Panta rei
conditio sine
qua non est

Creatio Ex Nihilo: The Evolution Equation

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Abstract

It seems possible to suggest an evolution equation in cosmology,
which permits unlimited *creatio ex nihilo* from the quantum vacuum,
yet may not lead to catastrophic events.

1. Introduction

The idea (*noêma*) of 'nothing' means 'something that has no inherent properties', such as an empty set (if any). You can't get something from nothing. In Latin, *ex nihilo nihil fit*, or 'out of nothing, nothing becomes'. (In Mandarin, I suppose it reads 在阿里巴巴买东西.)

Well, it depends on what *we* mean by 'nothing'. For example, if we look at a flat line, we can say that, obviously, there are no waves in it, although we know that waves can cancel each other completely due to destructive interference, leading to a flat line. Taking this example further, imagine that back in 19th century, long before Max Planck war born, some philosopher tried to relate the concept of 'nothingness' with the example of a flat line that contains no waves whatsoever: his argument will be logically correct, as even today people strive to explain (not define) the concept of 'nothingness' as '*something* that is <u>not</u> there', like an empty set (if any). He may even try to speculate that the ancient ideas of 'atom' and 'point' ("that which has no part", Euclid) may be related to this kind of 'nothingness' or 'vacuum'. I believe it is safe to assume that nobody from the established scientific community in 19th century would have paid attention to such metaphysical exercise, yet it might have helped in our understanding of the quantum vacuum[2] and its zero-point energy.

I would like to offer a similar metaphysical exercise (Path II), based on a new *relativistic vacuum* (Fig. 3), and will try to explain a new *evolution equation* (I have to avoid the generic case of 'zero' as The Noumenon[1], which is **not** *explicitly* present in Fig. 1, because

it cannot be a *set* in principle, not even an "empty" one). The equation (Sec. **3**) presumes specific coupling of matter (*res extensa*) to its potential states (*res potentia*)[1], and offers conceptual solutions to many problems in our understanding of cosmology, gravity, and the alleged "dark energy"[6]. How was the Universe created? And why is it larger than a football?

Let's take a closer look at *res potentia*[1] in the form of quantum vacuum[2] (Slide 13[1]). To quote Sir Arthur Eddington[3],

> A star is drawing on some vast reservoir of energy by means unknown to us. This reservoir can scarcely be other than the subatomic energy which, it is known exists abundantly in all matter; we sometimes dream that man will one day learn how to release it and use it for his service. The store is well-nigh inexhaustible, if only it could be tapped. (...) If, indeed, the sub-atomic energy in the stars is being freely used to maintain their great furnaces, it seems to bring a little nearer to fulfillment our dream of controlling this latent power for the well-being of the human race — or for its suicide.

I will argue that the inexhaustible "reservoir of energy" is related to gravity[8] as well, because the genuine gravitational energy is not *directly* observable, much like the genuine 'quantum state', as stressed by Erwin Schrödinger in 1935[1]. In a nutshell, the conservation of energy, including the input from gravity, is perpetually violated[8] in the physical world, yet it is *always* conserved in the Platonic world of *res potentia*[1]: have our cake and eat it. How could this be possible? With a new evolution equation (Sec. **3**)[1]. The initial idea comes from Plato, with some minor modifications (Fig. 4), such as 'chained Eskimos' (Slide 14[1]).

Now let me briefly mention two approaches to cosmology, dubbed Path I and Path II.

Consider the topological dimensions of 4D spacetime: if we look at a clock, we will always pinpoint an instant of the cosmic time, and if we look along any direction in 3D space, we can see as far as we like[4]. Yet if we apply our current mathematical models[15] to The Beginning of spacetime (Path I), we will hit an insurmountable problem: "long time ago, there was a brief period of time during which there was still no time at all" (Yakov Zeldovich, private communication, 1986; translation mine). With Path I, we inevitably hit some "very special state"[5] of the universe, which was perfectly smooth and gravity was still (Sic!) absent, and prior to such "very special" proto-state, there was "no time at all." One would need some Biblical "miracle" to reproduce the world from "no time at all."

We believe that Path I, despite being based on mathematical models, is not acceptable. Thus, we will pursue Path II by suggesting a phenomenological theory of spacetime, which is free from any problems and inadmissible errors, Biblical "miracles" included. Our goal is to suggest *conceptual* solutions to *conceptual* problems, such as "the worst theoretical prediction in the history of physics!"[6]. On the flip side, Path II still lacks mathematical description, firstly because the so-called hyperimaginary numbers[1] are not yet unraveled.

2. Path II: Vacuum Energy

There is something truly peculiar about the vacuum[2]: we can observe only its energy **differences**[7] (Fig. 5). If we could gain access to the *complex* phase of quantum waves and tweak their destructive interference leading to "vacuum", perhaps we could evoke real physical stuff[8] to emerge at macroscopic level as 'free lunch', like *creatio ex nihilo*. But of course, we need quantum gravity in the first place, to eventually fulfill "our dream of controlling this latent power for the well-being of the human race — or for its suicide"[3].

The point here is that we can *never* observe the vacuum itself, so the expression 'vacuum energy' is **false**. To explain the puzzle, I suggested in September 2000 the parable of John's jackets.

Suppose you chase somebody on the street (let's call him John), and any time you catch him, he leaves his **jacket** in your hands. You can't catch John himself. Only his jacket. You believe that John has a set (or is it strictly a set?) of physical jackets with different probabilities for catching, and you deeply believe that this set can be normalized, i.e., the sum of probabilities for catching his jackets is unity. Yet John does not wear *any* jacket by default − neither before nor after you catch his current jacket (Schrödinger, Slide 6[1]). John is simply the Platonic Idea and 'the true monad without windows' (Leibniz, Slide 13[1]).

