

# Potential Reality I: Relative Scale Spacetime

D. Chakalov  
35A Sutherland St  
London SW1V 4JU, U.K.  
Website [chakalov.net](http://chakalov.net)

## Abstract

Ensuing from first principles, a new theory of spacetime has been suggested, called ‘relative scale spacetime’. It denounces the absolute size of objects at different length scales, thanks to which the phenomena known as quantum state (“just in the middle between possibility and reality”, Heisenberg) and Einstein’s “total field of as yet unknown structure” are unified as *potential reality* of quantum-gravitational origin (dubbed *causal field*), endowed with relative-scale metric. At macroscopic scale, it produces what is known as gravitation, without any “dark” matter nor “dark” energy.

## 1. Introduction

This is the first from three papers<sup>1</sup>, presenting a theory of spacetime, based on the ideas of [Plato](#), [Heraclitus](#), and [Aristotle](#). It is called *relative scale spacetime*<sup>\*</sup>, and is applicable to quantum, gravitational, and biological systems. The theory reflects my personal, and perhaps strongly biased, views on quantum gravity and foundations of Mathematics, and adopts the philosophical doctrine about the *design* of the Universe, according to which it is both the only possible *and* the optimal one – Nature is *coherent*, therefore if we uncover the *physics* of life and solve the [mind-body problem](#)<sup>6</sup>, one could expect that such solution will outline *the* only possible theory of quantum gravity (Paper II<sup>1</sup>) as well. To unite [life science](#) with quantum gravity, I model the *physical* presentation of the Universe as ‘[Brain of the Universe](#)’, suggesting an universal *flow of events* defined with a new form of *retarded relativistic* causality applicable to quantum, gravitational, and biological systems, dubbed ‘*biocausality*’<sup>2</sup> (Paper II), for which the so-called hyperimaginary numbers have been introduced (Paper III<sup>1</sup>). The proposition about [qualia](#)<sup>21</sup> from the Brain of the Universe (e.g., [Universal Mind](#) and [The Holy Trinity](#)) is considered *undecidable* and will not be discussed. God as ‘the Universe as [ONE](#)’ is considered *purely* mathematical object, which is beyond our cognition and cannot be proved nor disproved.

This paper, dedicated to the centenary of Einstein’s General Relativity<sup>9</sup> announced on [25 November 1915](#), suggests a new quantum-gravitational spacetime, in which the *size* of objects is not considered absolute, but ‘relative to their length scale’, hence the concept of *relative scale spacetime*. In a nutshell, I suggest to abolish the presumption of absolute [length scale](#) and replace it with *relative* length scale: the “size” of an objects, say, a table with length 1m, is *dual*. On the one hand, it is indeed smaller with respect to the size of a galaxy and larger with respect to the size of a proton, but on the other, its (quadratic) [invariant spacetime interval](#) “1m” is not only “[flexible](#)”<sup>56</sup> due to [coordinate-free](#) presentation of gravity (there is no background spacetime supplied by an [ether](#), due to [background independence](#)), but is also *indistinguishable* from the size of a galaxy *and* the size of a proton ([Fig. 15](#)) – the *metric* in relative

---

\* A pdf copy of the paper, with live (clickable) links, can be downloaded from my website <http://chakalov.net>.

scale spacetime **changes** along the length scale, in such way that a galaxy and a proton will have, within their respective length scale domains, the same *indistinguishable* relative-scale “size” of “1m” **as well**. Hence the quantum-gravitational spacetime begins from the macroscopic length scale of tables and chairs in two opposite “directions”, toward the Large and the Small, and all physical objects *always* keep their *relative* and **dual** “size”. This unique feature of relative scale spacetime might (i) facilitate the bootstrapping of the entire Universe by a topological “bridge” of all systems along the **length scale** (Table 1), produced by sharing a common quantum-gravitational *potential* reality (dubbed spacetime entanglement in Paper II<sup>1</sup>), and (ii) open the possibility for spacetime engineering, provided the human *brain* can access such topological “bridge” (Paper III<sup>1</sup>).

With *relative scale spacetime*, the phenomenon known as ‘gravity’ is reduced to *variable relative metric* (not to “**curvature**”<sup>44</sup>), and the choice of **tensors** for mathematical presentation of gravity is considered **wrong**: the gravitational “field” is not classical objective reality ‘out there’. If it were, it will be a force field, like the electromagnetic field, in which case the gravitational energy will be localizable at a point<sup>4</sup> and the inertial mass of an accelerating particle will be a simple “back-reaction to its own gravitational field”<sup>5</sup>, which in turn will render the *geometrization* of gravity impossible. The alternative viewpoint would be that gravity “does not exchange energy-momentum with both particles and electromagnetic field. So, it is not a force field, it does not carry energy-momentum” (email communication from Zhaoyan Wu), which makes the energy-momentum contributions of gravity pure magic. Either way, the unwarranted presumption in present-day General Relativity<sup>60</sup> that the gravitational “field” were objective reality subject to *classical* physics (cf. **Sec. 3**) will force us to choose from two alternatives, both of which inevitably lead to dead end<sup>6</sup>.

In my opinion, the only way to resolve the puzzle of how matter couples to its geometry<sup>6</sup> is to elaborate on the proposal by **Plato** and suggest a new kind of reality, called after **Aristotle** ‘potential reality’, which becomes *physicalized* by exerting energy-momentum *and* angular momentum in the physical stuff placed in right-hand side of **Einstein’s field equations**, yet does **not** exist as objective reality ‘out there’. Surely the *potential reality* is not ‘mind’ nor anything related to *res cogitans*, but a new kind of *physicalizable* reality “just in the middle between possibility and reality”<sup>7</sup>. In Quantum Theory, we encounter *quantum* potential realities in terms of **quantum state** and ultimately **quantum vacuum**, which are neither objective reality ‘out there’ nor plain mathematical abstraction. As Erwin Schrödinger stressed in 1935<sup>8</sup>,

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

In brief, I suggest *gravitational* potential reality, which casts its *physicalized* explications à la **Plato** in terms of invariant **spacetime intervals** with *variable* relative metric, resulting in *relative scale spacetime* (Fig. 15). The two main issues are (i) the relative scale “size” of objects (recall the example with one-meter table above) and (ii) the *emergence* of gravity due to alteration of the *variable* relative metric, producing force-free gravitational attraction and, at extragalactic scale, force-free gravitational “inflation” (**Hubble flow**). Hence (i) offers a global relational theory of ‘**space**’ with properties ‘large’ vs. ‘small’ and ‘inside’ vs. ‘outside’, but without absolute **length scale**, while (ii) suggests the *origin* of gravity by reducing it to *local* effects of variable relative metric. (Recall that the current version of Einstein’s theory

of gravity does not even try to explain how “[central mass](#)” could evoke the appearance of gravitational “field”.) The scope of *relative scale spacetime* is to seek full *geometrization* of gravity and ultimately recover Einstein’s “total field of as yet unknown structure”<sup>9</sup>:

The right side is a formal condensation of all things whose comprehension in the sense of a field-theory is still problematic. Not for a moment, of course, did I doubt that this formulation was merely a makeshift in order to give the general principle of relativity a preliminary closed expression. For it was essentially not anything more than a theory of the gravitational field, which was somewhat artificially isolated from a total field of as yet unknown structure.

Briefly about the Ansatz of relative scale spacetime. After an overview of the theory, offered in this section, I will examine the proposal by Plato and the arguments for *gravitational* potential reality ([Sec. 2](#)). In the next two sections, I will suggest the origin of gravity as *local* alteration of the spacetime metric (full *geometrization* of gravity), and then offer conceptual solution to “the worst theoretical prediction in the history of physics!”<sup>10</sup>, removing all “dark”<sup>53</sup> manifestations of gravity – there is no need for any *physical* stuff acting as “[cold dark matter](#)” nor as “[dark energy](#)”, because the “shrinking” and “inflating” of the metric (producing in case (i) a “small” proton and a “large” galaxy, relative to a macroscopic table) are presented as force-free effects of the variable metric of relative scale spacetime. The force-free gravitational *rotation* will be examined in [Sec. 4](#), as the phenomenon of [torsion](#) is considered an essential property of *gravitational* potential reality. In [Sec. 5](#), I will offer a discussion of relative scale spacetime and will finish with an outline of the next Paper II<sup>1</sup>.

The alternative, and strictly materialistic, view on the *origin* of spacetime bluntly ignores the proposal by [Plato](#) viz. the presence of *physicalizable* potential reality, and leads to “non-tensorial” (whatever this means) nature of gravitational energy (*physical* energy-momentum tensor for the gravitational field does not exist<sup>11,12</sup>) and inherent energy non-conservation<sup>13</sup>. In my view, the current formulation of GR<sup>9</sup> cannot be applied to a spacetime point<sup>4</sup> nor to the [observable universe](#), and is also based on mathematical jabberwocky<sup>14</sup>, which I hope can be fixed by solving particular problems of the *continuum* of spacetime points, namely, by introducing ‘potential reality’ to point set topology, set theory, and number theory (Paper III<sup>1</sup>). To explain why we need to “insert” potential reality in the *continuum* of spacetime points, imagine a train moving along its railroad: we can suggest all sorts of alterations of the railroad (spacetime) to *geometrize* gravity, but these alterations cannot *in principle* encode the **engine** of the train – the railroad alone cannot *drive* the train. The train's engine is not present in the railroad, being the Aristotelian [Unmoved Mover](#) endowed with self-action<sup>6</sup> (dubbed ‘Aristotelian Connection’ in Paper II<sup>1</sup>). Thus at every instant ‘here and now’, we’ve been passing through ‘the Universe as ONE’ ([Luke 17:21](#)) possessing [indetermined](#) numerical values, being *both* the smallest object called ‘the atom of geometry’ or simply ‘point’ *and* the largest object in “asymptotically” flat spacetime, located *exactly* at null-and-spacelike infinity ([absolute infinity](#)). Notice that the entire physical universe, equipped with metric, is “wrapped” by two presentations of ‘the Universe as ONE’, obtained by reaching the limit of the physical world at [absolute infinity](#), yet these presentations cannot have metric and are indistinguishable, being “that which has no part” ([Euclid](#)). Stated differently, from the perspective of the [length scale](#) of the physical world equipped with metric, ‘the Universe as ONE’ looks *extremely* small or *extremely* large, while it is in fact one and the same *dimensionless*

potential reality. There can be no metric (P. Chrusciel<sup>19</sup>, p. 226) in such luxonic realm<sup>20</sup>, just as there is no size of Platonic ideas placed “behind” the chained observers (Fig. 1), to claim that the *idea* of a tree is smaller than the *idea* of a mountain.

Let me begin with an explanation of the object referred to as ‘potential reality’. Later I will introduce ‘necessary and sufficient conditions for spacetime’, arguing that one cannot *derive* the topological dimensions of spacetime exclusively from the physical stuff in the universe; hence the need for potential reality and ‘causal field’ as *sufficient* conditions for spacetime. Following Niels Bohr, I wish to stress that every sentence in the theory<sup>1</sup> should be understood not as an affirmation but as a question.

