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 not 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 (see Path II below), 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** 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]. 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 6×10^{-10} joules per cubic meter"[7] to 8.8×10^{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 8.8×10^{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* the **self-acting** *physicalized* universe[13] along the so-called Arrow of Space (see p. **10** in Hyperimaginary Numbers[1]), from any given instant/frame to the **next** one (Fig. 4). This elementary transition **dt** (Fig. **1**) equates to **work**, and we expect that the 'quantum of energy' has extremely small **finite** value, 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

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

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.

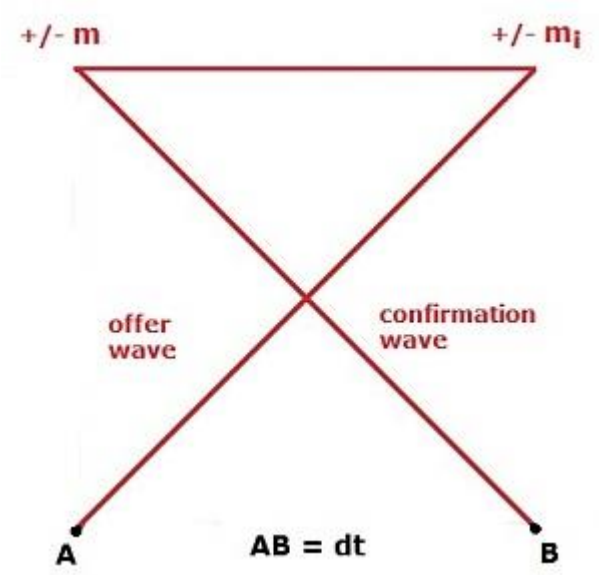


Fig. 1

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 +/- $\mathbf{m_i}$) will be "frozen" or "stand still"[11] to all physical clocks (*not* to the human brain).

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

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

Say, 0 = 3/3 - 5/5 or 0 = 9/9 - 25/25 = 1 - 1. Notice that $(+/-3)^2$ or $|\mathbf{3}|^2 = 9$ and $(+/-5)^2$ or $|\mathbf{5}|^2 = 25$. 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): $|\mathbf{w}|^2 = |\mathbf{5}|^2 + |\mathbf{5_i}|^2$, and we will have **more** *physicalized* or "positive" mass — $|\mathbf{5}|^2 > |\mathbf{3}|^2$.

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.

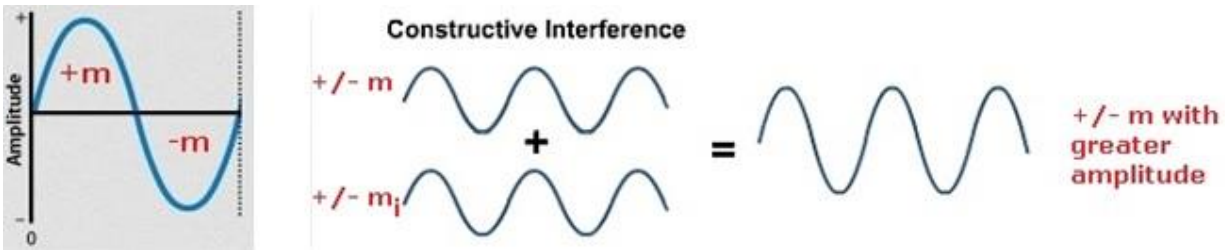


Fig. 2

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 $|\mathbf{w}|^2 = |\mathbf{2}|^2 + |\mathbf{2_i}|^2$ (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, and maybe even try one day to reproduce it with spacetime engineering. **Mark my words**.

As of today, however, Eq. 1 is not at all clear, firstly because we instructed $|\mathbf{w}|^2 = \mathbf{0}$, 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**[1]. 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*.

