful" spacetime (not shown) **only** as [infinitesimal](#) "changes" **dt**, but **(i)** it is impossible to detect

the transition between any **dt** and its *next dt* online (along axis **w** on p. 22 in Addendum **1** below), as it "happens" in time-like "direction", and (ii) the "sizes" of **dt** are *indistinguishable*, as all different-in-size colorless canvases contain the same *undecidable* "number" of spacetime points (**Cantor**). If **dt** had [Archimedean topology](#) and could be presented with a *number*, say, **dt** = 10⁻⁴⁴ s (**Planck time**), we could use an *absolute* 'one second' and determine the duration of each colorless canvas, as read with a physical clock. Thanks to **Cantor**, we know that it is impossible *in principle* to attach any *numerical* value to **dt**, as it *emerges* from *potential* "colorless canvases" with *undecidable* "size" due to the absence of *any* metric there.

Again, **dt** is *the only* thing we can observe from the three colorless canvases below, so we cannot determine whether it *emerges* from "large" or "small" colorless canvas, as the latter does **not** have any *metric*. Although the three colorless canvases are shown as 'different in duration', what we *cannot* see is the **one single** "colorless" point (cf. Eq. **3** below) which is the *source* of potential or "colorless canvases", being both "that which has no part" (**Euclid**) and 'that which has no end nor part' (see the explanation at Eq. **1** below).



The "colorless canvas" is both "that which has no part" (**Euclid**) and 'that which has no end nor part' (cf. Eq. **1** below). It is a [mind-like](#) entity (dubbed [God's thoughts](#) by **Einstein**) *without* any metric: the *idea* (cf. Plato below) of a tree cannot be "smaller" than the *idea* of a mountain (e.g., the "largest" canvas).

Hence Nature can obtain smaller or larger *physical* (colorful) stuff (just "details", **Einstein**) with smaller or larger size, pertaining to the so-called *local* (physical) mode of spacetime (see below). 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 *explanations* 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* physical object is 'blue'.

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: 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](#)?

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

This symbolic equation shows the ultimate puzzle of the [invariant](#) 'one meter' and 'one second' of **finite** (Sic!) size and duration, obtained by multiplying "that which has no part" ([Euclid](#)) by 'that which has no end nor part'. Suppose we place an [invariant](#) 'one second' in the right-hand side. All we can say is that 'one second' is **finite**. Which means that, on the one hand, it can be *physicalized* by "colorful" stuff and offer *metric* for its *physicalized* "colorful" stuff, thank to which we can use [Archimedean topology](#) for the *physicalized* "colorful" stuff (Case II below). On the other hand, the same [invariant](#) 'one second' can be *physicalized* by "colorful" stuff **iff** it has the non-Archimedean "blank colorless canvas" as *potential reality* (cf. above) in which there is no metric, so the three canvases depicted in the drawing above are *indistinguishable* (Case I) as well.

We can interpret the right-hand side of Eq. 1 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 $dt = \mathbf{0}$. Also, **c** does not possess [Archimedean topology](#) either; for example, in [theory of relativity](#) $0.8c + 0.7c = \mathbf{c}$. 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

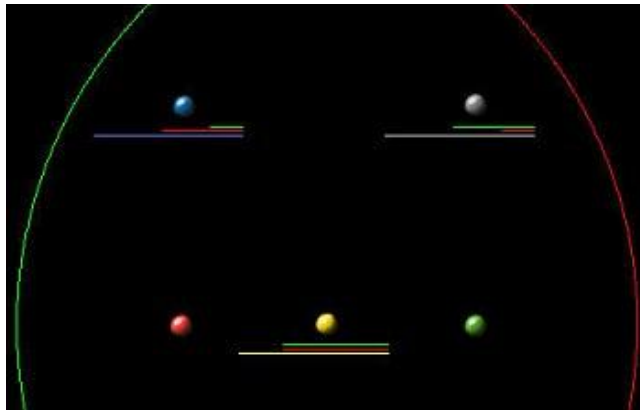
introduce an **absolute** length scale of *bare* 'spacetime *per se*', which is *very bad* idea (see below).

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 negotiation 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).