## 2. Potential reality: Causal field

The ancient idea that the physical world *emerges* from a different form of reality, for which I chose the term ‘potential reality’, can be presented with the famous ‘allegory of the cave’ by Plato, modified by adding an axis **W** (Fig. 1) from Fig. 4. The explicated world of physical “shadows” is cast on a continuum depicted with a film reel (Fig. 2) comprised from infinitely many (uncountably infinite) snapshots possessing *indetermined* “size”, called spacetime points (Fig. 3), such that every spacetime domain of *finite* size (invariant spacetime interval with *relative scale* metric) is a set of such spacetime points, whereby the *cardinality* of such uncountable set is undecidable<sup>15</sup>. Every individual snapshot or frame (Fig. 2) is a **re**-created “shadow” (Fig. 1) obeying Einstein’s *equivalence principle* (‘no evidence of gravity’<sup>16</sup>), while the ‘engine of the train’ (see above) is the *light source* in Fig. 1. Only a *sequence* of such **re**-created frames (Fig. 2) can *assemble* the topological dimensions of the spacetime of physicalized “shadows”, and *within* such sequence the law of energy non-conservation is mandatory<sup>13</sup> and we encounter gravitational radiation<sup>17</sup>. As Hermann Bondi remarked, the gravitational waves are real, “one can boil water with them!”<sup>18</sup>. Yet at every individual frame (Fig. 2), the presence of gravity is completely **re**-eliminated<sup>16</sup>, once-at-a-frame, as read with a physical clock. Again, the topological dimensions of spacetime are obtained **only** by *assembling* the individual “shadows” to obtain a *sequence* of frames (Fig. 2), while the *duration* of the light along **W** (Fig. 1) is *indetermined*. If we picture the light source as a movie projector and the physical world as an *assembled* 4-D movie, we cannot notice whether the movie operator (not shown) have decided to, say, take a break and “temporarily” halt the movie, because her “time” pertains to the dark strips “between” the frames (Fig. 2). Such unphysical “time” pertains to *light-like* intervals<sup>19</sup> and to the atemporal<sup>2</sup> (with respect to a physical clock) *potential* reality living on the light cone<sup>20</sup> and “attached” (Paper III<sup>1</sup>) to quantum, gravitational, and biological systems<sup>21</sup>.

In the second paper (Paper II<sup>1</sup>), I will suggest *perfectly* continual trajectories of quantum-gravitational objects in *relative scale* spacetime, offering a different interpretation of the ideas of Kevin Brown<sup>22</sup>. Suffice it to say that the metaphor of a film reel (Fig. 2) is **wrong**: the *dark strip*, separating consecutive “frames”, does **not** exist in Nature. Although we cannot imagine individual “frames” without something that would *separate* them, like the dark strips “between” the consecutive instances ‘here and now’, such metaphoric idea is very misleading, because it makes the “frames” *countable* (Sic!) and suggests *Hausdorff space*, which are *illusions* (Fig. 13). To produce a *perfect* continuum of ‘points and *nothing but points*’, we have to ignore the convenient, but unavoidably wrong, idea of ‘dark strips’ and introduce brand new



structure of the spacetime continuum, by **dual topology** of every point ‘here and now’ (Fig. 3), such that every (**uncountably infinite**) set of such points will yield a spacetime of *physicalized* points, **wrapped** by a *boundary* of potential reality (highlighted in **red**, Fig. 5), which will be called ‘causal field’. Stated differently, I replace the poetic expression ‘asymptotic flatness at infinity’ and all related jabberwockies<sup>14</sup> with ‘causal field’, stressing that the latter encodes the primordial *structure* of spacetime points, known as ‘time orientability’ (P. Chrusciel<sup>19</sup>, p. 247). Notice that the so-called causal field must **not** be *physical* reality, which would make it a *physical Lorentzian ether* at **absolute rest** or a *physical* ‘reference fluid’ fixing the points in space and their instants of time<sup>23</sup>, but an *atemporal luxonic*<sup>20</sup> potential reality endowed with the *self-action* of the **Unmoved Mover**. Needless to say, the causal field is not *res cogitans* either<sup>6</sup>, but the Platonic, *not-yet-physicalized* reality “just in the middle between possibility and reality”<sup>7</sup>, residing in the *potential* future of biocausality<sup>2</sup>. Every spacetime event ‘here and now’ is the very *interface* (Fig. 3) “between” its past and potential future, possessing **dual topology**: it is both fixed in its irreversible past and *indefinable* in its potential future (causal field) spanned along the axis **W** in Fig. 4. At every physicalized event in the right-hand side of Einstein’s field equations<sup>22</sup>, the axis **W** (Fig. 4) is being **completely re-nullified** (resembling the **Phoenix Universe** of Abbé Georges Lemaître), to meet the requirements for *perfect* spacetime continuum (no “dark strip”, Fig. 2) along the entire **length scale**.

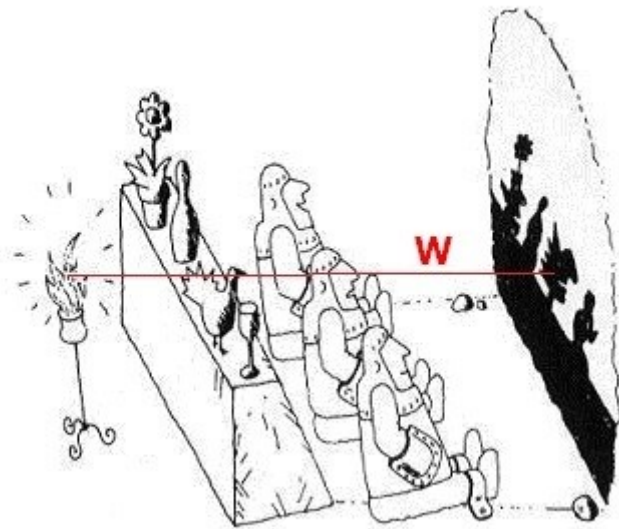


Fig. 1, adopted from Plato

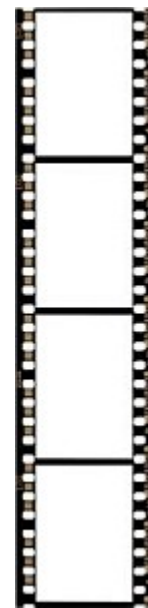


Fig. 2

Also, our *physical* experience is comprised of *already* completed interactions<sup>22</sup>, like one single event of emission-and-absorption of a photon (resembling clapping hands), and in this sense the *physical* “part” of the interface ‘now’ (Fig. 3), pertaining to the right-hand side of Einstein’s field equations<sup>22</sup>, is always **already-fixed** in its irreversible past, while the *potential* “part” of the same interface ‘now’ (Fig. 3) remains **always indefinable**, as it belongs to the *not-yet-physicalized* potential reality placed in the potential future of biocausality<sup>2</sup>, dubbed ‘causal field’ and endowed with an *extended* instant ‘now’ (but *not* with qualia<sup>21</sup>) along the atemporal<sup>2</sup> luxonic<sup>20</sup> **W** axis (Fig. 4). Were the *wegtransformierbar*<sup>24</sup> gravitational field a *physical* reality<sup>4</sup> (recall the

statements by Heisenberg<sup>7</sup> and Schrödinger<sup>8</sup> above), it will have to be “dark”, which will inevitably lead to “the worst theoretical prediction in the history of physics!”<sup>10</sup>.

Going back to the *interface* ‘here and now’ (Fig. 3 and point P in Fig. 4), which presents the notion of spacetime point or ‘event’, notice that the left-hand side of Einstein’s field equations<sup>22</sup> is replaced with potential reality as ‘causal field’ (Einstein called it ‘marble’) residing in the *potential* future (highlighted in red, Fig. 3) and endowed with self-action (Aristotle), and also with *completed* or *actual infinity*, explained by David Hilbert (4 June 1925) as “a totality of things which exists all at once”<sup>26</sup>. The same interface ‘here and now’ (Fig. 3 and point P in Fig. 4) represents also the *physicalized* content of spacetime (Einstein called it ‘timber’), placed in the *irreversible* past (highlighted in blue, Fig. 3) and endowed with never-ending *potential infinity*. The latter is crucial for making the *physical* manifold *perfectly* smooth (all sets and intervals are open) by infinitely differentiable ( $C^\infty$ ) “glue”<sup>25</sup> – no physical object could run out of points due to some mythical “geodesic incompleteness”. The existence of “discrete” or quantized objects is beyond doubt, but, to use the analogy in the previous section about the *idea* of a tree and the *idea* of a mountain, keep in mind that such not-yet-physicalized objects are stored in the “memory” of the causal field (resembling aether and akasha), so their *physicalized* “discreteness” does not lead to any “quantum jumps” (*verdammten Quantenspringerei*, Erwin Schrödinger) in the *intact* quantum world<sup>29</sup>.

To make the **dual** topology of the interface ‘here and now’ easier to explain, I will call the causal field (marble) residing in the potential future ‘global mode of spacetime’, and the *physicalized* – once-at-a-time<sup>16</sup> – mode of spacetime, placed in the irreversible past, ‘local mode of spacetime’ (timber). The axis orthogonal to the “inflated” local mode of spacetime, passing at P, is denoted with **W** (Fig. 4), from the German *wunderbar*, as a humble tribute to Theodor Kaluza. The ark APB (Fig. 4) shows the scale-dependent proper time and proper distance in *relative scale* spacetime.

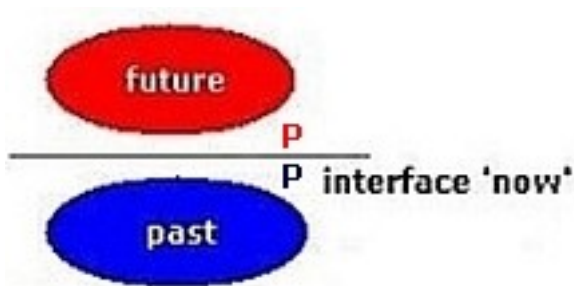


Fig. 3

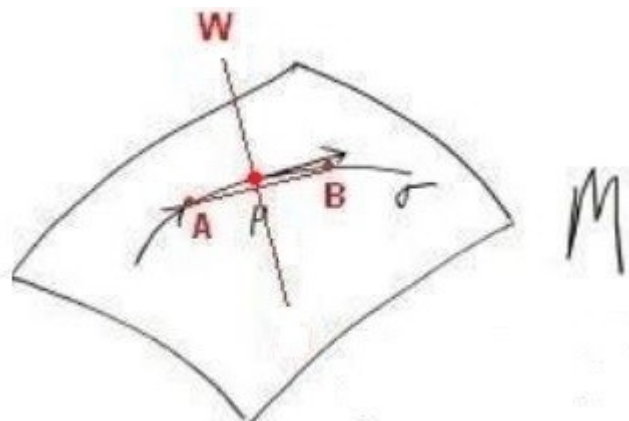


Fig. 4

Physically, the inflation time, matching the radius (Fig. 9 and Fig. 6) of the “inflating balloon”<sup>46</sup> (Fig. 4), is tending *asymptotically* toward The Beginning (John 1:1) and The End by never-ending *potential infinity* (highlighted with blue, Fig. 5), so the *physical* time can never *actually* reach it. In this sense, the *local* (physical) mode of spacetime is “infinitely old because infinitely many things have happened since its beginning”<sup>27</sup>.