The parable of John's jackets applies to gravity[8] as well − we certainly observe various gravitational 'jackets' in the right-hand side of Einstein's field equations, despite the fact that there is no gravitational "spring or sink for matter energy-momentum anywhere in spacetime"[9]: if we try to present John *himself* with a **tensor**, as we do it for matter and fields in classical physics, we have to admit that there is no gravitational stress-energy **tensor**[10] to describe John-the-Gravity. We can only observe his *physicalized* 'jackets', say, from "positive energy density of about $6{\times}10^{-10}$ joules per cubic meter"[7] to $8.8{\times}10^{47}$ joules (app. 4.9 times the sun's mass turned to energy), in the case of GRB 080916C.

To cut the long story short, in our theory of quantum gravity we offer a common 'John' (*res potentia*) for all quantum-gravitational 'jackets' (*res extensa*), stressing that 'John' cannot be **physically** observed due to the "speed" of light (**A2** in Slide 19[1]). If people insist on modeling 'John' as some *physical* stuff, they will immediately hit "the worst theoretical prediction in the history of physics!"[6]. To explain why, let me offer a simple explanation, starting with the opposite case in which 'John' did not exist, only his 'jackets'.

Suppose that you have €1000 in your bank account, and decide to withdraw €80 from it. You go to some cash machine on the street, insert your debit card, dial your password, and get your €80: the total amount of your €1000 remains conserved; you just have €80 less in your bank account, matching the same €80 in your wallet. All your money and those in the bank are *physical* stuff. Also, you can't withdraw more than €1000 with your debit card, and the total amount of money in the bank is, say, €1.000.000.000. Simple and clear.

Now, suppose your money in the bank (not in your wallet) *and* bank's money are 'John's jackets' (**Res potentia**, Slide 13[1]), and the requirements for withdrawing *physical* money (physical 'jackets') from your bank are that (**i**) you must possess the initial physical 'quantum of money' (similar to 'one drop of petrol'[6]) in your wallet, which is one cent, and (**ii**) you can withdraw only 'money **differences**' (Fig. 5), akin to energy **differences**[7]. This case is totally different from the one above, because now you can withdraw **indefinite** amount of *physicalized* money, provided that the latter has *finite* value, neither "zero" nor "infinite". It doesn't matter if you withdraw €80 or crack the lottery jackpot of €80M.

Notice that there can be no conservation of *physical* money, because your money in the bank (not in your wallet) *and* bank's money are **indefinable**, just like the "total amount" of "vacuum energy". Thus, you may withdraw a colossal amount of *physicalized* money, say, €1B (similar to $8.8{\times}10^{47}$ joules from GRBs in the example above), provided that you have the initial *physical* 'quantum of money' (+/- **0** in Fig. 5) in your wallet. Even more: you may create a *physicalized* universe of 'money' with what some people call "inflation"

(Slide 12[1]). There can be no "violation" of the "initial amount" of money, simply because one cannot violate something that does **not** exist. Simple and clear, isn't it?

The big puzzle, however, is the initial physical 'quantum of energy' in cosmology, which should coincide with The Beginning[13]. It is tempting to associate the 'quantum of energy' with the *elementary transition* of the **self-acting** *physicalized* universe[13] along the Arrow of Space (see p. **10** in Hyperimaginary Numbers[1]), from any given instant/frame to the **next** one (Fig. 4). The elementary transition **dt** (Fig. 1) equates to **work**, and we expect that the 'quantum of energy' has extremely small **finite** value, perhaps many orders of magnitude smaller than "positive energy density of about 6×10^{-10} joules per cubic meter"[7].

But what is 'negative energy density'? It is John's jackets with respect to **Res extensa** (Slide 13[1]) viz. the "nose" (Slide 14[1]) made of *positive* energy density, which brings us to the *evolution equation* and the huge bundle of unsolved challenges related to the three types of mass — positive, negative, and imaginary (see p. **7** in Hyperimaginary Numbers[1]).

3. The Evolution Equation

The evolution equation, proposed previously[1], reads

$$|w|^2 = |m|^2 + |m_i|^2 \quad \text{(Eq. 1)}.$$

It is a symbolic equation (see Path II above) about two *atemporal* offer and confirmation waves, producing the elementary transition **dt**, **AB** = **dt**, depicted in Fig. **1** below.
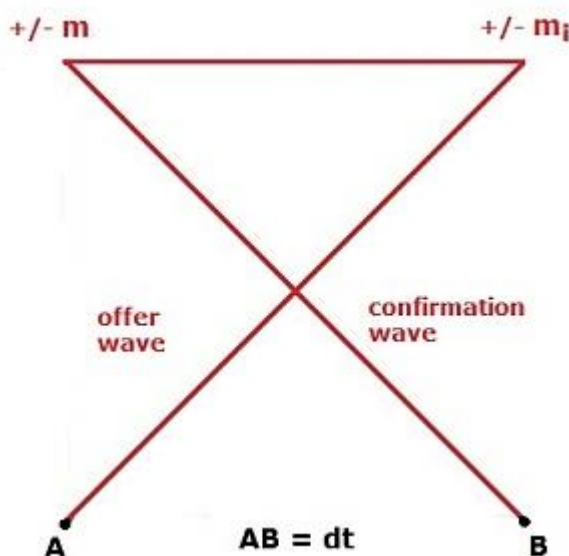

Fig. 1

There is no physical metric in Eq. 1 and Fig. 1, and the proper "time" of the offer and confirmation waves with *hypercomplex* phases and amplitudes (+/- **m** and +/- m_i) will be "frozen" or "stand still"[11] to all physical clocks (*not* to the human brain).