**Which goes first?
Matter or geometry?**

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

$$G_{\mu\nu} = R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R$$

"The field equations simply equate this to the energy-momentum tensor T_{mn} , 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 $R_{mn} = T_{mn}$, 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 $H_i U O_i$ (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 (Sic!) 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'.

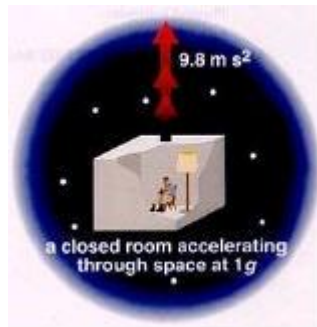
Notice that the issue of conservation vs. non-conservation of energy can be formulated only and exclusively only in classical physics, in which we have 'objective reality *out there*' (e.g., the state of the Sun when nobody is looking at it; see [Heisenberg](#)). To use the ATM (cash machine) analogy 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 "free 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.

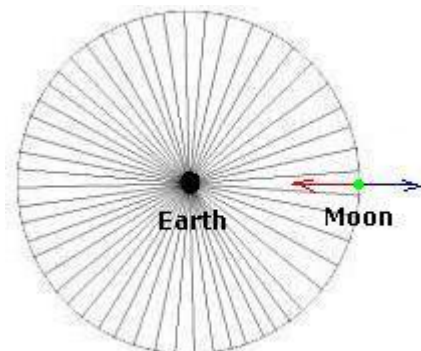


Fig. 1.1

Centripetal and centrifugal gravitational gradients

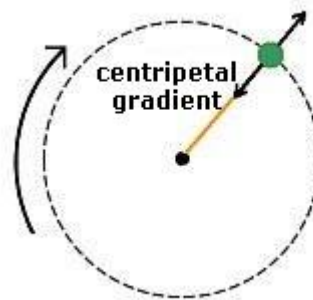


Fig. 1.2

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 *centripetal* 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_L** 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_L** (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 *centripetal* 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 *derivative* **dd/dT** 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

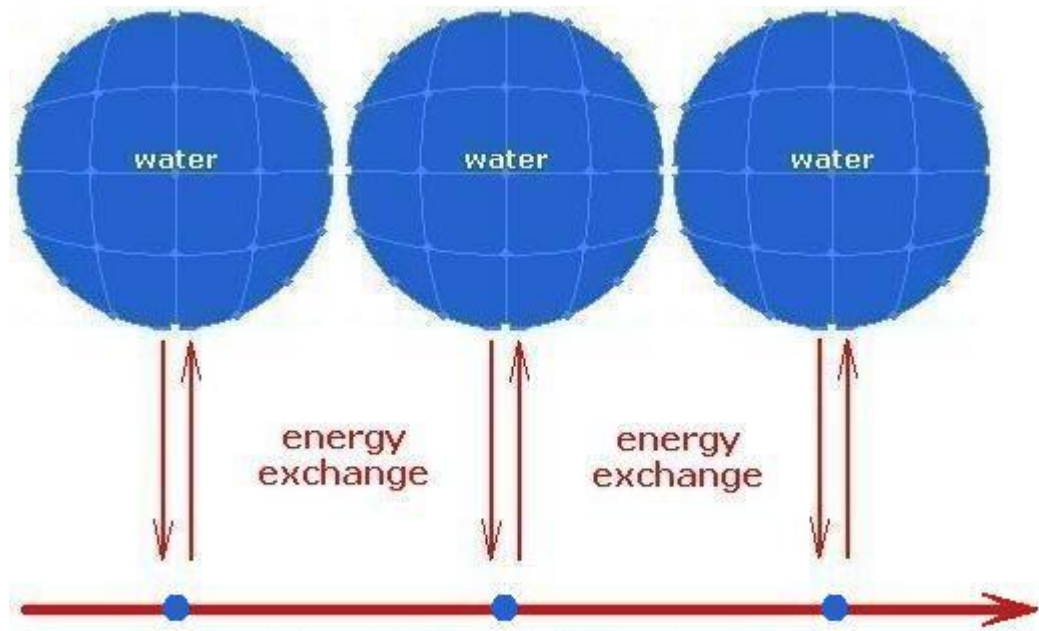
duration $\mathbf{T} = 1/30$ s and rate $\mathbf{R} = 30$ FPS. However, in the second case of 90 FPS we denote 1 frame with \mathbf{T}' , stressing that in RS spacetime the *flexible* duration \mathbf{T}' is **3x increased** relative to \mathbf{T} , as if it were spanned over 3 frames from the first video. Hence with the *increased* duration \mathbf{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. \mathbf{B}_S below), and set its duration of 1 frame \mathbf{T}'' to be **3x smaller** *relative* to \mathbf{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 \mathbf{T} as 'gravity differential', after Wilbur B. Smith (cf. Addendum **1**). Notice that the "value" of \mathbf{T} is scale-dependent and cannot be determined with observation or experiment. \mathbf{T} valid for case \mathbf{A} is *indistinguishable* from (not identical to) \mathbf{T}' valid for case \mathbf{B}_L (Addendum **1**). Ditto to \mathbf{T}'' . There is no absolute scale with which we could detect any *change* of the "duration" \mathbf{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 \mathbf{AC} (see Eq. **1** above) to be indistinguishable (not identical) *between all* length scales, $\mathbf{T} = \mathbf{T}' = \mathbf{T}''$ (Case I). Yet different length scales are different *for themselves*, as different "values" of \mathbf{T} lead to *assembling* different durations \mathbf{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 $\mathbf{RT} = \mathbf{1}$ (e.g., $30 \times 1/30 = 90 \times 1/90 = 10 \times 1/10 = 1$). The equation of the second case (Case II) is $\mathbf{RT} = \mathbf{D}$, and different "values" of \mathbf{T} lead to different durations of \mathbf{D} viz. different-in-size *spacetime* regions. In all three cases, \mathbf{T} (Alice, see below), \mathbf{T}' (Large), and \mathbf{T}'' (Small), \mathbf{dt} can and will obtain point-like numerical values as 'limit' (cf. Sec. Topology [here](#)), yet \mathbf{dt} will pertain to different-in-size regions of spacetime, which are being *assembled* by different "values" of \mathbf{T} .