On the other hand, the same cosmological time has *finite* duration as well (Fig. 10), as at every interface ‘here and now’ (Fig. 3) it is presented with a **closed interval** defined in the causal field and fixed with *actual infinity* (David Hilbert), in such way that every interface **P** ‘here and now’ (Fig. 5) is just as “real” as is The Beginning. In physical theology (see Case IV below), The Beginning (John 1:1) was (notice the temporal ordering of events) the union  $M \equiv N = O \cup AB \equiv [\text{absolute infinity}]$ , after which God as the **Unmoved Mover** created the spacetime (Luke 17:21). I believe this proposition is **undecidable**, as it cannot be falsified and presented with a theorem.

To sum up, I suggest ‘dual cosmological time’ and Finite Infinity<sup>28</sup> (Fig. 5), and the so-called ‘eye of the Universe’ (Fig. 8). Again, let me stress that there is a fundamental difference between ‘time as change *within* spacetime’ (the ark **APB** in Fig. 4), called ‘**proper time**’ and denoted with the Greek letter  $\tau$  (tau), and its orthogonal complement ‘time as change of the spacetime itself’ along the axis **W** in Fig. 4. The genuine dynamics of General Relativity<sup>9</sup> is based on both cases of ‘time as change’. The first case pertains to physical, non-inertial observers endowed with *unending* potential infinity, while the second case corresponds to some ideal inertial “meta” observer endowed with unphysical *actual infinity* (Fig. 10), who can capture the evolving physical universe *en bloc* (Hubblesite), including the **red** ideal endpoints in Fig. 5, hence claim that the universe is always ‘finite’. Yet a physical, non-inertial observer will always claim that the same universe is ‘infinite’. Who is right? Wrong question. Both observers are “right”, thanks to Finite Infinity.

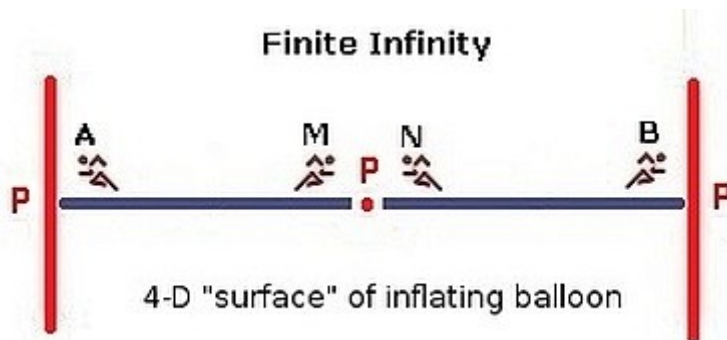


Fig. 5

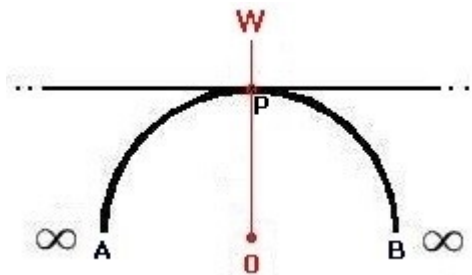


Fig. 6, adopted from [43]

With respect to the physical world equipped with metric, depicted with **blue** in Fig. 5 and in Fig. 3, the Universe as ONE (depicted with **red**) is both extremely “small” and extremely “large” Platonic object (like a “small” *idea* of a tree and a “large” *idea* of a mountain; see above), which does **not** belong to the local (physical) mode of spacetime. It (not “He”) is called ‘causal field’ (global mode of spacetime). It also acts as *unphysical* boundary “wrapping” each and every *interface* ‘here and now’ (Fig. 3) viz. the *entire* local (**blue**) mode of spacetime *en bloc*, presented in the current, and essentially incomplete<sup>9</sup>, formulation of GR with the right-hand side of Einstein’s field equations<sup>22</sup>. Thus, the topological boundary, made by the causal field (depicted with **red**, Fig. 5), is not some *subset* of the topological space of the *physical* world, as suggested in the current statements regarding **topological boundary** and **topological interior**: the causal field is **not** some “subset” of the topological space pertaining to the *physical* world depicted with **blue** in Fig. 5.

Again, the causal field harbors the *potential*, not-yet-physicalized states of the physical world (see Heisenberg and Schrödinger [above](#)), which do **not** exist as an objective, [non-contextual](#) physical reality<sup>3,29</sup>. It is like the grin of the Cheshire cat<sup>45</sup> [without the cat](#), which is why the [grin](#) is not a “subset” of cat’s topological space.

Recall the existential definition of ‘set’ by Georg Cantor (7 November 1895)<sup>30</sup>: any gathering-together (*Zusammenfassung*) of determined and well-distinguished objects into a **whole** (*zu einem Ganzen*). Replace ‘a **whole** (*zu einem Ganzen*)’ with ‘causal field’ and keep in mind that both objects are purely mathematical. In the quantum-gravitational realm, the causal field casts a *physicalized* world (depicted with [blue](#), [Fig. 5](#)), once-at-a-time<sup>16</sup>, yet the causal field itself is **not** ‘physical reality’<sup>4</sup> and does **not** “collapse”<sup>29</sup>. It can be ignored only in the macroscopic world of inanimate objects, described in classical physics, where its influence is vanishing small, yet **not** zero. The causal field is *potential* reality “just in the middle between possibility and reality”<sup>7</sup>, and may have qualia<sup>21</sup>, but this is relevant to its practical implications, such as spacetime engineering (e.g., [REIM](#)), which will be examined later (Paper III<sup>1</sup>). To be a bit more precise, in relative scale spacetime all quantum, gravitational, and biological systems<sup>6</sup> are endowed with an *extended* instant ‘here and now’<sup>21</sup> (cf. the Brain of the Universe in [Sec. 1](#)), depicted with the axis **W** in [Fig. 4](#), but the physical “footing” of **W** on the local (physical) mode of spacetime ([blue](#) line in [Fig. 5](#)) matches the “thickness” of the *interface* ‘here and now’ in [Fig. 3](#). Even in the macroscopic world of tables and chairs, the *atemporal* “duration” of **W** ([Fig. 4](#)) is vanishing small but **not** zero, which marks the beginning of Quantum Gravity with the causal field. Its effects *increase* along **W** and **OW** ([Fig. 6](#)), leading to what I dubbed previously ‘entanglement of spacetime’ (cf. the example with one-meter table in [Sec. 1](#)), but these effects are always *perfectly* localized on the local mode of spacetime ([blue](#) line in [Fig. 5](#)), once-at-a-time<sup>16,29</sup>. If we denote the so-called entanglement of spacetime (topological “bridge”, [Sec. 1](#)) with **w**, the effects of the causal field can be “spanned” along **OW** ([Fig. 6](#)) as follows:

Case **I**: **w** → **0**, classical physics  
 Case **II**: **0** < **w** < **∞**, quantum gravity and [life sciences](#)  
 Case **III**: **w** → **∞**, hyper physics (?)  
 Case **IV**: **w** ≡ **0** ≡ **∞**, physical theology. At the interface ‘here and now’ ([Fig. 3](#)), we pass through the Noumenon ([Luke 17:21](#)) at [absolute infinity](#).

Table 1

The so-called hyperimaginary numbers (Paper III<sup>1</sup>) involve **w**, which becomes *physicalized* with its unique property  $\mathbf{w}^2 = \mathbf{0}$ , casting its “shadows” ([Fig. 1](#)) on *any point* (not ‘number’, cf. [Sec. 3](#)) from the [number line](#) ([blue](#) line in [Fig. 5](#)), including the real parts of imaginary numbers. The Platonic case in which **w** is **not** squared pertains to an extended atemporal presence ‘now’<sup>21</sup> along the non-squared **w** viz. the effects of the causal field in Cases I - III in Table 1 above, as **w** lives “within” [light-like](#) intervals<sup>20</sup> (global mode of spacetime).

Regarding Finite Infinity, let me show the Universe as ONE (the [red](#) objects in [Fig. 5](#)) *exactly* at infinity: the ark **APB** in [Fig. 4](#) is depicted at [absolute infinity](#) in [Fig. 6](#) with a horizontal black line and, due to the absence of any metric there, **AP** = **PB** =  $\emptyset$ . All



physical points along **APB** will fuse into *one* single point, together with The Beginning at **0** and the causal field along **OW**. Obviously, the metaphysical notions of ‘infinity’, ‘empty set’  $\emptyset$  and ‘zero’, and ‘point at infinity’ are completely devoid of specific substance, yet need exact mathematical clarification.

To sum up, in relative scale spacetime the endless *physical* world<sup>56</sup> passes through ‘the Universe as ONE’ at *absolute infinity*, once-at-a-time, by non-smooth sphere-torus transitions (Fig. 7), trespassing (Sic!) the black horizontal lines at *absolute infinity* in Fig. 6 and Fig. 7. The murky expression ‘*asymptotic flatness at infinity*’ is replaced with *quasi-flat* spacetime being *infinitesimally* close to **both** closed spacetime (sphere, Fig. 6) with maximal size tending asymptotically toward infinity, and open spacetime (torus) with maximal size tending asymptotically toward infinity. Namely, the **blue** horizontal line in Fig. 5 is not “flat” but is tending *asymptotically* toward the horizontal lines in Fig. 6 and Fig. 7, from both “south” (sphere) and “north” (torus). These hypothetical topological waves of the causal field (global mode of spacetime) remotely resemble *quantum waves*, as their non-squared “amplitude” **w** along **OW** (Fig. 6) is also unphysical. Perhaps one can expect various physical effects by tweaking their hyperimaginary *phase* (Paper III<sup>1</sup>). Perhaps spacetime engineering can only be performed *effortlessly*, much like the way we “move” our thoughts<sup>21</sup>, but with the *Law of Reversed Effort*.

