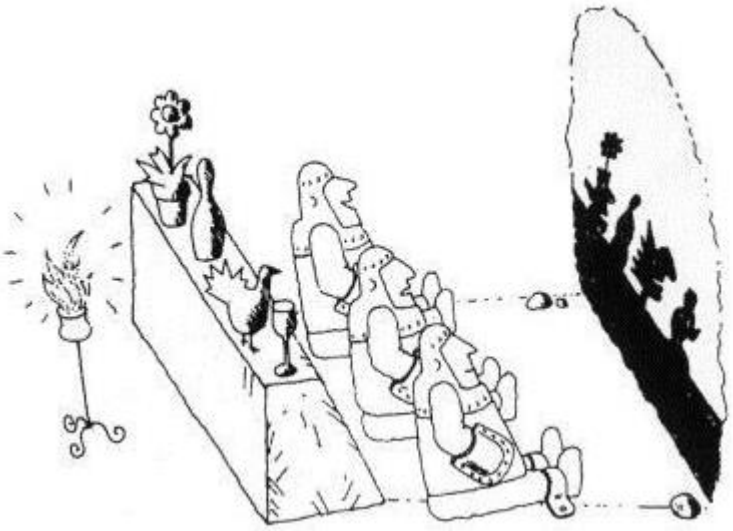
Gentlemen! The views of space and time which I want to present to you arose from the domain of experimental physics, and therein lies their strength. Their tendency is radical. From now onwards space by itself and time by itself, along with the entire physical world, will recede completely to become physicalized 4D shadows of their Platonic source.



About Space and Time

Video lecture, 21 September 2018, 10:00 GMT

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Commemorating 110 years of Hermann Minkowski's lecture RAUM UND ZEIT, given at the 80th Meeting of the Natural Scientists in Cologne on 21 September 1908 and based on the crucial contributions to the theory of Special Relativity by Hendrik Lorentz, Albert Einstein and Henri Poincaré[2], I offer my video lecture, entitled: 'About Space and Time'. It will be posted at my YouTube channel on Friday, 21 September 2018, at 10 AM GMT. Here is a brief introduction to the video lecture (draft version), which will be amended with the final text version by the end of September 2018. The lecture is organized in three sections: (**i**) what is the Platonic theory of spacetime, (**ii**) where it comes from, and (**iii**) what follows from it (read below). I hope that the video lecture, backed by its final text version with references and notes, will be easier to understand and study.

Ensuing from Plato's Cave and the ideas by Heraclitus and Aristotle, I present the Platonic theory of spacetime: the atom of geometry (dubbed "point") is treated as complex object endowed with topology, kinematics, and dynamics. It is suggested that what we call 'spacetime' is not some inert geometric object, but a holistic bootstrapping phenomenon, which holds the entire physical world together, as the latter evolves along the so-called Arrow of Space. Hence 'space' and 'time' are interpreted as *emergent* phenomena pertaining solely to the 'wall' in Plato's cave, whereas their **nonphysical** Platonic source,

[1] Email: dchakalov@gmail.com. Download the final version of about_spacetime.pdf on 30.09.2018 from this http URL.
[2] H. Poincaré, Sur la dynamique de l'électron, *Comptes Rendus Acad. Sci* Paris, 140, 1504-1508 (5 Juin 1905).

dubbed 'potential reality' or *Res potentia*, does **not** live anywhere on Plato's 'wall' (called 'local mode of spacetime', pp. **8-9** in FRAUD.pdf) and remains *perfectly* hidden by the "speed" of light (**A2** in Slide **19** in Quantum Spacetime). What physicists nowadays call 'spacetime' is treated as *local mode* of spacetime relevant only to the *physicalized* explications of the Universe cast on the light cone — nothing but 4D "shadows" of *Res potentia*, as Plato suggested many centuries ago. Thus, a new quantum-gravitational spacetime, equipped with local and global modes, is proposed for quantum gravity and cosmology: every *physicalized* system is endowed with both 4D local mode of spacetime determined by the local properties of matter and fields, and global mode of spacetime determined by the global properties the entire Universe as ONE. It's a bundle.