Surely one cannot measure some proper values (if any) of \mathbf{T} and \mathbf{R} -- we cannot detect some "river banks" of [Heraclitus river](#) at *absolute* rest to measure the *flow* of time (\mathbf{D}) as 'one second per second' -- yet the minimal timelike displacement, \mathbf{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 \mathbf{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.



http://en.wikipedia.org/wiki/Cloud_chamber

Q: How will you explain the emergence of the visible trajectory made from water droplets by ENERGY EXCHANGE with one single quantum particle?

Wait for the mathematical theory of MST. In the context of *set theory*, the **dual** potential reality, denoted with ϕ in June 2007, is explicated as *physicalized* members (*shadows* on Plato's cave) of its set, yet ϕ is residing 'outside' its set *as well*: God is purely *mathematical* object, residing *both* inside of the universe *and* outside of it, as 'the Universe as ONE'. There will be no "angels" (Richard Feynman) nor mythical CDM & DDE there. Only *self action* along *null surface* (*biocausality*), performed by the Universe as ONE (Luke 17:21).

D. Chakalov
October 31, 2014

Addendum 1

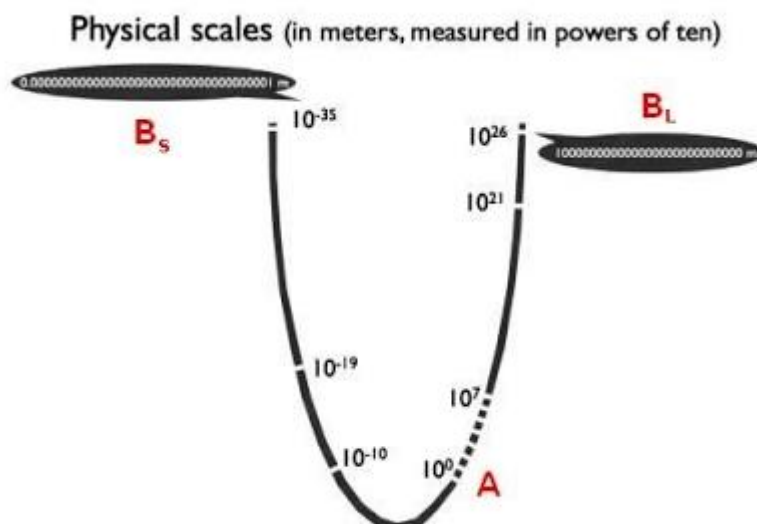
According to Relative Scale theory of spacetime (hereafter RS spacetime), the length scale in Nature, shown in the Gedankenexperiment *Powers of Ten* (watch the video below), is not absolute but *relational*. The *assembling* of spacetime by the Aristotelian Connection (**AC**) along the Arrow of Space (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 to 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.