The so-called ‘eye of the Universe’ (Fig. 8) shows the causal field (depicted in **red**), immersed into a *colorless* area presenting a *bona fide Noumenon* (*Das Ding an sich*), also known as ‘the true monad without windows’ (Leibniz). It is an omnipresent non-reality, which explicates its physical and mental content as *colored* reality. It is ‘the unknown unknown’, resembling some physical-and-cognitive vacuum, explicated along the **W** axis (Fig. 4) by genuine *creatio ex nihilo*. It (not “He”) can never be exhausted, not even during an infinite cosmological time. As John Wheeler put it, “Time is Nature’s way to keep everything from happening all at once.”<sup>31</sup>

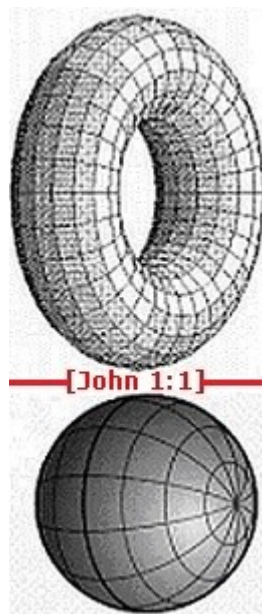
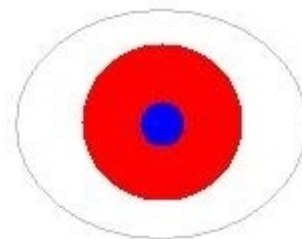


Fig. 7

The eye of the Universe



Physical (**blue**) and potential (**red**) denote the two forms of reality, complemented by an omnipresent colorless non-reality

Fig. 8

The *union* of colored reality (**red** and **blue**) and *colorless non-reality* should correspond to the incomprehensible ‘Universe as ONE’, known as God (**John 1:1**; **Luke 17:21**). It cannot be grasped with human cognition: we operate with ‘sets’ but cannot produce the ultimate ‘set of all sets’. No statement about God’s existence can be presented with a theorem that can be proven true or false, hence reduce God to science and Mathematics. Thank God, this is impossible.

In Sec. 3 below, I will offer specific arguments in support of the main ideas in **Fig. 3**, and will also ‘put my cards on the table’ by providing the conditions under which the entire theory<sup>1</sup> can and will be rejected. Then in **Sec. 4** I will suggest the *origin* of gravity by reducing it to dynamic relative-scale metric, and **Sec. 5** will present the current unsolved problems – *nur die Fülle führt zur Klarheit, und im Abgrund wohnt die Wahrheit* (**Friedrich von Schiller**).

### 3. Verification of the main ideas

In **Sec. 2**, I tried to explain the proposal for relative scale (hereafter RS) spacetime. Here I will do my best to verify the theory by showing where it comes from, and will begin with the most controversial, in my opinion, hypothesis in the current, and essentially incomplete<sup>9</sup>, mathematical relativity, known as ‘locally Minkowskian’.

We are led to believe that, in a “sufficiently small”<sup>32</sup> neighborhood around every spacetime point (cf. the two running guys **M** and **N** in **Fig. 5**), one can “erect a locally inertial coordinate system in which matter satisfies the laws of special relativity”<sup>32</sup>. In my opinion, the slippery boundary of such “sufficiently small”<sup>32</sup> neighborhood is sheer poetry, not even an operational definition, because ‘sufficiently small’ cannot be defined with the exact boundary of an **open set** viz. with the radius  $r$  of a ball with center **P** (**Fig. 9**). Namely, if we imagine a ‘sufficiently small’ neighborhood of a ball with center **P** (**Fig. 5**), depicted with its diameter  $2r$  (**Fig. 9**), it can be defined only with the  $(\epsilon, \delta)$ -**definition of limit**, based on actual infinity<sup>26</sup>. An explanation from a bartender runs as follows (**Fig. 10**):

An infinite crowd of mathematicians enters a bar. The first one orders a pint, the second one a half pint, the third one a quarter pint... “I understand”, says the bartender - and pours two pints.

But this recipe for obtaining the exact boundaries at **M** and **N** (**Fig. 5**) and the diameter  $2r$  (**Fig. 9**) viz. the two pint beer (**Fig. 10**) cannot be used in GR<sup>32</sup> to define a ‘small’ **MN** (**Fig. 5**), not to mention ‘*sufficiently small*’. It cannot define *the largest* “beer” (**Fig. 10**) at *actual infinity beyond AB* (**Fig. 5**) either: see the conformal recipe by R. Penrose<sup>14</sup>. If we cut an apple into two pieces, we can see that there is a “sufficiently small” neighborhood around its center, occupied by its seeds, yet such neighborhood and the boundaries of the apple (the diameter  $2r$  in **Fig. 9** and the two pint beer in **Fig. 10**) must be defined *relationally*, with respect to both (i) the center at **P** (**Fig. 5** and **Fig. 9**) and (ii) *the largest* “beer” (**Fig. 10**) bordering its *unphysical* environment called causal field (highlighted with **red** in **Fig. 5**), residing “within” **P** as well.

Thus, I suggest to treat **P** as an *interface* ‘here and now’ (**Fig. 3**), and endow **P** with **dual topology** to solve the problems of localization of gravity<sup>4</sup> and the quantum state<sup>29</sup>.

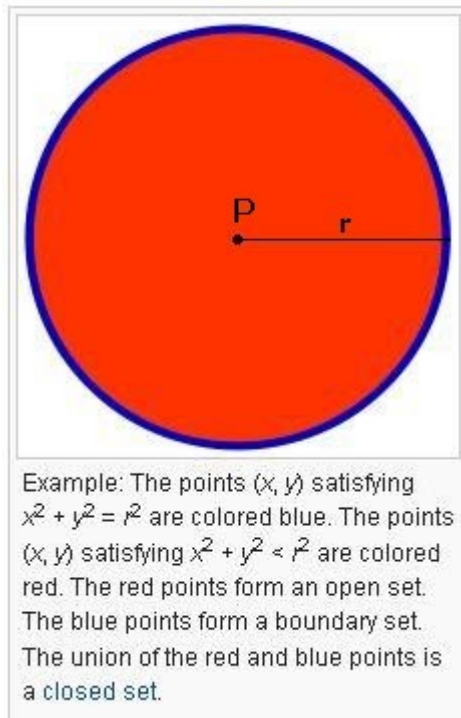
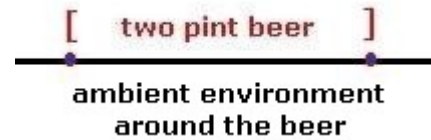
Fig. 9, adopted from [Wikipedia](#)

Fig. 10

The two endpoints belong both to the two pint beer and to its ambient environment around the beer

Let me explain. First, the “thickness” of the blue boundary in Fig. 9 above cannot be that of one *single* point or “frame” separated by “dark strips” (Fig. 2), because it will make such individual *single* point **countable**, as mentioned [above](#), while the genuine *perfect* continuum of ‘points and *nothing but points*’ (Fig. 3) contains **uncountably infinite** points, which form a set<sup>15</sup> with **undecidable** cardinality<sup>33</sup>. Thanks to [Thomson’s lamp paradox](#) (see [below](#)), none of the colored points in Fig. 9 can be *individuated* viz. counted, which is why there is no difference *whatsoever* between **countably infinite** sets with the alleged cardinal “number” **aleph-0** and uncountably infinite sets with **undecidable** cardinality<sup>33</sup>: **aleph-0** is *undecidable* as well, and no ‘number’ can designate the **infinite** points assembling the **number line** in Fig. 10 (more below).

What we call ‘spacetime point’ is the very *interface* ‘here and now’ endowed with **dual** topology (Fig. 3), thanks to which its ‘potential reality’, with footprint on the *physical reality*<sup>16</sup> marked with **blue** in Fig. 3, is spanned along the unphysical axis **W** in Fig. 4 and **W0** in Fig. 6 **as well**, leading to so-called hyperimaginary numbers (Paper III<sup>1</sup>) and to physical theology, as explained [above](#). The presentation of blue points forming a “boundary set” in Fig. 9 is false, because it **requires** a “dark strip” (Fig. 2) inserted somehow ]between[ the “boundary set” and the “open set” in Fig. 9.

Such “dark strip” does not exist in Nature, however. It is a grave misconception, which makes the continuum problem<sup>33</sup> insoluble and leads to mathematical jabberwockies<sup>14</sup>.

**NB:** The localization of gravity<sup>4</sup> is only and exclusively only on the *physical* footing of **W** (Fig. 4), which is placed in the irreversible past depicted with **blue** in Fig. 3. The *potential* gravitational state, residing in the potential future of *the same* interface

‘here and now’ (Fig. 3), does **not** exist in the *physicalized* state<sup>24</sup> in the past (recall the analogy with the Cheshire cat<sup>45</sup> above), which is why we can “eliminate” it by hand<sup>4</sup>.

Without such distinction between the two “components” of gravity, physical and potential, we cannot understand Einstein’s **equivalence principle** (‘no evidence of gravity’<sup>16</sup>) and the localization of gravity is impossible *in principle*. The same solution applies to the *potential* quantum state and its localization; the problem is widely known since 1911, thanks to **Charles Wilson**, which is why I consider it *the* most widely known public secret in theoretical physics<sup>29</sup>.

The explanation of the so-called “sufficiently small”<sup>32</sup> neighborhood, in which the spacetime were ‘locally Minkowskain’, is straightforward: it is not “small”, but pertains only and exclusively only to the *physicalized* gravity placed in the irreversible past, depicted with **blue** in Fig. 3. Hence we can ‘catch two birds with one stroke’: the localization of gravity and Einstein’s **equivalence principle** are two facets of the same gravitational phenomenon, while the second ‘bird’ is the localization of the quantum state<sup>29</sup> – check out Heisenberg<sup>7</sup> and Schrödinger<sup>8</sup> above.

The joint solution to these two problems, presented as localization of the quantum-gravitational *causal field* (see above), also explains the puzzle of the energy density of the vacuum<sup>34</sup> and resolves what has been called “the worst theoretical prediction in the history of physics!”<sup>10</sup>: if we treat the causal field as ‘nothing but physical reality’, the energy density of the quantum vacuum, with cutoff at Planck scale<sup>35</sup>, will correspond to “a mass density of about  $10^{96}$  kilograms per cubic meter!”<sup>34</sup>, and there will be an enormous “dark”<sup>53</sup> manifestation of gravity in terms of “**cold dark matter**” and “**dark energy**”.

Moreover, the current theoretical physics will need some Biblical “miracle” to raise a robust **Lorentzian metric** within  $10^{-30}$  seconds “after” the “big bang”, starting much earlier at  $10^{-35}$  seconds “after” it (the spacetime metric is already postulated), when the spacetime were just about 1 cm across and a causally connected region would have been only  $10^{-24}$  cm across (the **horizon problem**), in such way that one could “**inflate**” the spacetime by a factor of  $10^{78}$  and then safely keep the **Lorentzian metric** for at least **13.798 ± 0.037 billion years** rooted on the Planck scale<sup>35</sup> at which the spacetime points have become totally fuzzy and locality has lost *any* meaning<sup>36</sup>.

I will assume that no “miracles”, included those performed for profit<sup>37</sup>, are acceptable in science, and will proceed further by declaring the conditions under which the whole theory *can and will* be rejected.

Consider the dynamics of General Relativity<sup>9</sup> exhibited in the transport of energy by gravitational waves (GWs): the phenomenon is genuinely *non-linear*<sup>18</sup>, and no linearized approximation<sup>17</sup> can be applied for detecting the *physicalized* energy of GWs. I will also presume that the theory suggested in **NB above** is either *true* or *false*. So if it is proven *false*, I will immediately trash it.