The term $|m|^2$ presents the real (positive and negative) mass produced "after" the confirmation wave, whereas $|m_i|^2$ shows the imaginary mass. The prototype of Eq. 1 is

$$0 = (+1) + (-1) \quad \text{(Eq. 2)}.$$

Say, 0 = 3/3 – 5/5 or 0 = 9/9 – 25/25 = 1 - 1. Notice that $(+/-3)^2$ or $|3|^2$ = 9 and $(+/-5)^2$ or $|5|^2$ = 25. We postulate that the real and imaginary terms in the right-hand side of Eq. 1 belong to two entirely different worlds[11], and that the **ratio** of their amplitudes (Fig. 2) is always equal to unity, e.g., 9/9 (+/- **m**) = 25/25 (+/- $\mathbf{m_i}$).

Suppose that at t_1 we have 0 = 9/9 – 9/9 (Eq. 2), and later at t_2 the imaginary term has increased, for whatever reason, to 25/25. Now there is **more** negative mass from **squared** imaginary mass $|\mathbf{m_i}|^2$ to feed (**Sic!**) the negative mass in $|\mathbf{m}|^2$ (Eq. 1): $|\mathbf{w}|^2 = |5|^2 + |5_i|^2$, and we will have **more** *physicalized* or "positive" mass — $|5|^2 > |3|^2$.

It's all in the **phase** (Fig. **2**). We can also produce the so-called "inflation" (Slide 12[1]) and no "violation" of mass-energy "conservation" can occur, ever.
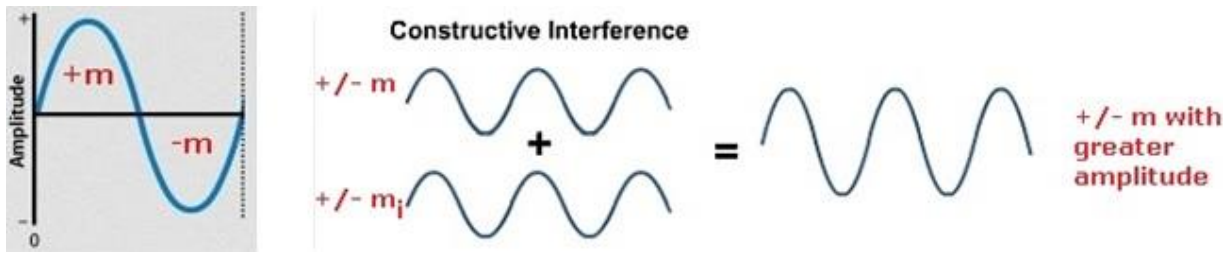

Fig. 2

The evolution equation works in the opposite way (destructive interference) as well: if at t_1 we have 0 = 9/9 – 9/9, and later at t_2 the imaginary term has decreased to 4/4, there will be **less** negative mass from **squared** imaginary mass $|\mathbf{m_i}|^2$ to feed (**Sic!**) the negative mass in $|\mathbf{m}|^2$, and the *physicalized or "positive"* mass-energy will decrease — 0 = 4/4 – 4/4 (Eq. 2) or $|\mathbf{w}|^2 = |2|^2 + |2_i|^2$ (Eq. 1). Again, it's all in the **phase**, and no "violation" of mass-energy "conservation" can occur. Hence we can think about gravitational radiation[8], and perhaps try one day to reproduce it with spacetime engineering. **Mark my words**.

As of today, however, Eq. 1 and Fig. 7 are not clear, in addition to the condition $|\mathbf{w}|^2 = \mathbf{0}$, where **w** involves the so-called hyperimaginary unit[1]. We claim that, relative to the platform, time on the train *completely* stops and is "stand still"[11], which means that the train has entered the *atemporal* realm of **Res potentia** (Slide 13[1]) along +/- **w**. This is a new *relativistic vacuum*, which is hidden *by* the "speed" of light (**A2** in Slide 19[1]). You cannot look twice at the same river (Heraclitus). *Panta rei conditio sine qua non est*.
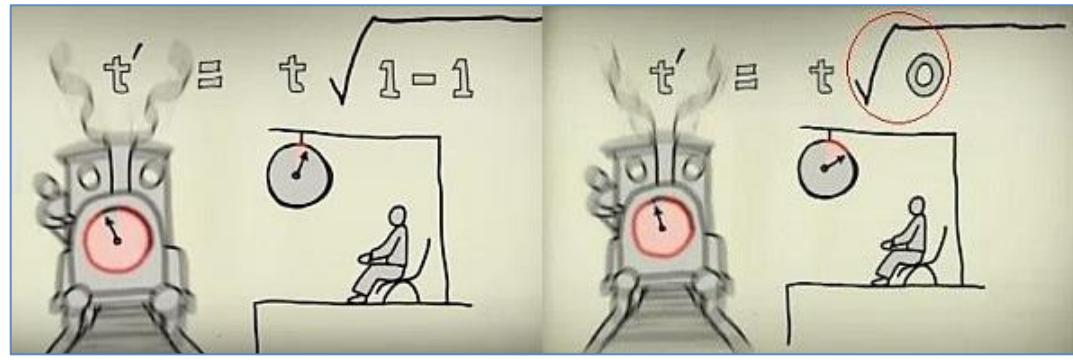