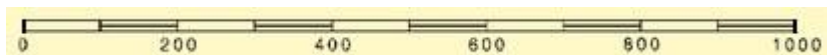


How could this happen? By altering the physically unobservable and *flexible* variable **T** (see above) which determines the *physical* '1s time of light' (**D**) in all *finite* spacetime regions. How? At the level (Sic!) of the *potential reality* of **D**, denoted above with **T**.

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:



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*.

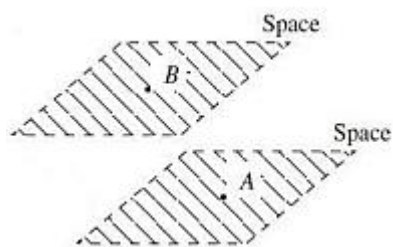
Of course, Alice is right. So is Bob (**B_s** & **B_L**), because there is no absolute 'one meter' nor 'one second' -- at **all** length scales they are being *rendered* by the Arrow of Space (see Fig. **1** [here](#)) from 'one and the same' *continuum* of **non-Archimedean** topological points (cf. 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** (Case II) -- not to *his* **T'** (Case I). 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 **A**. Relative to him, $T' = T$, hence $D' = D$ viz. $L' = L$: see FPS analogy and its *disambiguation* in the main section above.

NB: If Alice is observing **B_L** rendered with *his* $T' = KT$, she will consume **K**-times *more* time (e.g., playing Bob's 1s video rendered with 90 FPS by Alice's 30 FPS will consume 3s from *her* time), 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).

Again, if Alice and Bob had a common background [Newtonian spacetime](#) to act as some fixed grid endowed with *absolute* metric, they could *prove* which spacetime region is larger by introducing [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](#)).

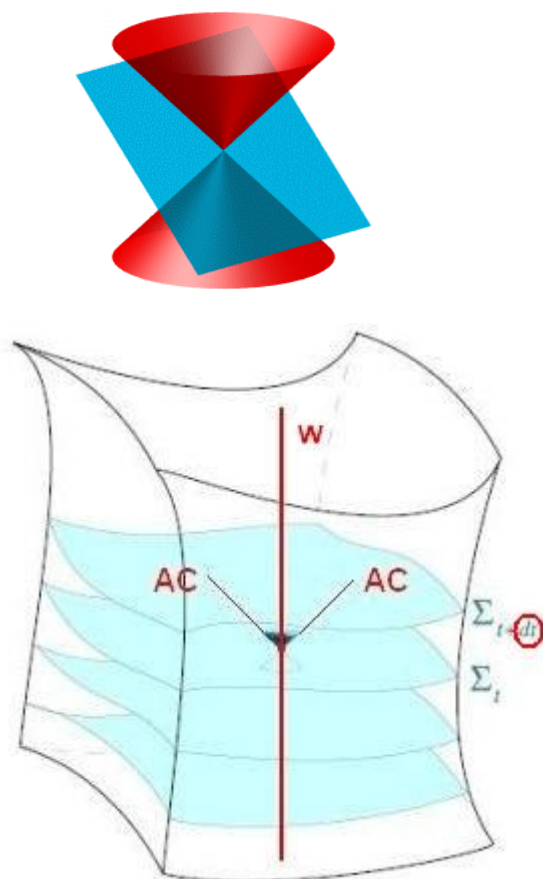


Fiber-bundle structure where each moment in time, **dt**, pertains to its own **re-created** 3-D "[slice](#)" of the Universe: space is erased and redefined "within" each instant $AB = dt$,