First, some history. On June 2, 2008, commemorating the one-hundredth anniversary of Hermann Minkowski's lecture 'Space and Time' on 21 September 1908, I invited many theoretical physicists and mathematicians to attend my talk in Munich on 21 September 2008: read my invitation at this http URL. Now I offer a video lecture, which will be available on 21 September 2018 (read above). Feel free to subscribe by email with subject "About Space and Time, 21 September 2018". You will receive password to watch the lecture (app. 20 min) and will be able to download it until 10 AM GMT on 30 September 2018. The main idea was explained at my first talk on 21 September 2008[3]: every *finite* (bounded) spacetime region has both *local* properties (local mode of spacetime) and *global* properties (global mode of spacetime); the latter are determined by the properties the entire Universe as ONE, most notably by the **self-acting** faculty of Aristotle's Unmoved Mover. Thus, we arrive at the proposal by Heraclitus 'you cannot look twice at the same river', and suggest that the irreversible *flow* of 4D events 'here and now', constituting the local mode of spacetime, cannot be observed in principle due to the "speed" of light. We only have *physicalized* remnants from the **self-action** of the Universe as ONE (global mode of spacetime), which some (otherwise smart) people consider "dark". Simple, isn't it? Yet ten years after my conceptual solution of "dark" gravity, it has not been even mentioned!

To give you a glimpse to the forthcoming video lecture, check out (**i**) Slide **7** and **A2** in Slide **19** in Quantum Spacetime, (**ii**) my comments on the alleged temporal and spatial orientability of spacetime at this http URL, and (**iii**) pp. **21-26** in Hyperimaginary Numbers. Instead of mimicking Nature by postulating the orientability of spacetime 'by hand', we should get professional and uncover the proper mathematical formalism and tools.

Now, to understand 'space' and 'time', let me stress that their *origin* poses an outstanding challenge. Consider, for example, Sergio Ulhoa *et al.*[4] (I will talk on the Hubble Law later):

> The modern observational cosmology inaugurated at the Mount Wilson Observatory gave a great impetus to understanding the Universe [1]. The Standard Cosmological Model, alongside the Cosmological Principle and field equations of GR, describes all knowledge about large structures with good approximation. The Hubble Law shows how fast galaxies move away from each other at a relatively small distances. Thus it could be used to test new cosmological theories. The Cosmological Principle states that the Universe is isotropic (above 100 Mpc) and homogeneous (there is no center) in addition its dynamics is given by the Einstein field equations, $R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R = 8\pi T_{\mu\nu}$. In such a way it is possible to trace a complete time evolution of the Universe. If the time is set backwards (Sic! – D.C.) we see that everything started in a warm and dense state with domination of the radiation energy. The metric that admits the Cosmological Principle and the dynamics given by the GR is that of Friedman-Lemaître-Robertson-Walker (FLRW) [2-6]:

[3] You may wonder, why am I doing these efforts to promote again the Platonic theory of spacetime? Because spacetime engineering is the future. If people again ignore my work, as they did ten years ago — so be it. Matthew 7:6.

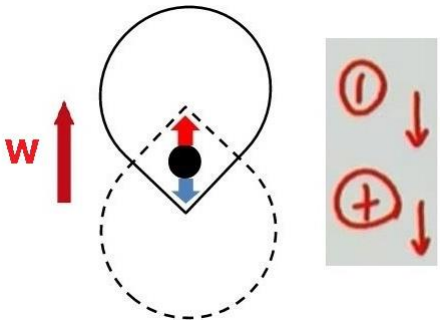
[4] Sergio Ulhoa *et al.*, arXiv:1802.08087v1 [gr-qc], 21 February 2018.

$$ds^2 = -dt^2 + a^2(t)\left[\frac{dr^2}{1-\kappa r^2} + r^2 d\Omega^2\right], \qquad d\Omega^2 \equiv d\theta + \sin^2\theta\, d\phi^2 \tag{1}$$

where k assumes values of −1 (negative or closed spatial curvature), 0 (null or flat spatial curvature) or +1 (positive or open spatial curvature).