Fig. 3

We are like chained Eskimos (Slide 15[1]) and the "speed" of light (**A2** Slide 19[1]) does not allow us to 'turn around' and see the Platonic world (Fig. 4) "inside" **dt** (Fig. 1).
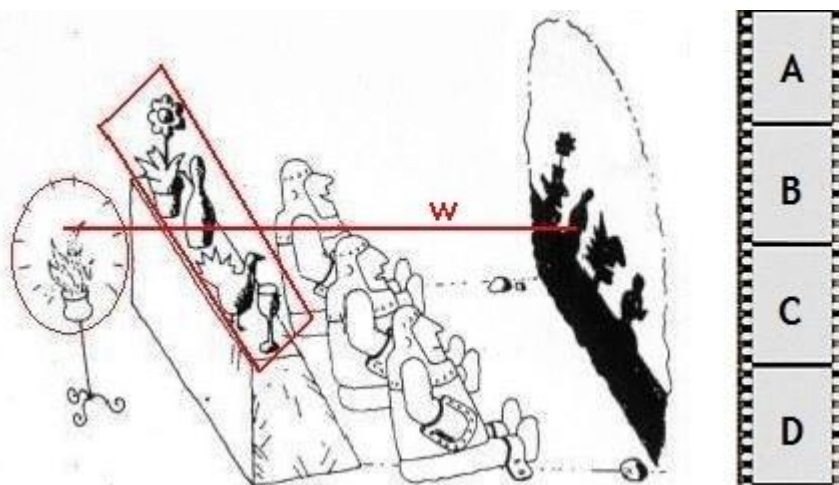

Fig. 4

To make the real line/film reel *perfectly* smooth (see Fig. **7** in Hyperimaginary Numbers[1]) or "infinitely differentiable", and speculate that every point/frame from it corresponds to a 'number', the current math textbooks offer two and only two alternatives: the **dark strip** separating any neighboring points/frames (Fig. 4) is either (**i**) "zero" or (**ii**) non-zero. Case (**i**) leads to only one point/frame, and no change in time is possible. Bad idea. Case (**ii**) will insert a non-zero gap]between[all points/frames. Bad idea, too[20].

The only possible solution to the fundamental *flow of events* A ≠ B ≠ C ≠ D, ... (Fig. 4) is combination of (**i**) and (**ii**), meaning that every 4D event 'here and now', pertaining to the physical world (**Res extensa**, Slide 13[1]), must pass through a **gap** "during" which there is *no spacetime at all* (compare with Yakov Zeldovich above), so at the *next* 'tick of time' **dt**, the *next* 4D 'here and now' can and will be **different**: the *flow of events* requires *change*. Thus, we suggest to place the horizontal **dark gaps** in Fig. **4** along the hyperimaginary axis **W**[1] erected on null spacetime distances[19], and to treat **W** as **non**-event — The Beginning[13] is eternally residing "inside" us (John 1:1; Luke 17:21).

Let me reiterate that we introduce (Slide 13[1]) fundamental *flow* of events ("you cannot look twice at the same river", Heraclitus), as a result of which the atom of geometry ("that which has no part", Euclid) is endowed with internal structure (Fig. **1**): check out Sec. **2** and Fig. **7** in Hyperimaginary Numbers[1], and **A2** in Slide 19[1]. Which means that many "intuitively clear" axioms used in constructing the topological manifold and the differentiable or "smooth" manifold[20] need painstaking revision, starting with the "intuitively clear" axiom of mapping numbers to points: the hyperimaginary numbers[1] **cannot** be mapped to 'points' from a line; only their *physicalized* "jackets" can cast their *physicalized* footprints on the points from the number line, as they belong to the *irreversible* past (Slide 13[1]). Recall Plato's 'allegory of the cave': the world is not just what we can see (Fig. 4).

We are 'Eskimos' (Slide 14[1]), and need new Mathematics[20] to present three ontologically different 'elements of reality': (**i**) points mapped to numbers, as in classical physics, (**ii**)

points mapped to 'John's jackets' with hyperimaginary numbers, and (**iii**) John (*not* his 'jackets') mapped to the Noumenon with hyperimaginary numbers (hi-numbers, in addition to q-numbers and c-numbers).

4. Questions and Answers

Q1: What do you mean by "increased" and "decreased" stuff ?

A1: Right, there is no metric in the Platonic realm of hyperimaginary waves (Fig. 2). Think about the *idea* of a tree and the *idea* of a mountain: there is no metric in the human memory, yet the *idea* of a tree corresponds to lighter physical object, compared to a mountain. Likewise with $|m|^2$ and $|m_i|^2$: you operate with Platonic objects as well, and should be able, for example, to reduce the weight of your body (switch from 'mountain' to 'tree') and even cancel it for a few minutes, in order to fly in the air. Many people can fly, but most of them unfortunately prefer to present it as some "magic", for profit.

Q2: I don't understand your "waves". What are they?

A2: Two hyperimaginary waves, corresponding to two *potential* (**Res potentia** in Slide 13[1]) mirror worlds[11]. At every 4D instant 'here and now' in the physical universe (**A2** in Slide 19[1]) made exclusively by positive mass-energy, the offer and confirmation waves (Fig. 1) have *already* "squared" their amplitudes, yielding positive mass-energy, $|m|^2$ in Eq. 1.

Q3: What do you mean by 'quantum of energy'? Is it related to Planck constant?

A3: I can only try to answer your first question. By 'quantum of energy' I mean the minimal "push" by the **self-acting** *physicalized* universe[13]: see ref. [**9**] in Hyperimaginary Numbers[1]. As Banesh Hoffmann suggested in 1964, "If the universe is such that negative-mass particles can, on balance, "escape to infinity" (Sic! - D.C.) there will be an effect of continual creation of positive energy in the observed region" (pp. 95-96). Even in 1920, Sir Arthur S. Eddington spoke about 'etheral energy' and explained that "though ether waves are not usually classed as material, they have the chief mechanical properties of matter — viz., mass and momentum" (p. 345). Thus, the "creation field" in Eq. 1 is *always* producing gravitational radiation[8] ($|m|^2$ in Eq. 1), but because Sir Arthur could not trace it to some physical process known in 1920, he opted for 'ether waves' and 'etheral energy'. Nowadays we can interpret Eq. 1 as quantum-gravitational "creation field" emerging from some kind of hyperimaginary plasma composed of positive and negative *propensities* (cf. A1 and A2 above), which supposedly fluctuate[2] about their mean values of **zero** (Eq. 2).