The condition for proving the theory *false* is to demonstrate that the textbook presentation of GR as *classical* theory<sup>38</sup> is indeed correct. If so, we have only two alternatives for explaining the transport of energy by GWs: either they are (i) *physical* waves capable of transporting **energy, momentum, and angular momentum** along a continual path, or (ii) GWs are *not* physical waves and therefore they cannot transport

any physical stuff, much like the [quantum waves](#). Again, notice that such *alternative* framework, either GWs are physical or not, is mandatory for a *classical* theory.

As an example for continual path of energy transport by GWs, consider PSR J1603-7202<sup>39</sup>, with *dimensionless* amplitude  $2.3 \times 10^{-26}$ : case (i) requires that their *intangible* energy (Sir Hermann Bondi<sup>13</sup>) is being converted into some physical (tangible) energy at each and every point<sup>4</sup> along the path from PSR J1603-7202 to Earth<sup>39</sup>. To prove case (i) possible, at least in principle, the proponents of GW “astronomy”<sup>39</sup> must use the only available theory of gravitational radiation, suggested by Sir Hermann Bondi in 1961 (private communication by Josh Goldberg) and published one year later<sup>18</sup>, and of course abandon the *linearized* approximation<sup>17</sup>. Here’s a simple example of case (i), depicted in Fig. 11:

Imagine an empty plastic bottle on your desk, trespassed by GWs from PSR J1603-7202<sup>39</sup>, with dimensionless amplitude  $2.3 \times 10^{-26}$ , and explain the coupling<sup>17</sup> of their wave strain to the plastic material of the bottle, leading to stresses<sup>40</sup>. How could gravitational radiation<sup>18</sup> produce **work** to induce stresses<sup>40</sup> and squeeze the bottle ? Perhaps at  $2.3 \times 10^{-26}$  m ?

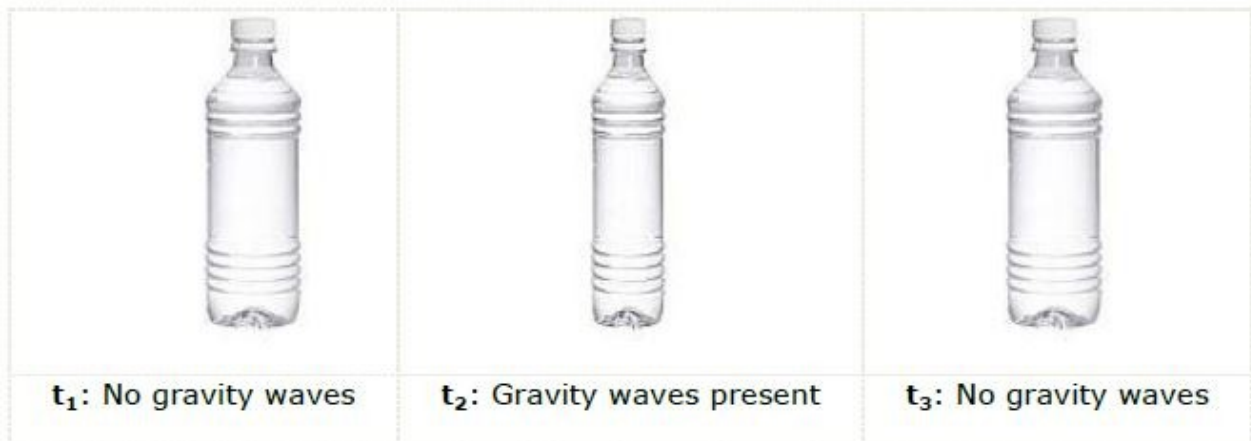


Fig. 11

Even if this formidable task is achieved and case (i) proven correct, at least in principle, the dynamics of GR will be reduced to describing some *physical* gravitational field, which in turn requires that its localization<sup>4</sup> and energy conservation<sup>13</sup> will be possible with such *classical* theory – *reductio ad absurdum*. The alternative case (ii) requires that GWs are fictitious objects<sup>41</sup> that cannot transport any physical stuff – *reductio ad absurdum*, again.

Thus, the initial presumption that General Relativity<sup>9</sup> were *bona fide* classical theory is proven **wrong**, and the only possible theory, by means of logical choice, is the one presented in this paper. Yes, GWs transport [energy, momentum, and angular momentum](#), but only and exclusively only by their localization explained in **NB above**. Hence we can ‘have our cake and eat it’.

Needless to say, if case (i) *or* case (ii) are proven correct, the theory will be trashed and I will gladly switch to other activities, say, to raising tomatoes in my garden.



Meanwhile let me explain the new form of causality, dubbed biocausality<sup>2</sup>, and suggest ‘necessary and sufficient conditions for spacetime’.

In the outline of the theory presented [above](#), the quantum-gravitational *potential* reality, called causal field, *complements* the physical reality placed in the past and marked with [blue](#) in [Fig. 3](#). The latter forms the *necessary* condition for spacetime, while the former is considered *sufficient* condition for spacetime. Their causality is called biocausality<sup>2</sup>, covering Cases I - III [above](#). It is relativistic causality, conforming to the metaphysical [principle of locality](#), and retarded causality, because the “dark strip” ([Fig. 2](#)), which would allow for advanced causality viz. [tachyons](#), does **not** exist in the *perfect* continuum of instances ‘here and now’ ([Fig. 3](#)). If the Planck scale<sup>35</sup> were *only* physical reality and *nothing but physical* reality, resembling an individual (hence [countable](#)) pixel in a digital image, the spacetime would be fundamentally discrete and one could recover the size of every finite object *exactly*, say, a table with length 1m would be recovered by multiplying the [Planck length](#) by its reciprocal value,  $1.616199(97) \times 10^{35}$ . If this was the case chosen by Nature, the set of such *extended* points, constituting ‘one meter’, will have **countable** cardinality of extended points plus extended “dark strips” between them ([Fig. 2](#)), the “dark strip” will be the ultimate cutoff at Planck scale<sup>35</sup>, and Cantor<sup>15</sup> will be wrong, because 1m will contain *less* countable points than one cube with rib 1m.

Now let me show how the interface ‘here and now’ ([Fig. 3](#)) can be derived from the [limit of a sequence](#). First, see [Thomson’s lamp paradox](#), which will be explained here with a limit 1 minute:

Consider a lamp with a toggle switch. If flicking the switch once turns the lamp **on**, another flick will turn the lamp **off**. Now suppose that there is a being endowed with *infinite* time, and able to perform the following task: starting at time zero, she turns the lamp **on**. At the end of half minute, she turns it **off**. At the end of another quarter of a minute, she turns it **on**. At the next eighth of a minute, she turns it **off** again, and she continues thus, flicking the switch each time after waiting exactly one-half the time she waited before flicking it previously. The sum of this infinite series of time intervals is exactly one minute. The following question is then considered: Is the lamp switched **on** or **off** after *exactly one* minute?

The alleged paradox is based on mixing apples (MN in [Fig. 5](#)) with oranges (P): the lamp is always a *finite* physical stuff possessing *unending* potential infinity, depicted with the finite interval MN in [Fig. 5](#), while the endpoint or [limit](#) at *exactly* 1 m is reached only with *completed* infinity, which has **ended** at the endpoint P in [Fig. 5](#).

The fundamental difference between MN and P is that the former is physical stuff operating with unending *potential* infinity, while the latter is obtained only by actual/completed infinity<sup>26</sup>, just like the [limit](#) ‘two pint beer’ in [Fig. 10](#). And since P in [Fig. 5](#) has **dual** topology, being the *interface* P ‘here and now’ in [Fig. 3](#), we can *think* of MN as having an exact limit,  $MN \rightarrow P = 1$ , but only to the extent to which P has a physical footprint or “component” placed in the *irreversible* past, marked with [blue](#) in [Fig. 3](#), thanks to which we can *imagine* (Sic!) a ‘number’ associated with it. Notice that there are no [numbers](#) in Nature; only ‘points’ with *physical* footprints, thanks to which we can *imagine* some “fixed” number *within* the infinitesimal MN.

Again, we can *imagine* in Fig. 5 that  $MN = \emptyset$  (notice  $R_\infty = \emptyset$  in Fig. 12 below), but only to the extent to which its limit **P** (Fig. 3) has a *physical* “component” in the *past*. Yet the *interface* **P** in Fig. 3 has a *potential* “component” as well, which is placed in the *potential* future and is considered ‘potential reality’ (Fig. 8). Hence no *physical* stuff, depicted in Fig. 5 with  $MN$ , can “collapse” on the *entire interface* **P** endowed with *dual* topology (Fig. 5 and Fig. 3). This is the reason for augmenting the current *number theory* with *hyperimaginary numbers* (details in Paper III<sup>1</sup>).

Now compare the endpoint 1 in Thomson’s lamp paradox with the endpoint in Fig. 12 below (adopted from Lakoff and Núñez<sup>42</sup>), labeled also with 1.

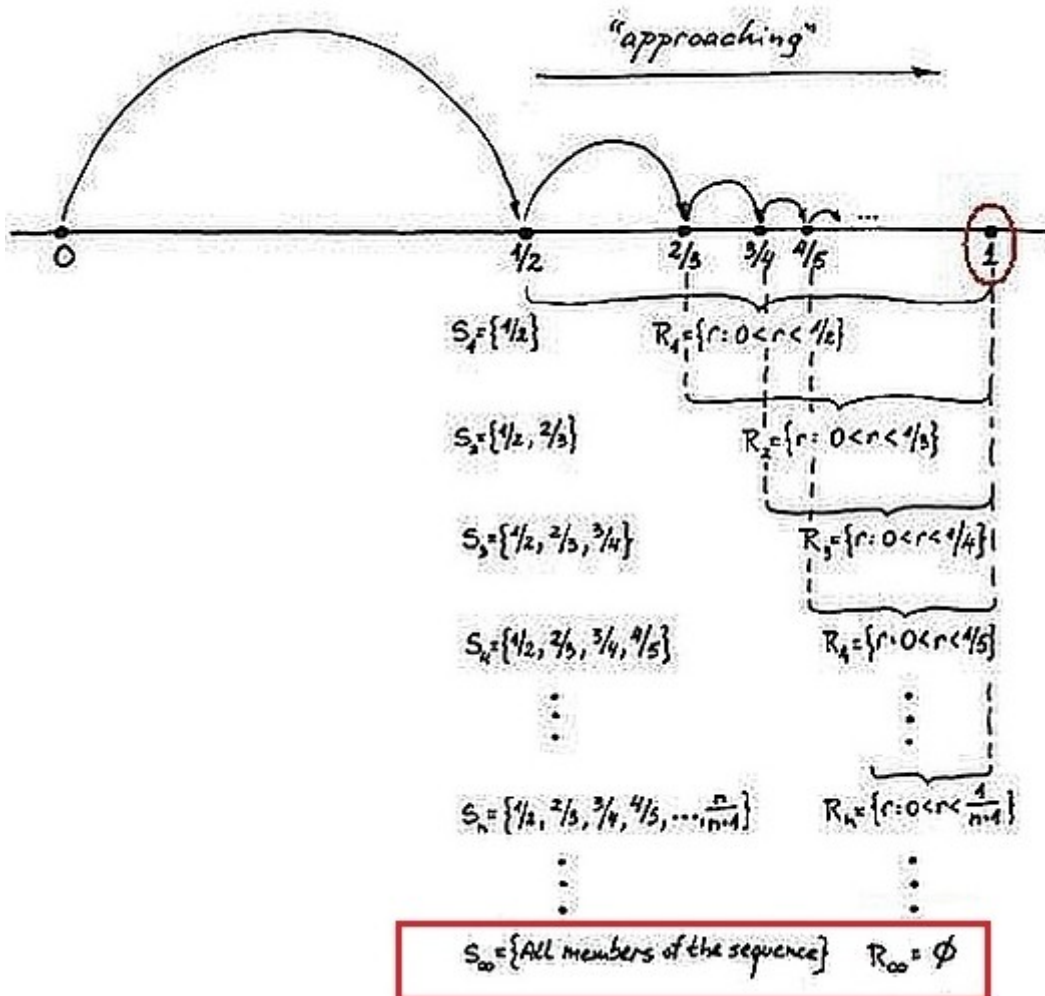


Fig. 12, adopted from Lakoff and Núñez<sup>42</sup>

Here the process of *approaching* the limit 1 (or the largest beer in Fig. 10) pertains again to the unending potential infinity, and  $R_n$  in Fig. 12 matches  $MN$  in Fig. 5, while the endpoint 1 is reached *only* with actual/completed infinity<sup>26</sup>.