Here's the problem: once we introduce *metric* of spacetime, as Hermann Minkowski did at his famous talk on 21 September 1908, we face the ***origin*** of spacetime, which must have existed "before" the instant of creating spacetime endowed with metric. This **metric paradox** prompted Yakov Zel'dovich to suggest that "long time ago, there was a brief period of time during which there was still no time at all." (Private communication; translation mine – D.C.) Needless to say, he was joking. Point is, the metric paradox remained unsolved until the author of these lines found its unique, and highly non-trivial, solution dubbed Finite Infinity (**FI**)[5]. Do you remember the ancient Dragon chasing its tail? You need two *dual* states of the Dragon: one in which it has already caught its tail, and another one in which it is only approaching its tail, but can never actually catch it. The first state of the Dragon is called actual or completed infinity, while the second one is known as potential infinity. Blend the two states and you will obtain **FI**, plus the so-called *dual age* of the Universe (p. **4** in Hyperimaginary Numbers). But let's go back to the basics.

Let me again suggest, following my previous talk on 21 September 2008, two *modes* of the Universe viz. its spacetime: local mode (determined by actual or completed infinity) and global mode (determined by potential infinity). It's a bundle: see Fig. **3** in Gravity-Matter Duality. We can explain the local mode only by referring to properties of the global mode, and *vice versa*. I will elaborate later on the hypothetical *polarization* of primordial mathematical points (read my comments at this http URL); for now let me stress that the two *modes* of spacetime exist due to the Heraclitean *flow* of 4D events 'you cannot look twice at the same river'. Prior to the *polarization* of primordial points, the proto-Universe could have existed only as 'non-reality' or [John 1:1] which, *after* the Beginning, is located "inside" each and every fleeting 4D shadow 'here and now' (Luke 17:21).



The **self-action** of the Universe. Check out Fig. **5** in Gravity-Matter Duality, Refs **9** and **10** in Hyperimaginary Numbers, and Sec. **3** in *Panta Rei*: The Evolution Equation.

The two modes of spacetime can be visualized with spacetime "lattice" in which every two consecutive points, **A** and **B**, are timelike separated ($\mathbf{s^2 > 0}$), only now you have to *totally* remove **all** gaps and make the spacetime manifold *perfect* continuum: see Fig. **1** in *Panta Rei*: The Evolution Equation, p. **4**. In the *local* mode, the gaps are **non-existent** due to the "speed" of light (**A2** in Slide **19** in Quantum Spacetime), while in the *global* mode the same gaps are "elevated" along the **atemporal** *hyperimaginary* axis **W** (the radius of expanding balloon, Fig. **4** in Gravity-Matter Duality) harboring the Platonic *Res potentia*.

[5] D. Chakalov, viXra:1410.0194vD, 2015-11-08, p. 7; viXra:1705.0219v8, 2017-06-21, p. 6.

Notice that the local 4D "shadows" on Plato's wall (local mode of spacetime) are patches from the inflating balloon in Fig. **4** in Gravity-Matter Duality, p. **5**.

In a nutshell, every **next** event 'here and now' along the Heraclitean *flow* of events is **jointly** (Sic!) determined by its irreversible history and potential future. This new form of *retarded* causality (there are no tachyons — the cause and its effect are always timelike separated) was called 'biocausality' in January 1990, but it took over **23** years to model gravity and suggest the theory of quantum gravity on 20 October 2013.

Here I won't have time to explain the Heraclitean *flow* of events hidden by the "speed" of light (**A2** in Slide **19** in Quantum Spacetime), which produces two modes of spacetime. Let me briefly mention that the infinitesimal step "forward" along the *flow* of events (dubbed 'Arrow of Space') is *complemented* by infinitesimal step of "rotation"[6]. It's a bundle. Check out the drawing above and study the references. As I mentioned previously, we have in the local mode of spacetime only ***physicalized*** remnants from the **self-action** (depicted above) of the Universe as **ONE** in the global mode, which some people consider "dark".