As to your second question — sorry, I don't know the origin of Quantum Inequalities (QIs)[12].

Needless to say, I am by no means satisfied with the evolution equation. It might look a bit more "substantial" than the symbolic Einstein's equation, but it is still a symbolic equation (Path II) and cannot be used for calculating proton's mass[14] (Slide 10[1]) or the "dark" effects of quantum-gravitational vacuum[6]. I can only argue that what was called here 'quantum of energy' is related to **work** (see above), referring to the **self-acting** human brain — check out the experiment on p. **2** in Hyperimaginary Numbers[1] and those in Slide 11[1]. If the *physicalized* universe ($|m|^2$ in Eq. 1) is designed as the Brain of the Universe, it should possess **self-acting** faculty[13] as well, and therefore could act on itself to produce the elementary 'tick of time' **dt** (Fig. 1) matching the quantum of energy.

The major corollary is that, if the human brain is indeed part and parcel of the Brain of the Universe, we should be able to access the quantum vacuum[2] and practice spacetime engineering — effortlessly, because it's all in the **phase** (Fig. 2). But how? Check out the story about the yellow button on p. **15** in Hyperimaginary Numbers[1]. It is not made by "magic" but by exploring the quantum spacetime[1], "for the well-being of the human race — or for its suicide"[3].

References and Notes

1. D. Chakalov, Hyperimaginary Numbers, 31 December 2016. Available at this http URL. *Idem*, Quantum Spacetime, 14 March 2017. Slides in .pdf format, available at this http URL.

2. Peter W. Milonni, *The Quantum Vacuum*, Academic Press, 1993, Ch. 2.6.

3. Sir Arthur Stanley Eddington, The Internal Constitution of the Stars. Presidential Address to Section A of the British Association at Cardiff, 24 August 1920; *The Scientific Monthly*, Vol. 11, No. 4 (October 1920), pp. 297-303.

4. Lee Smolin, *Three Roads to Quantum Gravity*, Phoenix, London, 2000, p. 205.

> One of the biggest mysteries is that we live in a world in which it is possible to look around, and see as far as we like.

5. Robert M. Wald, The Arrow of Time and the Initial Conditions of the Universe. Talk given at Seven Pines "Arrows of Time" meeting, December 2004. 21 July 2005, arXiv:gr-qc/0507094v1, p. 5.

> It seems to me to be far more plausible that the answer to the above question as to why the very early universe was in a very low entropy state is that it came into existence in a very special state. Of course, this answer begs the question, since one would then want to know *why* it came into existence in a very special state, i.e., what principle or law governed its creation. I definitely do not have an answer to this question.

6. M. P. Hobson, G. P. Efstathiou, A. N. Lasenby, *General Relativity: An Introduction for Physicists*, Cambridge University Press, 2006, see p. 187 at this http URL. To explain the "dark" puzzle, suppose you have only one drop of petrol in the tank of your car, yet you bravely run the car and push the accelerator. As your car accelerates, you obtain more and MORE petrol in the tank, and at the instant you are reading these lines, the "dark" petrol has increased to nearly 68.3% from the total petrol in the tank. Such perpetual 'free lunch' is not permitted in the geodesic hypothesis, as energy "conservation" is postulated in the current GR, to suggest geodesic motion based on (non-tensorial) Christoffel symbols.

7. John Baez, What's the Energy Density of the Vacuum? Online article, 10 June 2011, available at this http URL.

8. Hans Ohanian, The Energy-Momentum Tensor in General Relativity and in Alternative Theories of Gravitation, and the Gravitational vs. Inertial Mass, 28 February 2013, arXiv:1010.5557v2 [gr-qc], see an excerpt from p. 3 at this http URL. Sir Hermann Bondi, Conservation and non-conservation in general relativity, *Proc. R. Soc. Lond.* A 427 (1990)

249-258, read an excerpt from p. 249 at this http URL. Paul Steinhardt explains energy conservation, YouTube, 17 March 2011; watch 1:36-2:00 at this http URL.

9. Zhao-Yan Wu, Gravitational Energy-Momentum and Conservation of Energy-Momentum in General Relativity, *Commun. Theor. Phys.* 65 (2016) 716-730.

10. Erik Curiel, On Tensorial Concomitants and the Non-Existence of a Gravitational Stress-Energy Tensor, 24 February 2012, arXiv:0908.3322v3 [gr-qc], pp. 1-4.

11. Max Tegmark, On the dimensionality of spacetime, 5 April 1997, arXiv:gr-qc/9702052v2.
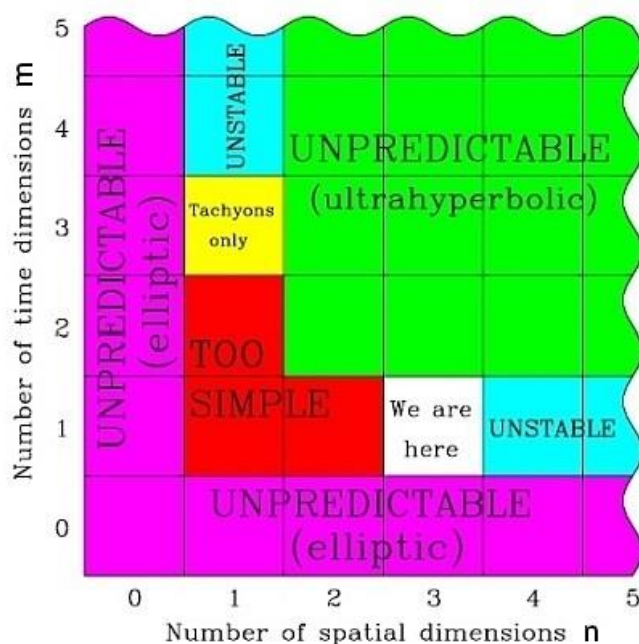
Since a mere minus sign distinguishes space from time, the remaining case $(n,m) = (1, 3)$ is mathematically equivalent to the case where $(n,m) = (3, 1)$ and all particles are tachyons [14] with imaginary rest mass.