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 **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:

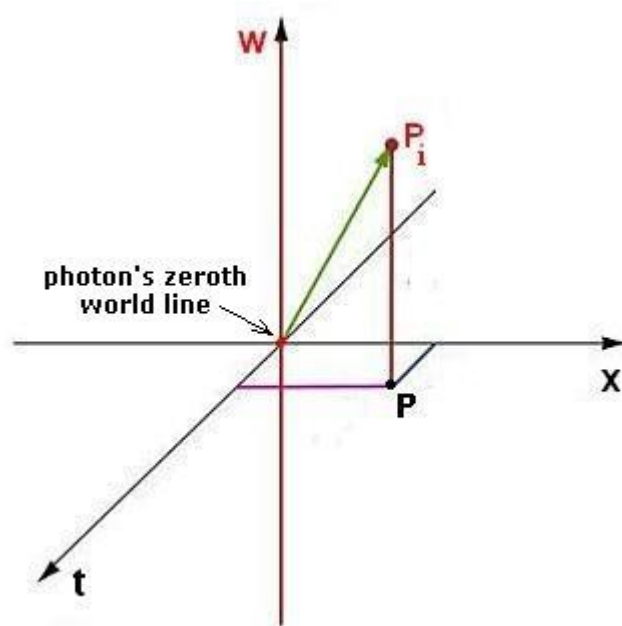
Case I: $RT = 1$ (Eq. 1.1), so if we multiply **T** by **K**, **R** will be multiplied by K^{-1} , and all *relative-length* spacetime regions, **A** and **B_S** & **B_L**, will be *indistinguishable* (not identical). Alice (**A**) remains in the middle between **B_S** and **B_L**, with "30 FPS": see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

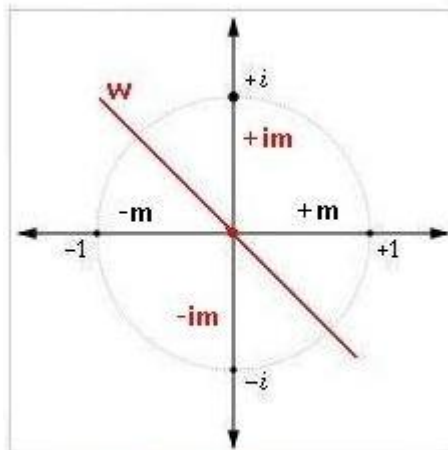
Also, the entire spacetime, **A** & **B_S** & **B_L**, is rendered *from* $K = 1$ in two opposite "directions", *simultaneously* toward **B_S** & **B_L**. The largest physical region of spacetime, *rendered* as **B_L**, will be an *asymptotic* region of $K \rightarrow \infty$, which can **never** be 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.

$$w^2 = (m_i)^2 + (+/-m)^2$$



i in the complex or cartesian plane. Real numbers lie on the horizontal axis, and imaginary numbers lie on the vertical axis

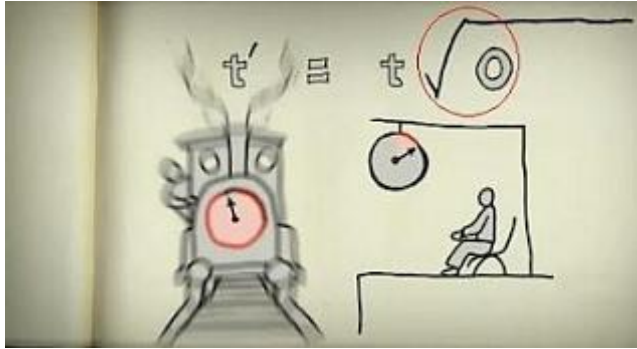
The two imaginary degrees of freedom, $+i$ and $-i$, facilitate the *atemporal offer and confirmation* waves of potential reality "outside the train" ([September 2011](#)), like the two 'drawing hands' of Escher above. The *atemporal offer and confirmation* waves of potential reality should eliminate '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