But what is *local* mode of spacetime? It pertains to the *physicalized* 4D world of "shadows" (see above). It is always "squared" (Wikipedia) and is placed exclusively in the *irreversible* past of every instant 'here and now' (Sec. **4** in Gravity-Matter Duality) from the light cone. The *global* mode of spacetime, on the other hand, does not live anywhere on the light cone (pp. **8-9** in FRAUD.pdf). It inhabits the *potential* future (*Res potentia*) of the same instant 'here and now'. The latter is supposedly endowed with kinematics, dynamics and topology: the transition from potential future to irreversible past (recall the Dragon chasing its tail, p. **3** in Penrose-Norris Diagram) is neither along an open (straight) causal line nor along a closed causal circle, but "along" topological *superposition* of the two (Fig. **1** in CEN.pdf).

Regarding Quantum Theory, the reason for introducing *global* mode of spacetime was explained in Quantum Spacetime (e.g., Slide **7**). In one sentence: the genuine quantum state[7] of every quantum system is an **intact** *Res potentia*, which is neither "particle" nor "wave", does not "collapse" nor "decohere", and is not "uncertain" but *flexible*: God casts the die, not the dice (Albert Einstein). As to General Relativity (GR), we need the *global* mode of spacetime to understand the origin of inertia[8] and the *physicalization* of gravity in (the *local* mode of) spacetime. In current GR textbooks, it just doesn't work (MTW p. 467) — check out the analogy with gravitational pizza in Gravity-Matter Duality.

In short, I suggest quantum-gravitational spacetime endowed with local and global modes, which could allow us to model the entire Universe as human brain. Now let me more specific on the two modes of spacetime and their origin [John 1:1].

We assume that 'spacetime' is represented by geometry, but what is 'geometry' made of? What is the ***atom*** of geometry? We know 'matter' from classical physics, say, tables and chairs or physical fields (e.g., electromagnetic field). Given the indisputable practical success of Quantum Mechanics (QM), we are sufficiently confident that what we call 'matter' is ultimately rooted on energy, at least to the extent to which mass and energy are "equivalent" (there is a big can of worms in this issue, which I am not going to open right now). However, we cannot reproduce 'matter' solely from 'energy', because an *absolutely essential* ingredient of the physical world is missing in today's QM textbooks:

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[6] D. Chakalov, viXra:1705.0147v3, Sec. 3.

[7] P. Ghose, arXiv:0906.0898v1 [quant-ph], 4 June 2009; M.S. Leifer, arXiv:1409.1570v2 [quant-ph], 6 November 2014.

[8] Ignazio Ciufolini and John A. Wheeler, *Gravitation and Inertia*, Princeton University Press, 1995, pp. 4-5 and p. 270.

the **matrix**. Let me quote from the seminal speech by Max Planck *Das Wesen der Materie* (The Nature of Matter) at Florence in 1944:

> There is no matter as such! All matter originates and exists only by virtue of a force which brings the particles of an atom to vibration and holds this most minute solar system of the atom together. We must assume behind this force the existence of a conscious and intelligent Geist (bewußten intelligenten Geist). This Geist is the matrix of all matter.

But the **matrix** is not 'mind' (bewußten intelligenten Geist): the **matrix** is not *Res cogitans*, but Platonic *Res potentia* or 'potential reality'. Surely one cannot somehow "attach" mind and consciousness to quantum particles and the vacuum; check out a simple explanation on p. **3** in Hyperimaginary Numbers.

You may ask, if the **matrix** is not physical stuff (*Res extensa*), how is the physical world related to it? By its spacetime **topology**: the **matrix** operates exclusively in the global mode of spacetime, whereas the creative effects of the **matrix** (Slides **9**-**12** in Quantum Spacetime) are being *physicalized* (Sic!) in the local mode of spacetime (Table **1** in The Spacetime, p. **14**).