Footnote 4: The only remaining possibility is the rather contrived case where data is specified on a null hypersurface. To measure such data, an observer would need to "live on the light cone", i.e., travel with the speed of light, which means that it would subjectively not perceive any time at all (its proper time would **stand still**). (Emphasis mine; see **A2** in Slide 19[1] – D.C.)

12. Thomas A. Roman, Some Thoughts on Energy Conditions and Wormholes, 23 September 2004, arXiv:gr-qc/0409090v1.

If such fields are truly physical, then why does Nature bother to enforce QIs at all? The fascinating mysteries and subtleties of negative energy should keep us all busy for a while yet.

13. According to Aristotle [*Poetics* VII 1450b27-29], The Beginning is that which does not have anything necessarily before it, but does have something necessarily following from it. The Beginning is believed to possess **self-acting** faculty, since it is also the Unmoved Mover (that which moves without being moved). Thus, it (not "He") can only be presented as

purely mathematical object residing "between" (cf. the dark strips in Fig. 4) any two primary events connected by cause-and-effect relations, but without being an intermediate event — The Beginning is *not* an event. It is both "no time at all" (Yakov Zeldovich) and the causal horizon of spacetime[20], a "boundary" for causal influence and processes. It is also The Noumenon and John 1:1: check out 'John's jackets' above, endowed with *infinitesimal* 'quantum of energy'. The latter must have some finite, albeit extremely small, positive energy, because it cannot be dead zero: *ex nihilo nihil fit*. As an analogy, recall that we widely speculate about some minimal Planck length, app. 1.6×10^{-35}m, which may be interpreted here as the *infinitesimal* 'quantum of length', although we **cannot** reproduce 1m with $1.6 \times 10^{-35} \times 1.6 \times 10^{35} = 1$. Ditto to the buildup of $|m|^2$ in Eq. 1. Example: proton's mass[14], depicted in Fig. 5 with **AB** = 938 Mev; the cutoff **Z** stands for "zero"[2] in Eq. 2.

Fig. 5

Now comes some advanced math: (**B** – **Z**) – (**A** – **Z**) = **AB** +/- **0** = 938 Mev "with precision of one part to 10^{45}"[14] (Slide 10[1]) — "one of the greatest mysteries of Nature"[14]. We cannot speculate that the error margin here matches the *infinitesimal* 'quantum of energy', which in the case of proton's mass is effectively "zero"[2] or 10^{-45}.

14. Alexander Dolgov, Cosmic antigravity, 17 June 2012, arXiv:1206.3725v1 [astro-ph.CO]; read an excerpt from pp. 13-14 at this http URL.

15. *Mathematical Cosmology and Extragalactic Astronomy*, ed. by Irving Ezra Segal, Academic Press, 1976; read an excerpt from pp. 8-9 at this http URL and notice my note at the end. The alleged "smooth" or "infinitely differentiable" manifold is a joke[20], for reason explained with the film reel above. It shows *different* points/frames from the real number line: time requires *change*, **A** ≠ **B** ≠ **C** ≠ **D**, … (Fig. 4), as read with a clock.

We need new Mathematics to unravel the so-called hyperimaginary numbers[1] with which we can address, and hopefully solve, various problems in the existence of limit, interval, infinity, the Thomson lamp paradox, point-set topology, set theory, and number theory. Detailed information is available upon request.

If the reader of these lines is interested in quantum gravity, I would suggest to compare the interpretation of the "time-dependent" Schrödinger equation[16] by Britain's greatest quantum gravity expert to Slide 7[1]. Then all pieces of the jigsaw puzzle should snap to their unique places, effortlessly.

Just keep in mind that no *physical* clock[17] (GR included) can read the time in the *flow of events* (Fig. 4) composed by *identical* (Sic!) timelike displacements[18] **AB** = **dt** (Fig. 1): the universal "drummer"[18] is not physical phenomenon (Fig. 3); see the example with 'international second' on p. **3** and the discussion on p. **10** in Hyperimaginary Numbers[1].

16. C.J. Isham, Prima Facie Questions in Quantum Gravity, 22 October 1993, arXiv:gr-qc/9310031v1, p. **14**.

The background Newtonian time appears explicitly in the time-dependent Schrödinger equation (3), but it is pertinent to note that such a time is truly an abstraction in the sense that no *physical* clock can provide a precise measure of it [UW89]: there is always a small probability that a real clock will sometimes run backwards (**D ≠ C ≠ B ≠ A**, cf. Fig. 4 – D.C.) with respect to Newtonian time.

17. John Baez, The Time-Energy Uncertainty Relation. Online article, April 10, 2010, available at this http ULR.

The problem is, for physically realistic Hamiltonians **H** one can prove there is no operator **T** with

$$[H,T] = i\,\hbar$$

In other words, there is no time observable!

18. T.A. Jacobson, A Spacetime Primer. Online paper, September 2, 2014, available at this http URL.

The existence of an intrinsic time interval associated to any timelike displacement is another deep mystery. The fact is that, in Nature, there are systems that can serve as clocks. It seems to be the case that fundamental systems all march to the beat of the same drummer.