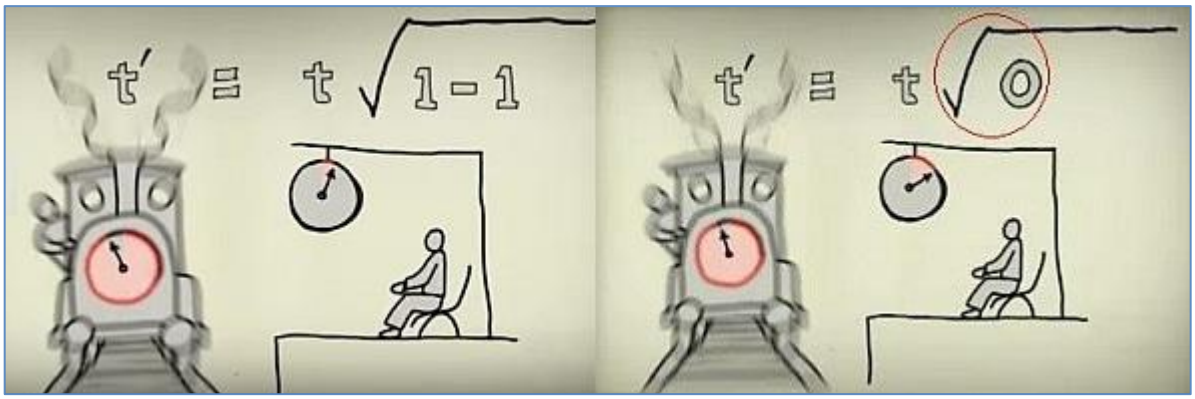


Fig. 3

To sum up, 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).

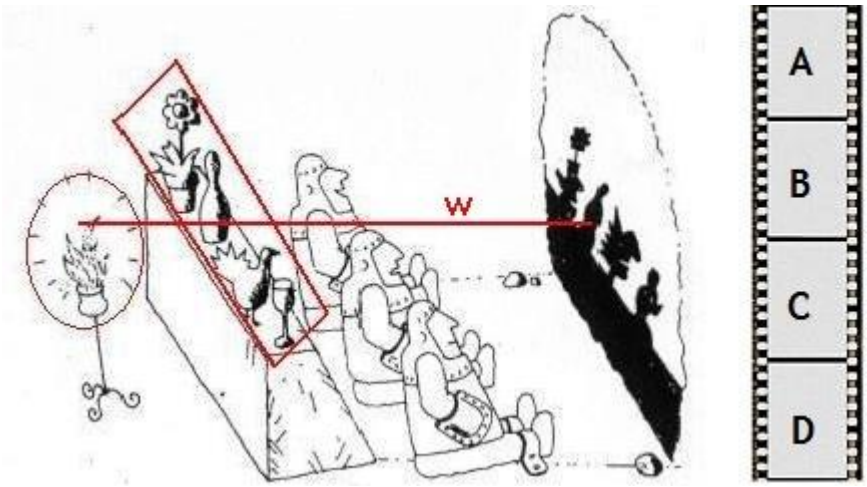


Fig. 4

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

In conclusion, I would like to 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[15] 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'[15]: the world is not just what we can see (Fig. 4). We are 'Eskimos' (Slide 14[1]) and need new Mathematics.

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 ($|\mathbf{m}|^2$ 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].

April 2, 2017, 20:00 GMT

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.

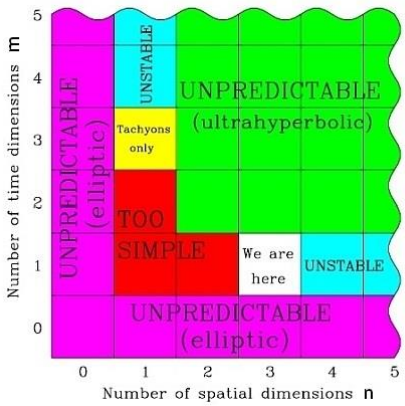
7. John Baez, What's the Energy Density of the Vacuum? Online paper, 10 June 2011, available at this http URL.

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, 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 $1.6\text{x}10^{-35} \times 1.6\text{x}10^{35} = 1$. Ditto to the buildup of $|\mathbf{m}|^2$ 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}. Big puzzle.

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, for reason

explained with the drawing of a film reel below. It shows *different* points/frames from the real number line: time requires *change*, **A** ≠ **B** ≠ **C** ≠ **D**, … (Fig. 4), as read with a clock.

To make the film reel *perfectly* smooth or "infinitely differentiable" and claim 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.

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 that at the *next* 'tick of time' **dt** the *next* 4D 'here and now' can and will be **different**: the *flow of time* requires *change***.** We suggest to place the horizontal **dark gaps** in Fig. 4 along the hyperimaginary axis **W**[1] and treat **W** as **non**-event — The Beginning[13] is eternally residing "inside" us (John 1:1; Luke 17:21).

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

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 with respect to Newtonian time.