Creatio Ex Nihilo: The Evolution Equation

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Abstract

It seems possible to suggest a hypothetical evolution equation in cosmology, which permits unlimited *creatio ex nihilo* of mass and energy from the quantum vacuum, yet does not lead to any catastrophic event.

1. Introduction

The evolution equation suggested by the author is based on a hypothetical coupling of matter (*res extensa*) to its potential states (*res potentia*)[1], and offers conceptual solutions to some outstanding 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[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 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 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]. If we could somehow gain access to the *complex* phase of quantum waves and tweak their destructive interference leading to "vacuum", we could perhaps 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 (FAQ, 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 (€0.01), and (**ii**) you can withdraw only 'money **differences**' (akin to energy **differences**[7]). This case is totally different from the one above, because now you can withdraw **indefinite** amount of *physicalized* money, as long as the latter has some *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 you already have the initial *physical* 'quantum of money' in your wallet. Even more: you may create a *physicalized* universe of 'money', with what some people call "inflation" (Slide 12[1]). There will 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. It is tempting to associate the 'quantum of energy' with the primordial "push" by the **self-acting** *physicalized* universe along the so-called Arrow of Space (see p. **10** in Hyperimaginary Numbers[1]). It should be capable of producing **work**, so one can expect that the 'quantum of energy' has astonishingly small, yet **not** zero, value, say, "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]), as you may have already anticipated. Which brings us to the *evolution equation* and the 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

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

Regrettably, it is still a symbolic equation (see Path II above). Let me start with explaining the right-hand side, stressing that its proper time, if read with a physical clock, would be "frozen" or "stand still"[11].

The term $|\mathbf{m}|^2$ presents the real (positive and negative) mass, whereas $|\mathbf{m_i}|^2$ corresponds to the positive and negative 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 stress that the real and imaginary terms in the right-hand side of Eq. 1 belong to two entirely different worlds[11], and also postulate that the **ratio** of their components must be always equal to unity, e.g., 9/9 = 25/25 = 1.

Suppose that at t_1 we have 0 = 9/9 – 9/9 (Eq. 2), and later at t_2 the imaginary term has increased 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 — $|\mathbf{5}|^2 > |\mathbf{3}|^2$. We can even produce the so-called "inflation" above, and no "violation" of mass-energy "conservation" can occur, ever.

The evolution equation works in the opposite way 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, no "violation" of mass-energy "conservation" can occur, ever.

Well, all this is certainly not simple and clear, firstly because we set $|\mathbf{w}|^2 = \mathbf{0}$, where **w** involves the so-called hyperimaginary unit[1].

In conclusion, I have to stress that I am by no means satisfied with the evolution equation. At best, it might look at bit more substantial than the symbolic Einstein's field equations, G(geometry) = T(matter), but at this moment I have no idea how to apply the evolution equation for deriving proton's mass (Slide 10[1]) or for calculating the "dark" gravitational energy: we need new Mathematics in the first place. Strangely enough, Eq. 1 nevertheless works tremendously well, much like a chemical reaction — check out the story about the large yellow button on p. **15** in Hyperimaginary Numbers[1]. More information is available upon request.

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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.

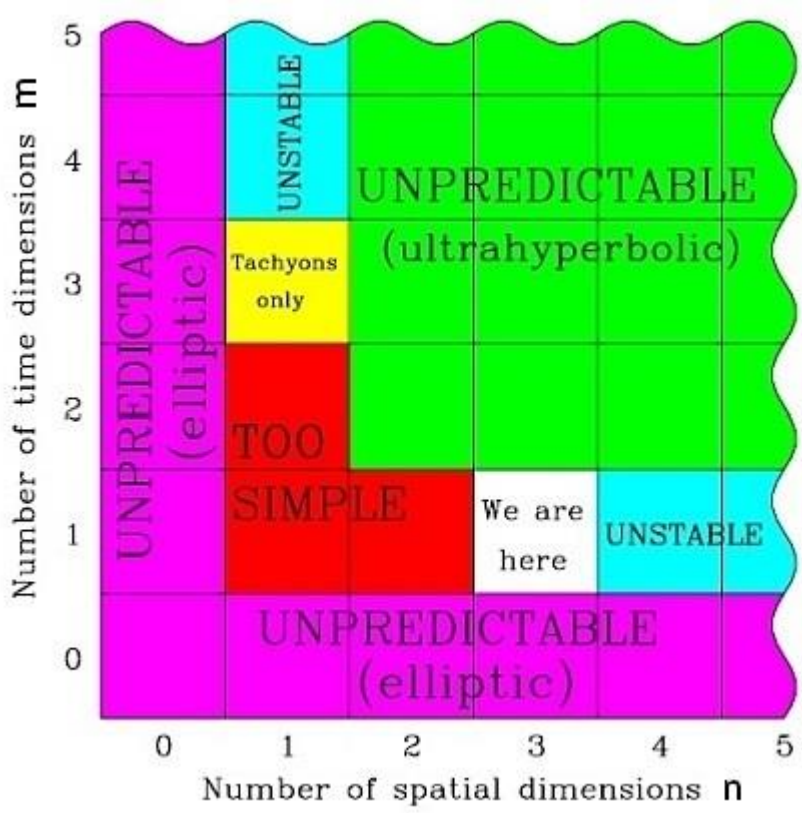
7. John Baez, What's the Energy Density of the Vacuum? Online paper, Sec. 4, 10 June 2011, available at this http URL.

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, see 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**).