To help you understand the **matrix**, replace it with 'money' and imagine a 4D physical universe made only by physical money: you can never see 'money *per se*' (global mode of spacetime), but only particular *physical* manifestation of 'money' (local mode). You cannot ask profound questions like 'what are money made of?', just as you cannot ask 'what is matter made of?'. Everything in the physical universe, including gold, silver, and crypto currencies, are *physical* manifestations of 'money'. If you prefer, you may replace the English label 'money' with different labels from other languages, say, *argent* (French), *Geld* (German), *pengar* (Swedish), 钱 (Mandarin), etc., yet you can never alter the *meaning* of 'money', nor observe its Platonic **matrix** 'money *per se*' kept in the global mode of spacetime. Why not? Because you can see only various *physicalized* 4D "shadows" from the **matrix** (see above) — you cannot "turn around" and look straight at their common **matrix**, as Plato explained many centuries ago. I wish to ameliorate Plato's proposal by suggesting that the Platonic **matrix** is both 'one' and 'many' (non-denumerable *Res potentia*), which cannot have any **metric** (Yakov Zel'dovich), just as there is no *physical* distance between the *idea* of a tree and the *idea* of a mountain. Also, if the qualia from electromagnetic radiation with wavelength 620-750 nm is what we call (in English) 'red', keep in mind that there is no qualia from the Platonic **matrix**, because the latter is inherently **UN**speakable: check out a simple experiment with your brain on p. **2** in Hyperimaginary Numbers. Thus, in cognitive psychology the **matrix** corresponds to 'cognitive vacuum', whereas in physics *the same* (Sic!) **matrix** corresponds to quantum vacuum[9]. If we learn how to access the **dual matrix** (cf. the doctrine of *trialism*, Slide **14** in Quantum Spacetime), perhaps we will be able to practice spacetime engineering. Again, the matrix ***itself*** is not directly observable, yet it is not "dark", as some (otherwise smart) people chose to call it. It is neither physical stuff (*Res extensa*) nor mental stuff (*Res cogitans*). It is 'potential reality' (*Res potentia*), "just in the middle between possibility and reality" (Werner Heisenberg[10]).

Can we uncover *Res potentia* in Mathematics? Yes we can. It has been residing, right after the Beginning [John 1:1], in the **atom** of geometry, dubbed "point" — "that which has no part" (Euclid). Let me explain, along with the topological property of spacetime manifold, called Finite Infinity (**FI**).

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[9] Peter W. Milonni, *The Quantum Vacuum*, Academic Press, 1993, Ch. 2.6.

[10] Werner Heisenberg (winter 1955-1956), *Physics and Philosophy*, Prometheus Books, 1999, p. 43 and pp. 155-156.

Look at $\mathbf{R_\infty = \emptyset}$ in Fig. **7**, p. **9** in Hyperimaginary Numbers, and notice that 'the Ghosts of departed Quantities' (George Berkeley) has **absolutely** (Sic!) disappeared *exactly* at the limit we know from Augustin-Louis Cauchy: *Res potentia* does not belong to the "points" from the real number line; it has only *physicalized* **footprints** there (p. **8** in FRAUD.pdf). We can include **absolutely** all points (**footprints**) from the spacetime manifold with **FI** (read above), by *both* actual infinity (Fig. **11** in The Spacetime, p. **12**) *and* potential infinity ("as closely as desired", Adolf Fraenkel): check out p. **6** in Penrose-Norris Diagram.

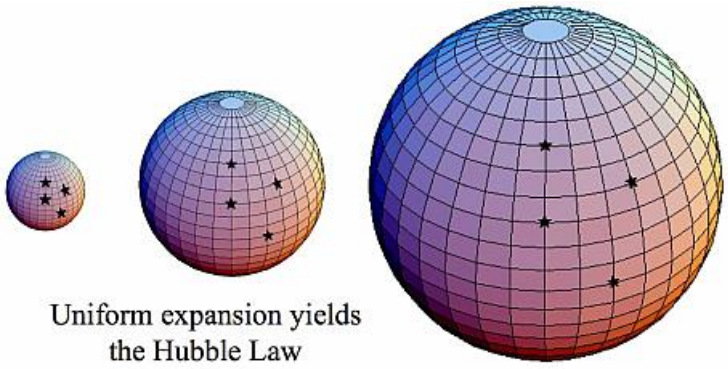
Everything said so far is intended only to explain the Platonic theory of spacetime, based on the two *modes* of spacetime above. Now I will demonstrate that we ultimately need it.