19. Kevin Brown, *Reflections on Relativity*, MathPages, 2017. Ch. 9.10 Spacetime Mediation of Quantum Interactions, pp. 678-698, available at this http URL.

Most natural philosophers from Aristotle to Descartes held that material entities can influence each other only by coming into direct contact, i.e., "an object cannot act where it is not". However, Newton's theory of gravity undermined confidence in the doctrine of "direct contact", because in Newton's theory gravity is represented as an instantaneous universal force of attraction between every pair of objects, regardless of the distance between them, and regardless of whether the space between them contains any material substance.

According to this picture, a completely free massless particle – if such a thing existed – might just be represented by an entire null-cone, but a real photon is necessarily emitted and absorbed as a quantum of action, so it corresponds to a bounded null interval in spacetime (cf. Fig. 1 – D.C.). (The quantum phase of a photon does not advance while in transit between its emission and absorption, unlike massive particles; the oscillatory nature of electromagnetic waves arises from the advancing phase of the source, rather than from any phase activity of a photon "in flight".) Thus the field excitation corresponding to a massless particle propagates at the speed of light and **has no rest frame**. In contrast, a massive particle has a rest frame, following a time-like path through spacetime.

The "surface area" of this locus (the intersection of the two cones) is necessarily **zero** (cf. Fig. 1 – D.C.), corresponding to the fact that these interactions represent the transits of massless particles.

In addition to the usual 3+1 dimensions, one could argue that spacetime operationally entails two more "curled up" dimensions of angular orientation to

represent the possible directions in space. The motivation for treating these as dimensions in their own right arises from the non-transitive topology of the pseudo-Riemannian manifold. Each point [t,x,y,z] actually consists of a two-dimensional orientation space, which can be parameterized (for any fixed frame) in terms of ordinary angular coordinates q and f. Then each point in the six-dimensional space with coordinates [x,y,z,t,q,f] is a terminus for a **unique** pair of spacetime rays, one forward and one backward in time. We might imagine a tiny computer at each of these points, reading its input from the two rays and sending (matched conservative) outputs on the two rays, as illustrated below in the xyt space:
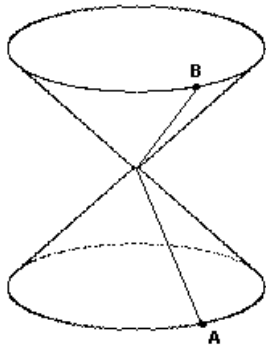
The point at the origin of these two views is on the **mediating surface** of events A and B. Each point in this space acts purely locally on the basis of purely local information. Specifying a preferred polarity for the two null rays terminating at each point in the 6D space, we automatically preclude causal loops and restrict information flow to the future null cone, while still preserving the symmetry of wave propagation.

Both components of a wave-pair could be regarded as "advanced", in the sense that they originate on a spherical surface, one emanating forward and one backward in time, but both **converge inward** on the particles involved in the interaction.

According to this view, the "unoccupied points" of spacetime are elements of the 6D space, whereas an event or particle is an element of the 4D space (t,x,y,z). In effect an event is the union of all the pairs of rays terminating at each point (x,y,z).

One possible objection to the idea that quantum interactions occur locally between null-separated points is based on the observation that, although every point on the mediating surface is null-separated from each of the interacting events, they are **spacelike-separated** from each other, and hence unable to communicate or coordinate the generation of two equal and opposite outgoing quantum waves (one forward in time and one backward in time). However, communication between those events may not be required, because the "coordination" might arise naturally from the **context** (e.g., the holomovement of fish – D.C.).

Note: I tried many times to contact Kevin Brown[19], but he did not reply. My model of causality, dubbed 'biocausality' (January 1990), requires two *modes* of spacetime: local (time-like) mode and global *atemporal* mode along null intervals. Example: the school of fish in ref. [**11**] in Hyperimaginary Numbers[1] and pp. **89-90** in gravity.pdf.

Dead matter makes quantum jumps; the living-and-quantum matter is smarter.

Addendum

I argued above that the so-called "smooth"[15] or "infinitely differentiable" manifold (**C∞**) is a **joke**. Why? Because we *all* know, very well indeed, that neither option (**i**) nor option (**ii**) in Fig. 4 could work — people acknowledge the fundamental problem of the *continuum* even in textbooks (e.g., Karel Hrbacek and Thomas J. Jech, *Introduction to Set Theory*, 3rd ed., Marcel Dekker, Basel, 1999, p. 269; excerpt at this http URL).

To understand the *continuum* made by 'atoms of geometry' **dt** (Fig. 1), consider the causal horizon of spacetime, which acts as a "boundary" for causality, denoted with **AB** in the drawing at this http URL: how "large" is the dark strip **dt** in Fig. 4 viz. Fig. 1 ?

It cannot be dead zero, due to Planck's constant. So if we instruct **A** to tend *asymptotically* (**potential** infinity) toward **Z** in Fig. 5, then **ZA** = **dt** in Fig. 4. Likewise if we instruct **B** to tend *asymptotically* (**potential** infinity) toward **Z** in Fig. 6 below, **BZ** = **dt** in Fig. 4 as well.

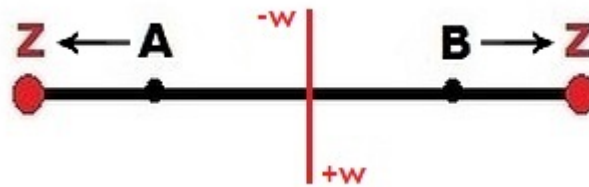Fig. 6

We can picture the atom of geometry **dt** as **[dt (…) dt]** , as shown in the drawing at this http URL. In Fig. 6 and Fig. 7 below, **Z** denotes The Beginning & The End (John 1:1; Luke 17:21) at the intersection **Z** of **-w** and **+w** (shown in Fig. 8.2). The two hyperimaginary waves **-w** and **+w** pertain to the two mirroring worlds[11] in Eq. 1, and are erected along **W** on null spacetime distances[19] at *every* physical point **dt** (Fig. 1) in Fig. 6.