Every *finite* region of spacetime, denoted with **MN** and **AB** in Fig. 5, can be viewed with both potential and actual infinities, but what could possibly define the obvious *difference* between **MN** and **AB** in Fig. 5? There is no number, denoted with **k**, to obtain **AB** from the smaller **MN** by  $k \cdot MN = AB$ , as in the definition of [international second](#), because the entire *interface* **P** in Fig. 3 is not a number. If we use actual infinity to *imagine* (not calculate) the *limits* of **MN** and **AB** in Fig. 5, we will end up with a nonsense:

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

But if we use actual infinity, pertaining to ‘potential reality’, to calculate the [invariant](#) size of **MN** and **AB**, we can obtain clear and fixed results (Fig. 10). If **MN** denotes the size of a proton and **AB** the size of a galaxy, obviously  $MN \ll AB$ . Fine, but we cannot use some number **k** nor Eq. 1 to *derive* **AB** from **MN** (Fig. 5), since the **MN** and **AB** are built by “the same” *uncountably* infinite and *undecidable* object **P** (Fig. 3), which “has no part” (Euclid).

Since the size of a proton (**MN**) and the size of a galaxy (**AB**) are not absolute, what if they are *relative*? What could *assemble* them from “that which has no part” (Euclid)?

#### 4. Relative scale spacetime

Before moving further, let me present in Fig. 13 some of the misleading ideas in the current set theory<sup>33</sup> (Fig. 9) and in mathematical relativity<sup>14</sup>, originating from Fig. 2.

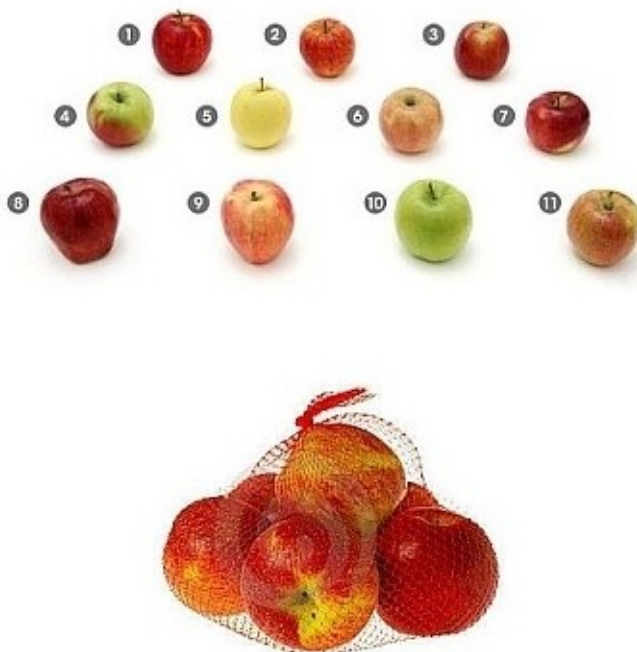


Fig. 13

Let me stress that the *union* of (i) the bag of apples and (ii) the air between apples (Fig. 13) does **not** belong to the apples themselves. It is a “colorless” (Fig. 8) object, which exists in *every set*<sup>30</sup> by its *colored* presentation as ‘potential reality’.

Again, it is not *res cogitans*<sup>6</sup>. It does not belong to the *members* of *any set* either. It is *Platonic reality* (Fig. 1), “just in the middle between possibility and reality”<sup>7</sup>. In this sense, every set<sup>30</sup> is *quantum set*, although in Case I in Table 1 above the presence of *potential* quantum-and-gravitational reality can be safely ignored.

The misleading ideas in Fig. 13 originate from Fig. 2, because many people interested in mathematical relativity<sup>14</sup> tacitly presume that the notion of an isolated, identifiable macroscopic apple (see MN above), which is denumerable and can be associated with a ‘number’, can be applied to the very *boundary* in Fig. 9, with radial extension of one single point. But in fact, the boundary is “that which has no part” (Euclid): the *interface* ‘here and now’ shown in Fig. 3 and Fig. 5. Hence the spacetime continuum<sup>33</sup> is *perfect*, because all members of *quantum sets* are **wrapped** by their potential reality shown in Fig. 3 as potential “component” of the interface P. Physically, we see only *physicalized* apples placed in the **past** (highlighted with blue in Fig. 3). In the physical world depicted with MN and AB in Fig. 5, there is no *physical* boundary whatsoever. The unphysical “boundary” is made of non-denumerable potential reality (highlighted in red in Fig. 3 and Fig. 5). Unlike in Plato’s proposal (Fig. 1), it cannot emit nor reflect light, and many people consider it “dark”<sup>53</sup> (more on this issue later).

Notice that the bag of apples in Fig. 13 and the two pint beer in Fig. 10 have *referential* background, while in the drawing of “expanding” universe (Hubblesite) the role of referential background is played by unphysical inertial “meta” observer, who can capture the entire physical spacetime *en bloc*, including its boundaries. But all physical observers belong to the physical spacetime (local mode of spacetime), which should have a ‘boundary’ *beyond* AB in Fig. 5. Following the discussion of the infinitesimal MN after Thomson’s lamp above, such spacetime boundary belongs to the local (physical) mode of time only to the extent to which its limit P (Fig. 3 and Fig. 5) has *physical* “component” located in the irreversible **past**. Hence the spacetime boundary *beyond* AB (Fig. 5) has **dual** topology, as it has *potential* “component” as well, located in the *potential* future of the interface P in Fig. 3.

Now, before explaining the Ansatz of relative scale spacetime (Fig. 15), let me stress “the lack of cosmological models with realistic, gravitationally bound objects”<sup>47</sup>: we still do **not** understand the gravitational radiation<sup>18</sup>, do **not** know how to detect it<sup>17</sup>, and certainly cannot “install” mirrors (Sic!) for gravitational waves *exactly* at the joint “border” of the spacetime at null-and-spacelike infinity, to obtain gravitationally closed system and prove that the mass of the physical “shadows” (Fig. 1) is indeed positive (**positive mass conjecture**). People try to suggest an unrealistic “vacuum spacetime” which supposedly admits a “smooth conformal completion”<sup>48</sup> à la Penrose<sup>49</sup> and even offer Penrose diagrams with “compactified coordinates”<sup>50</sup>, totally ignoring the unsolved mathematical problems of kinematical spacelike infinity (spi)<sup>51,52</sup> and the underlying mathematical jabberwockies<sup>14</sup>.

To introduce the prerequisites to relative scale spacetime (see Fig. 15 below), notice that the inflating<sup>55</sup> ark APB in Fig. 4 is not at all “curved”<sup>44</sup>, as many people<sup>54</sup> wrongly imagine. The dimensionless **scale factor**, pertaining to the inflating APB and to ‘time as measured with a clock’<sup>58</sup>, has an unphysical<sup>46</sup> “**orthogonal**” component along the axis

**W** in Fig. 4 (marked with red in the interface ‘here and now’ in Fig. 3), which will be totally ignored if we only work “intrinsically”, by applying the Gauss-Bonnet theorem. It does not exist as ‘physical reality’ (marked with blue in Fig. 3), yet is capable of altering the spacetime metric<sup>55</sup>, and many people consider it “dark”<sup>53</sup>.

I suggest that the axis **W** in Fig. 4 is related to atemporal *potential reality* pertaining to the “intermediate time” of a “free” photon “during” flight<sup>22</sup> (see above). It is luxonic reality<sup>20</sup>, and is anything but “dark”. Also, it should be capable of fixing the extensions of ‘1m’ (Fig. 12) and ‘two pint beer’ (Fig. 10) by actual infinity<sup>26</sup>. But how?

Good question. I don’t know the answer to it. Two things are clear, however.

Firstly, the buildup of ‘space’ cannot be based on some “intuitively clear” but totally wrong ideas of *finite* chunks of matter (Fig. 2), like in the definition of international second above, so that we can apply Baldy’s Law ‘some of it plus the rest of it is all of it’ at the fundamental level of “that which has no part” (Euclid) and treat the atoms of geometry as distinguishable denumerable apples separated by air and wrapped by a bag (Fig. 13), after which we ‘sweep the garbage under the rug’ with some “intuitively clear” jabberwockies<sup>14</sup> such as boundary set (Fig. 9), Hausdorff space, compact space, second countable topology, and countably infinite sets à la Chuck Norris.

Secondly, the alternative approach of seeking “intuitively clear” limit by actual infinity leads to treating the atom of geometry as “zero” viz. Eq. 1 above, which is also wrong.

In my opinion, the only solution is to apply the doctrine of trialism<sup>6</sup> and interpret the two alternatives above as two *complementary* presentations of “that which has no part” (Euclid), like an Eskimo trying to understand the elephant’s trunk<sup>29</sup>.

Therefore I will introduce the idea of ‘hyperimaginary element’, denoted with  $L_i$ , as *potential* gravitational reality (see the Platonic ideas behind the chained observers in Fig. 1), and will postulate that the quadratic invariant spacetime interval, such as 1m (Sec. 1), is being *assembled* along the axis **W** in Fig. 4 with so-called hyperimaginary element  $L_i$ , leading to ‘space’ and ‘time’ in *relative scale* spacetime. An observer at the length scale of tables and chairs (‘table 1m’ in Fig. 15) will see  $L_i$  being either “shrunk” to the size of a proton (MN in Fig. 5) or “inflated” to the maximal spacelike hypersurface (the normal vector at every point is time-like, cf. P. Chrusciel<sup>19</sup>, p. 247) approaching infinity at **P**, depicted with **AB** in Fig. 5.