The conceptual solutions to (**i**) the measurement problem in QM and (**ii**) the "dark energy", with the **self-action** (see the drawing above) of the entire Universe as **ONE**, are unique — there is no other solution to the unification of QM and GR. The latter theories turned out to be essentially incomplete, as their textbook versions lack the crucial notion of quantum-gravitational reality, presented with two *modes* of spacetime: read Gravity-Matter Duality.

Now I will argue about the need for Platonic theory of spacetime to understand the mundane notions of 'space' and 'time'. For example, suppose you look at the night sky and see an unbounded black space sprinkled with bright stars, while your clock reads every consecutive moment from your observation of this endless, seemingly infinite, 3D space. Simple, isn't it?

Not at all. Thanks to Edwin Hubble, we know that this enormous spatial container, dubbed 'space', is "expanding" ***within itself*** (Fig. **4** in Gravity-Matter Duality), and the *dynamics* of this totally incomprehensible "expansion" determines the dimensionless scaled factor, presented with what we call 'time', as read with a physical clock. Nothing is simple here, as the alleged "expansion" of space must be *non-referential*, that is, 'absolute'[11], and the engine of this "expansion" is related to the energy density of the vacuum, which leads to "the worst theoretical prediction in the history of physics!"[12]

The great Edwin Hubble never accepted the interpretation of his groundbreaking discovery as "expansion" of space. Georges Lemaître did, and now physicists and cosmologists have to use, *faute de mieux*, the FLRW model mentioned above, and quietly ignore the metric paradox exampled by Yakov Zel'dolich, about the **center** of the "expanding balloon":



See Fig. **4** in Gravity-Matter Duality

[11] Michal Chodorowski, arXiv:astro-ph/0610590v3, 27 March 2007, p. 1.
[12] M. P. Hobson, G. P. Efstathiou, A. N. Lasenby, *General Relativity: An Introduction for Physicists*, Cambridge University Press, 2006, p. 187.

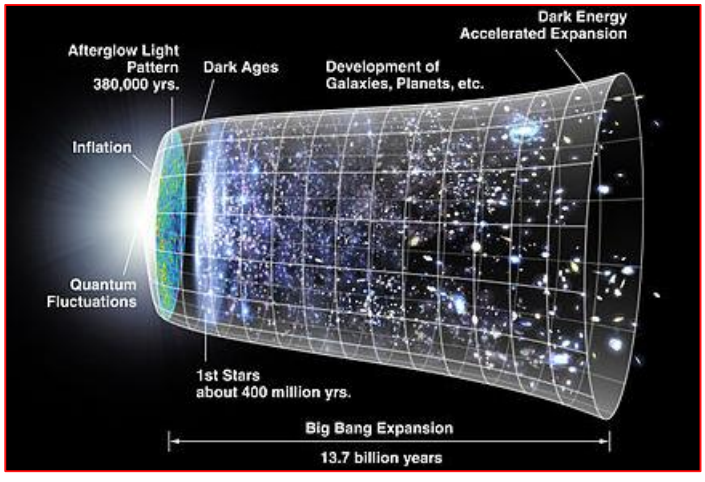
All physical systems live on the 3D surface of the cosmic "balloon" above, as 4D "shadows" depicted above. Thanks to the "speed" of light (**A2** in Slide **19** in Quantum Spacetime), we have no **direct *physical*** access to its (hyperimaginary) radius denoted with **W** in Fig. **5**, p. **6** in Gravity-Matter Duality, which matches the "direction" of the Heraclitean *flow* of events dubbed here 'Arrow of Space'. The latter is omnidirectional and *atemporal*, and its "vector" is *totally* eliminated in the **squared** (Sic!) spacetime interval (Wikipedia). Hence the Heraclitean 'arrow of time' (read my comments on the current temporal and spatial orientability of spacetime at this http URL) is **non**-relational and **absolute**, or else it will be *physical* phenomenon and the theory of relativity will be **demolished**. This very simple argument poses great problems to many people, perhaps because they are haunted by Marxist-Leninist philosophy and deeply believe that we are made exclusively by atoms (ref. [**18**] in Hyperimaginary Numbers, p. **15**).