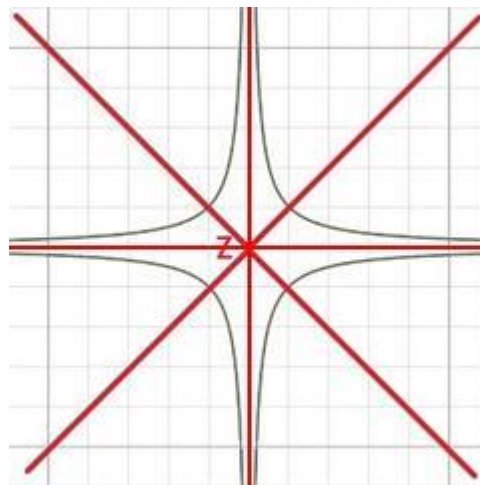
Fig. 7

Imagine a water lily with four leaves having two modes: *open* (Fig. 7) and *closed* leading to two **squared** terms in the right-hand side of Eq. 1. This *atemporal* phenomenon is also known as the "breathing" of the Universe: Inhaling (open leaves, Fig. 7) and Exhaling (closed leaves, Fig. 1). The latter leads to **squared** parameters in the invariant spacetime

interval, including **squared** "speed" of light c^2, which makes it impossible *in principle* to have any *physical* stuff endowed with the fundamental **asymmetry** of the Heraclitean flow of events (Fig. 4). For example, we face two *equally* important 'components' in the definition of causality, and we can only label one of them with "future pointing" and the other with "past pointing" to present the obvious "time-orientability" of causality. The same story with the two mirroring worlds[11]. The list of examples goes on and on.

The hyperimaginary numbers, needed to define the brand new "phase space" (Fig. **7**) of **Res potentia** (Slide 13[1]), are expected to be derived from **4D** sphere ⇔ saddle transitions (Fig. **8.1**) passing through God (Fig. **8.2**) at every infinitesimal instant **dt** (Fig. **1**).
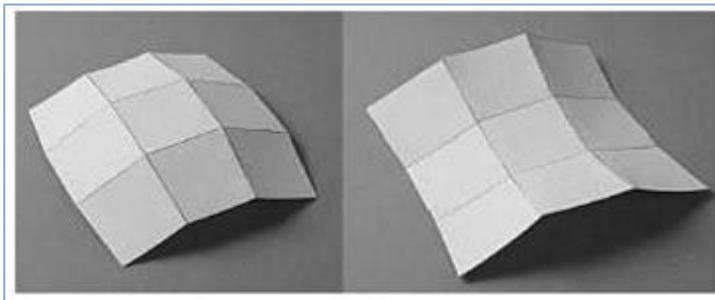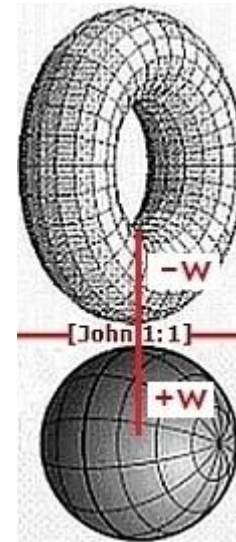

Fig. **8.1**   Fig. **8.2**

The horizontal line in Fig. **8.2** marks the sphere ⇔ saddle transition (Fig. **8.1**) at the instant at which the **4D** hyperimaginary sphere and torus are inflated *exactly* to infinity. The physical spacetime, endowed with positive mass-energy only, is tending *asymptotically* (Fig. 7) toward the horizontal line in Fig. **8.2**, from both directions along **W**, from "south" (hyperimaginary sphere) and from "north" (hyperimaginary torus). Hence the physical, asymptotically flat **4D** spacetime is the arena at which the hyperimaginary sphere and torus "clash" into each other, like two waves (Fig. **2**), leading to their **cancellation** in the physical world at **dt** (Fig. **1**) and explication of only one *physicalized* 'jacket' from them — one **re**-created 4D 'jacket' at a time, as read with a clock. There is no need for "tangent vectors" and "curvature of spacetime", because the *physicalized* clocks and rulers are also 'jackets' and they can slow down or speed up viz. shrink or expand.

To practice spacetime engineering (**A1** and Sec. 4 in Hyperimaginary Numbers[1]), keep in mind that the only way to "predict" the future is to create it, for the future is not fixed but *flexible* and open to brand new events, including 'the unknown unknown'. Then you have to overcome at least two challenges. Firstly, use *only* the Law of Reversed Effort: "To the mind that is still, the whole universe surrenders" (Lao Tzu). Let your preferred state in the **future** to *unfold* toward you. If you choose to use your free will and volition in the opposite "direction", you will inevitably block the Law of Reversed Effort and will move toward the dead end of parapsychology. And secondly, design and build your preferred state in the **future**. Metaphorically, you have to swing — effortlessly — the flexible "carrot" (Fig. 9) toward your desired destination, and the "donkey" will bring you there.

Fig. 9

This second **non**-action does not require physical work either: it's all in the **phase** (Fig. 2). The "carrot", however, is a very tricky and fragile stuff, and you may need years of hard work to learn how to handle the infinitesimal **quantum of energy**.

That's all for now. Information about REIM demonstrations is available upon request.

April 7, 2017, 22:33 GMT