True, but the observers with the size of a proton (seen as “small” MN, Fig. 15) and with the size of maximal spacelike hypersurface (seen as “large” AB, Fig. 15) will have “the same” *relative* extension within their opposite spacetime domains as well.

Who has the right ‘one meter’ and ‘one second’? Wrong question. All observers along the entire length scale are “right”.

Again, the hyperimaginary element  $L_i$  is neither *finite* (Fig. 10) nor *zero* (Eq. 1), but ‘something else’<sup>59</sup>, *sit venia verbo*. Relative to a table with size 1m (Fig. 15) depicted with two red dots in Fig. 14,  $L_i$  is being shrunk to MN and inflated to AB (Fig. 15), shown with the “running guys” in Fig. 5.



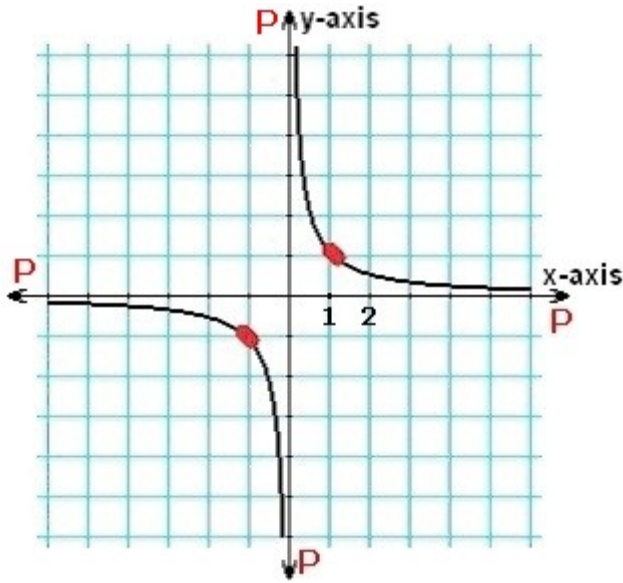


Fig. 14

Red dots :  $\pm x = \pm y = \pm 1$

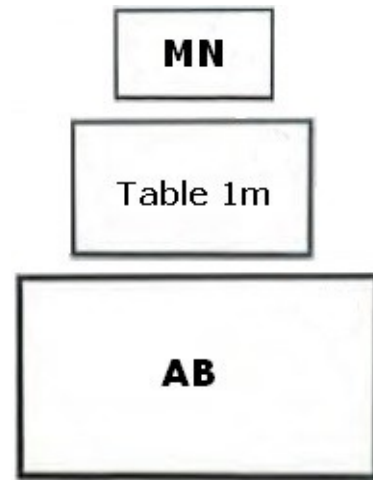


Fig. 15

Table 1m: red dots in Fig. 14

Fig. 14 shows the creation of relative scale spacetime by the so-called hyperimaginary element  $L_i$  taking non-zero positive  $x$  values;  $P$  (Fig. 5) is on  $x$  ( $y = 0$ ) and  $y$  ( $x = 0$ ).  $MN^{35}$  in Fig. 5 corresponds to  $x \rightarrow 0$  viz.  $L_i \rightarrow P$  ( $x = 0$ ) in Fig. 14, leading to the “smallest” region of relative scale spacetime, denoted with  $MN$  in Fig. 15, while  $AB$  in Fig. 5 corresponds to  $x \rightarrow \infty$  viz.  $L_i \rightarrow P$  ( $y = 0$ ) in Fig. 14, leading to the “largest” region of relative scale spacetime, denoted with  $AB$  in Fig. 15. The interpretation of the negative (mirror) case in Fig. 14 is unclear; I suppose it may be related to the [sphere-torus](#) transitions in Fig. 7. The inflation of space between  $x = 1$  and  $x = 2$  in Fig. 14 resembles [Hubble’s law](#), but is not linear and implies “[accelerating universe](#)”.

The Beginning ([John 1:1](#)) corresponds to  $x = y \equiv 0$ , matching Case IV in Table 1 [above](#).

Thus a macroscopic observer in the middle between  $MN$  and  $AB$  (Fig. 15) cannot observe the *global* inflation or shrinking of spacetime itself, but only its physical effects. In relative scale spacetime, there is no absolute inflation or absolute shrinking of spacetime viz. *absolute length scale*: see the introduction [above](#).

As to the origin of gravity (see [above](#)), it is interpreted as *local* inflation or *local* shrinking of  $L_i$ . The latter case removes the so-called non-baryonic “dark matter” and “[supermassive black holes](#)”, while the former eliminates the mythical “dark energy”<sup>53</sup>.

As to the gravitational rotation accompanying the two local gravitational effects of  $L_i$ , I suppose it is caused by “rotation” of the hyperimaginary element  $L_i$ , leading also to ‘[spin](#)’ in the quantum world.

## 5. Discussion

Undoubtedly the theory of relative scale spacetime is still a work in progress, hindered firstly by the unclear, to say the least, [hyperimaginary numbers](#) (Paper III<sup>1</sup>) needed for the so-called quantum sets (Paper II<sup>1</sup>) briefly mentioned above. The process of building the theory very much resembles a jigsaw puzzle, in the sense that every piece snaps to its unique place effortlessly, which also outlines a new blank part from the endless jigsaw puzzle: Nature is *coherent* (Sec. 1) yet endless. Let me offer a snapshot of the current status of relative scale spacetime.

1. Every point in [point-set topology](#) is *spacetime* point endowed with internal structure and **dual** topology (Fig. 3) due to its physical “footprint”, which is complemented by *atemporal* potential reality (Sec. 2) residing in the potential future of the so-called biocausality<sup>2</sup>, spanned along the atemporal (luxonic) axis **W** in Fig. 4 viz. **W0** in Fig. 6.
2. The dynamics of atemporal potential reality, dubbed [causal field](#), leads to physical theology (Table 1) in which God is presented as the union of two sets (Fig. 8) viz. to the incomprehensible ‘set of all sets’ endowed with the self-action of Aristotelian Unmoved Mover.
3. To explain the creation of relative scale spacetime from ‘something else’<sup>59</sup>, a pre-geometric plenum has been suggested, dubbed ‘[hyperimaginary element](#)’ and endowed with hyperimaginary rotation accompanying the two types of gravity, force-free gravitational attraction (local “shrinking” of spacetime) and force-free gravitational repulsion (local “inflation” of spacetime).

In my (perhaps biased) opinion, this is the only way to explain the spacetime. The theory is indirectly falsifiable, in the sense that every alternative theory of spacetime must be wrong.

The next Paper II<sup>1</sup> (in preparation) will introduce the so-called biocausality<sup>2</sup> by applying Ulric Neisser’s cognitive cycle<sup>61</sup> to the [Brain of the Universe](#). Stay tuned.

Draft version, 27 September 2015

## References and Notes

1. D. Chakalov, Potential Reality I: Relative Scale Spacetime. November 2015 (Paper I); Potential Reality II: Quantum Gravity. Manuscript in preparation, available in November 2016 (Paper II); Potential Reality III: Hyperimaginary Numbers. Manuscript in preparation, available in 2018 (Paper III).
2. D. Chakalov, How To Bind Mind To Matter? Unpublished manuscript, January 1990. Abstract and explanatory note available at [this http URL](#).
3. N. David Mermin, Is the moon there when nobody looks? Reality and the quantum theory. *Physics Today*, April 1985, pp. 38-47.
4. Charles W. Misner, Kip S. Thorne, John A. Wheeler, *Gravitation*, W. H. Freeman, 1973, cf. p. 467 at [this http URL](#).

5. Wolfgang Rindler, *Relativity: Special, General, and Cosmological*, 2nd ed., Oxford University Press, 2006, p. 22.

6. The situation with the coupling of geometry to matter<sup>9</sup> strongly resembles the so-called mind-body problem, in which we also encounter two alleged alternatives: either the mind can act on brain's tissue, in which case it cannot be *res cogitans* but material stuff obeying Newton's third law, or cannot act on its brain, in which case it becomes some kind of ghost totally detached from its brain. The solution was put forward by Gottfried Wilhelm von Leibniz, by means of [pre-established harmony](#) of *res cogitans* (mind) and *res extensa* (body), which spring jointly from a *third* (trialism) entity viewed as their common source<sup>2</sup>, [the Universe as ONE \(Luke 17:21\)](#) endowed with the self-action of the Unmoved Mover (Aristotle). Ever since The Beginning, the *physical* explications (*res extensa*) of the Universe have been perfectly fine-tuned and *pre-correlated* with all *future* requirements for life and cognition (*res cogitans*), which supports what physicists call [anthropic principle](#) and rejects the mythical "multiverse".

7. Werner Heisenberg (winter 1955-1956), *Physics and Philosophy: The Revolution in Modern Science*, Prometheus Books, 1999, cf. p. 43 and pp. 155-156 at [this http URL](#).

8. Erwin Schrödinger, Die gegenwärtige Situation in der Quantenmechanik, *Naturwissenschaften* 23, S. 807-812; 823-828; 844-849 (1935). Translated by John D. Trimmer, available at [this http URL](#).

9. Albert Einstein, *Philosopher-Scientist*, ed. by Paul A. Schilpp, Tudor Publishing Company, New York, 1951, p. 75. See also: A. Einstein, Dialog über Einwände gegen die Relativitätstheorie, *Naturwissenschaften*, 6(48), [697-702](#) (29. November 1918), S. 700: "Man kann deshalb weder sagen, das Gravitationsfeld an einer Stelle sei etwas Reales, noch es sei etwas bloß Fiktives." (...) "dem Gravitationsfeld an einer Stelle entspricht also noch nichts physikalisch Reales, wohl aber diesem Gravitationsfelde in Verbindung mit anderen Daten." ("One can say that the gravitational field [at a point](#) is neither real nor merely fictitious." (...) "nothing "physically real" corresponds to the gravitational field [at a point](#), only to the gravitational field in conjunction with other data." Translated by A. Afriat and E. Caccese<sup>24</sup>.)

10. M. P. Hobson, G. P. Efstathiou, A. N. Lasenby, *General Relativity: An Introduction for Physicists*, Cambridge University Press, 2006, cf. p. 187 at [this http URL](#).

11. Michael Forger, Hartmann Römer, Currents and the Energy-Momentum Tensor in Classical Field Theory: A fresh look at an old problem, *Annals Phys.* 309 (2004) 306-389; [arXiv:hep-th/0307199v1](#), cf. Eq. 228.

12. Erik Curiel, On Tensorial Concomitants and the Non-Existence of a Gravitational Stress-Energy Tensor, [arXiv:0908.3322v3 \[gr-qc\]](#).