The Platonic theory of spacetime solves all these problems *en bloc*. For if we use Finite Infinity (read the explanation above), we have *dual age* of the Universe: finite in the local mode of spacetime, and "infinite" or rather **un**decidable in the global mode. Once created by God [John 1:1], the Dragon can never reach any 'limit' and (inevitably) **stop** there.

Let me go back to the **self-acting** faculty (see above) of the entire Universe as ONE. In the physical world modeled with local mode of spacetime, there is only physical stuff. The Platonic *Res potentia* (global mode of spacetime) does not interact with the matter. Instead, matter interacts with **itself** by self-action: only matter can act on matter. In the world of *living* matter, such as the human brain and every living organism, their self-organization and self-action is known as 'activity', after Nicolas Bernstein[13].

As an example, consider the human brain: there is no "dark" computer in your brain, which could conduct and correlate billions of neurons and trillions of synapses, not to mention your embryonic state. But how is it done? With the **matrix** in the global mode of spacetime (read above). Now switch to the entire Universe modeled as 'brain' and check out the **matrix** above. If you don't like parapsychology and "anthropic principles", you need the Platonic theory of spacetime and the doctrine of *trialism* (Slide **14** in Quantum Spacetime).

Since I have to squeeze my lecture into 20 min, I cannot address here the *rate* of time. Check out [**6**] above, regarding the so-called 'relative scale spacetime' or **RS** spacetime. It's all relative. Keep also in mind that the popular drawing from Wikipedia below, showing the alleged topology of "expanding" space, is *terribly* misleading, to say the least.



[13] N.A. Bernstein, *Essays on the Physiology of Movements and Physiology of Activity*, Moscow, 1966 (in Russian).

There are no *absolute* inertial observers in GR, who could "see" the Universe *en bloc*: recall the metric paradox above and the bold fact that the "expansion" of spacetime is, and has *always* been, faster-than-light[14]. The entire Universe as **ONE** can exist only in its global mode, as Platonic *Res potentia* grounded on God (John 1:1; 1 John 4:8). Simple, no?

One practical issue remains open: can we produce unlimited clean energy with spacetime engineering (p. **9** in Gravity-Matter Duality)? I will be happy to explain my opinion to all people who have subscribed by 10 AM GMT on 21 September 2018. Yes, we can tweak our common global mode of spacetime (Fig. **10** in CEN.pdf, p. **11**). No, it is not "magic": Any sufficiently advanced technology is indistinguishable from magic (Arthur C. Clarke).

For comparison, the alternative to my project **BAVER**, from **b**rain-**a**ided **v**acuum **e**nergy **r**elease, is Wendelstein 7-X in Germany. People there deeply believe it might achieve "up to approximately 30 minutes of continuous plasma discharge in 2021." If confirmed, Wendelstein 7-X will be just 'the proof of concept'. So far over **€1 billion** (all taxpayers' money) were invested in it, as some "potential of stellarators as power plants". But how about the potential of **BAVER** as power plant? My proposal was sent by snail mail to Max Planck Society in **March 1994** (no typo), and again by email on 27 April 2017 (p. **94** in gravity.pdf). Dead silence (p. **20** in Hyperimaginary Numbers). Mind you, the idea of **BAVER** is *very* simple: see [**9**] above and Fig. **10** in *Panta Rei*: The Evolution Equation, p. **11**.

Perhaps we only need the Platonic theory of spacetime and new point-set topology, set theory, and number theory to model *Res potentia* with *hyperimaginary* numbers. All the rest is provided by the human brain embedded in the Brain of the Universe, and the Law of Reversed Effort: "To the mind that is still, the whole universe surrenders" (Lao Tzu).

Do you want to watch **BAVER** in action? It's not "magic" but gravitational radiation[15]. Only at this moment the **BAVER** effect is not yet scalable, as Nature does it. But we never know what the future holds in all the things we know that we don't know, and in those still in 'the unknown unknown'.

D. Chakalov
14 March 2018, 17:20 GMT

[14] Tamara M. Davis, Charles H. Lineweaver, arXiv:astro-ph/0310808v2, 13 November 2003, Fig. 1.
[15] Forget about "GW astronomy": read p. **25** in FRAUD.pdf.