$$\mathbf{1} \times \mathbf{1} = \mathbf{1} \quad (\text{Eq. 3}).$$

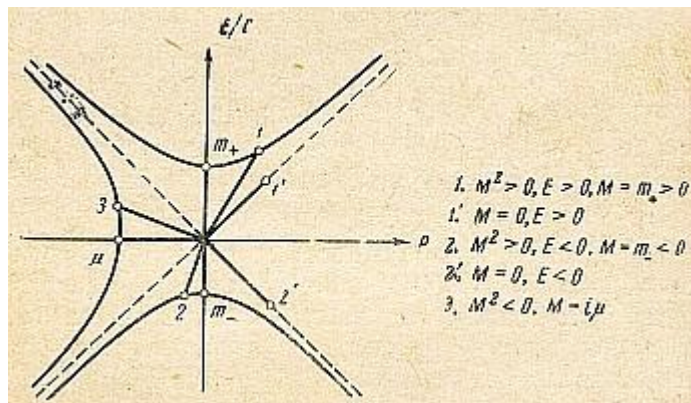
In RS spacetime the *physicalized* explications of 'the Universe as ONE' are produced by *atemporal* conversions -- one-at-a-time -- between [Eq. 3](#) and [Eq. 1](#) above, yielding **dual cosmological age** of the "retarded" physical world: once created by God ([John 1:1](#)), the physical universe 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 [Howard Georgi's scale-invariant theory](#) and explain the three kind of masses (positive, negative, and imaginary) shown below, from Terletsky (1966), Ch. VI, § 25.



Notice that the unphysical variables \mathbf{T} and \mathbf{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 ether (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 \mathbf{B}_s , set $\mathbf{K} < 1$ in the open interval $(0, 1)$. To obtain \mathbf{B}_L , set $\mathbf{K} > 1$ in the open interval $(1, \infty)$. Keep in mind that in RS gravity the centripetal and centrifugal gravitational *gradients* (see above) are due to $\mathbf{K} < 1$ (attractive gravity) and $\mathbf{K} > 1$ (repulsive gravity). That is, gravity "shrinks" the *metric* of physical spacetime without any "*dark matter*" nor "*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 $\mathbf{K} = 3$, you will fly with $3x$ 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 [sheeple.pdf](#)) the gravity differential \mathbf{dt} (cf. Wilbur B. Smith below) of your REIM drive by $\mathbf{K} > 1$. 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 (2x600km) 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 $\mathbf{K} = 3$ and makes his jet a REIM drive. Relative to his spacetime, his speed remains 600 km/h and can never exceed *his* relative-scale "speed" of light, but with $\mathbf{K} = 3$ his speed with respect to Alice will be 1800 km/h, so he will get back to her in app. 40min instead of 2 hours.

Three questions come to mind. Will Bob see at $\mathbf{K} = 3$ 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 $L = 1200\text{km}$ ($2 \times 600\text{km}$) 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 (practically at rest) 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 $3 \cdot 10^3$, yet the [relativistic time dilation](#) will be still too small to detect with atomic clocks. Now, the [diameter](#) of Milky Way is app. $120,000$ light-years, which makes $378,684 \times 10^7$ light-seconds, so an AVC would need to fly with $K = 378,684 \times 10^7$ 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 $5.7 \times 10^7 c$ 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 $(m_i)^2$ 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 light, $w^2 = 0$. 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?

Acknowledgments

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.

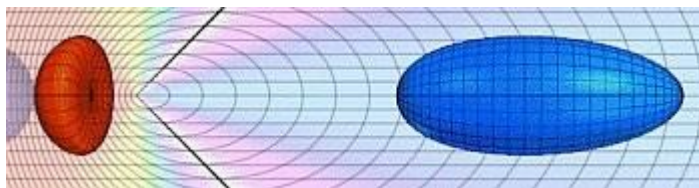
Surely the future belongs to youth, as explained by [Geheimrat](#) Max Planck (*Philosophy of Physics*, Norton and Company, New York, 1936, p. 97):

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 31, 2014

Addendum 2

A few days ago, I wrote to my good old friend [Erasmus 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 Erasmus 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](#)). 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](#)).



"Because the [object](#) arrives **before the light**, the observer sees **nothing** until 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* **w²** (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),

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

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

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 ($+\mathbf{m}$) 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?

D. Chakalov
October 29, 2014