13. Sir Hermann Bondi, Conservation and non-conservation in general relativity, *Proc. R. Soc. Lond.* A 427 (1990) 249-258, cf. p. 249 at [this http URL](#); Hans C. Ohanian, The Energy-Momentum Tensor in General Relativity and in Alternative Theories of Gravitation, and the Gravitational vs. Inertial Mass, [arXiv:1010.5557v2 \[gr-qc\]](#), cf. p. 3 a [this http URL](#); T. Padmanabhan, *Gravitation: Foundations and Frontiers*, Cambridge University Press, 2000, cf. pp. 211-213 at [this http URL](#).

14. Demetrios Christodoulou, Mathematical problems of general relativity I. *Eur. Math. Soc.*, February 2008, Sec. 3.1, p. 35, Definition 32 available at [this http URL](#); more mathematical jabberwockies in Fig. 9 and at [this http URL](#) and at [this http URL](#).
15. Kurt Gödel, What is Cantor's Continuum Problem? *The American Mathematical Monthly*, 54 (1947) 515-525, cf. p. 515 at [this http URL](#).
16. Merced Montesinos, The double role of Einstein's equations: as equations of motion and as vanishing energy-momentum tensor, [arXiv:gr-qc/0311001v1](#), cf. p. 5 and Eq. 23 at [this http URL](#).
17. Jose G. Pereira, Gravitational waves: a foundational review, [arXiv:1305.0777v3 \[gr-qc\]](#), cf. p. 8 at [this http URL](#).
18. H. Bondi, M.G.J. van der Burg, A.W.K. Metzner, Gravitational Waves in General Relativity. VII. Waves from Axi-Symmetric Isolated Systems, *Proc. R. Soc. Lond. A* 21, 269(1336) 21-52 (1962); cf. Bondi's news field.
19. James Hartle, *Gravity: An Introduction to Einstein's General Relativity*, Addison-Wesley, 2003, cf. p. 162 at [this http URL](#); Piotr T. Chrusciel, Lectures on Energy in General Relativity, February 22, 2013 (retrieved on 27 August 2015 from [this http URL](#)), cf. p. 226 at [this http URL](#) and p. 247 at [this http URL](#).
20. Max Tegmark, On the dimensionality of spacetime, [arXiv:gr-qc/9702052v2](#), footnote 4 and Fig. 1.
21. Only biological systems<sup>6</sup>, such as the [human brain](#), may obtain [qualia](#) from [potential reality](#), experienced as an *extended* moment 'now' from our psychological time arrow: we observe the world and, *at the same time*, are aware of doing so.
22. Kevin Brown, [Reflections on Relativity](#), Lulu, August 2015, cf. Sec. 5.8, *The Field Equations*, pp. 384-395, available at [this http URL](#); sec. 8.11, *Paths Not Taken*, pp. 610-617, available at [this http URL](#); and Sec. 9.9, *Locality and Temporal Asymmetry*, pp. 671-677, available at [this http URL](#).
23. J.D. Brown, K.V. Kuchar, Dust as a Standard of Space and Time in Canonical Quantum Gravity, [arXiv:gr-qc/9409001v1](#).
24. Alexander Afriat, Ermenegildo Caccese, The relativity of inertia and reality of nothing, [arXiv:0804.3146v7](#), p. 27.
25. R. W. Sharpe, *Differential Geometry: Cartan's Generalization of Klein's Erlangen Program*, Springer, 1997, p. 3.
26. David Hilbert, Über das Unendliche, *Mathematische Annalen* 95 (1926), S. 161-190. Translated by Erna Putnam and Gerald J. Massey, available at [this http URL](#).
27. Charles W. Misner, Absolute Zero of Time, *Phys. Rev.* 186, 1328-1332 (1969), p. 1331.

28. To the best of my knowledge, the term ‘finite infinity’ was first suggested by George F R Ellis<sup>54</sup>, see: Ellis G F R, *Relativistic Cosmology: Its Nature, Aims and Problems*, in: *General Relativity and Gravitation*, Ed. B. Bertotti *et al.*, Reidel, 1984, pp. 215-288; Sec. 5.2 and Fig. 11(c).
29. The solution to the measurement problem in Quantum Mechanics ([Schrödinger’s cat](#)) and to *the* most widely known public secret in theoretical physics (shown at [this http URL](#)) will be examined in Paper II<sup>1</sup>. If we use *classical* description of a quantum system, as suggested in current QM textbooks (e.g., [GianCarlo Ghirardi](#)), we will never understand the quantum world, just as an Eskimo could never understand elephant’s trunk by measuring it with two complementary devices, “nose” and “arm” (cf. pp. 7-8 in [HBP.pdf](#)). The [quantum state](#)<sup>7</sup> can only be described with *potential* quantum “trunk”, which is neither “particle” nor “wave”, does not “collapse” nor “decohere”, and is not “uncertain” but *flexible*: [God casts the die, not the dice](#) (Einstein).
30. Georg Cantor, Beiträge zur Begründung der transfiniten Mengenlehre, *Mathematische Annalen* **46** (1895) S. 481-512.
31. John A. Wheeler, Time Today, in: *Physical Origins of Time Asymmetry*, ed. by J.J. Halliwell, J. Pérez-Mercader, and W.H. Zurek, Cambridge University Press, 1994, p. 1.
32. Steven Weinberg, *Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity*, Wiley, 1972, pp. 62-68, p. 93 and p. 106.
33. Karel Hrbacek, Thomas J. Jech, *Introduction to Set Theory*, 3rd ed., Marcel Dekker, Basel, 1999, p. 269, available at [this http URL](#).
34. John Baez, What’s the Energy Density of the Vacuum? June 10, 2011 (retrieved on 17 September 2015 from [this http URL](#)).
35. S. J. Crothers, J. Dunning-Davies, Planck Particles and Quantum Gravity, *Progress in Physics*, **3** (2006) 70-73; [viXra:1103.0054](#).
36. Sergio Doplicher, The Principle of Locality, [arXiv:0911.5136v1 \[math-ph\]](#), p. 21.
37. Yif Magic, Lightspeed Teleportations, posted on YouTube on [December 3, 2012](#); watch a video clip (33Mb, mp4 format) from [this http URL](#). A demonstration of “levitation”, by Steven Freyne, is available at [this http URL](#).
38. Michele Maggiore, *Gravitational Waves: Theory and Experiments*, Oxford University Press, 2007.
39. LIGO Scientific Collaboration and Virgo Collaboration, Searches for gravitational waves from known pulsars with S5 LIGO data, [arXiv:0909.3583v4 \[astro-ph.HE\]](#).
40. Robert M. Wald, *Space, Time, and Gravity*, University of Chicago Press, 1992, p. 120; excerpt available at [this http URL](#).
41. Angelo Loinger, GW’s towards fundamental principles of GR, [arXiv:0709.0490v1 \[physics.gen-ph\]](#); *Idem*, On the origin of the notion of GW *et cetera*, [arXiv:physics/0407134v1 \[physics.gen-ph\]](#).



42. George Lakoff and Rafael E. Núñez, *Where Mathematics Come From*, Basic Books, New York, 2001, p. 189.
43. Eric Schechter, *Potential versus Completed Infinity*. Online essay, 5 December 2009 (retrieved on 22 September 2015 from [this http URL](#)).
44. Hyun Seok Yang, Towards A Background Independent Quantum Gravity, [arXiv:1111.0015v3 \[hep-th\]](#), pp. 1-2. To quote from Hyun Seok Yang (p. 2), “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** ?”
45. Lewis Carroll, *Alice’s Adventures in Wonderland*, Macmillan, 1865, Ch. 6 available at [this http URL](#).
46. Philip Gibbs, Where is the centre of the universe? Online article, 1997, retrieved on 24 September 2015 from [this http URL](#).
47. Timothy Clifton, What’s the Matter in Cosmology? [arXiv:1509.06682v1 \[gr-qc\]](#).
48. Piotr T. Chrusciel, Tim-Torben Paetz, Characteristic initial data and smoothness of Scri. I. Framework and results, [arXiv:1403.3558v3 \[gr-qc\]](#), pp. 2-5.
49. Roger Penrose, Conformal Treatment of Infinity. In: *Relativity, Groups and Topology*, Vol. 1, Ed. by B. DeWitt and C. DeWitt, Gordon and Breach, 1964, pp. 565-584; notice the “definition” of the boundary **exactly** at  $\Omega = 0$  on p. 565 at [this http URL](#).
50. Jerry B. Griffiths, Jiri Podolsky, *Exact Space-Times in Einstein’s General Relativity*, Cambridge University Press, 2009, Ch. 6.4, p. 83; see Fig. 6.8 at [this http URL](#).
51. Robert Geroch, Asymptotic Structure of Space-Time, in *Asymptotic Structure of Space-Time*, ed. by F. Paul Esposito and Louis Witten, Plenum, 1977; see an excerpt at [this http URL](#).
52. E. T. Newman, K. P. Tod, Asymptotically flat spacetimes, in *General Relativity and Gravitation: One Hundred Years After the Birth of Albert Einstein*, Volume 2, ed. by Alan Held, Plenum, 1980, p. 2; see an excerpt at [this http URL](#).
53. Sean M. Carroll, Why is the Universe Accelerating? [arXiv:astro-ph/0310342v2](#).
54. George F. R. Ellis, Physics in the Real Universe: Time and Spacetime, [arXiv:gr-qc/0605049v5](#), see Fig. 4 at [this http URL](#).

55. Tamara M. Davis, Charles H. Lineweaver, Expanding Confusion: Common misconceptions of cosmological horizons and the superluminal expansion of the Universe, [arXiv:astro-ph/0310808v2](https://arxiv.org/abs/astro-ph/0310808v2); see an excerpt at [this http URL](#).
56. Peter G. Bergmann, Observables in General Relativity, in *Gravitational Measurements, Fundamental Metrology and Constants*, ed. by Venzo De Sabbata and Vitaly N. Melnikov, NATO ASI Series Volume 230, Kluwer, 1988, pp. 15-18; see an excerpt at [this http URL](#).
57. Stephen Leacock, Alan Bowker, *On the Front Line of Life. Stephen Leacock: Memories and Reflections, 1935-1944*, Dundurn, 2004; see an excerpt from p. 186 at [this http URL](#).
58. Karel V. Kuchar, The Problem of Time In Quantum Geometrodynamics, in *The Arguments of Time*, ed. by Jeremy Butterfield, Oxford University Press, 1999, see an excerpt from p. 193 at [this http URL](#); Demetris T. Christopoulos, A simple definition of time, ResearchGate, 16 June 2014, available at [this http URL](#).
59. C.J. Isham, J. Butterfield, On the Emergence of Time in Quantum Gravity, [arXiv:gr-qc/9901024v1](https://arxiv.org/abs/gr-qc/9901024v1), p. 25.
60. Robert M. Wald, *General Relativity*, University of Chicago Press, 1984, pp. 7-8, p. 12 (“we shall consider in this book only manifolds which are Hausdorff and paracompact”), and pp. 423-426.
61. Ulric Neisser, *Cognition and Reality. Principles and Implications of Cognitive Psychology*, Freeman, 1976, Fig. 2 and Chs. 2 and 4.