Spacetime deformations evolution concept

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Abstract

I frame a concept that the matter and energy have evolved from a primordial, conformally flat spacetime (starting before the Planck Era). I apply the theory of Darwinism beyond its original sphere of organic evolution on Earth. Finally I present some points of view on computability of the actual Universe and its evolution.

This is a concept of principle (an universal concept delivering a description of nature) and not constructive concept (describing particular phenomenon using specific equations).

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Introduction

As a preliminary, we need a common language and we shall ask the question: how do we understand the reality notion. Following Oxford English Dictionary the reality is the state of things as they actually exist, as opposed to an idealistic or notional idea of them [1] or in another words: as they may appear or may be thought to be. This publication is addressing foundational questions in physics so we do not worry about a philosophy and dictionaries unless they do change the specific to physics point of view. In the language of physics the reality is meant to consist of the matter and energy (including the dark matter and dark energy). But what is the matter and energy? I propose an alternative point of view at this foundational issue and then I proceed to address the evolution.

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Human being's specific perception

Let us start from the perception of reality to understand a physical reality essence. The stages of perception process are: detection, interpretation and record. At the moment I need to explain shortly only the first and second stage. The detection is a wave reception using a detector e.g. an ear, camera, LHCb etc. In the detector one wave is changed into another one e.g. inside the inner ear an acoustic wave (longitudinal) is changed into an electromagnetic wave (a transverse wave in a nervous system). An interpretation is a process of comparison the current and previous (recorded) detections with future detections (expectations usually based on the past).

"Our perceptions are a species-specific user interface. Space, time, position and momentum are among the properties and categories of the interface of H. sapiens that, in all likelihood, resemble nothing in the objective world… I don't carelessly drag a file icon to the trash bin. I don't take the icon literally, as though it resembles the real file. But I do take it seriously. My actions on the icon have repercussions for the file"[2].

Strongly deformed spacetime region

With that in view let us start out with a very simple "thought experiment": we observe a small region in spacetime (the size of an elementary particle radius) deformed in the way that the wave we actually detect is not emitted or reflected by the observed object but it comes back to us along the geodesic (the notion of a "straight line" in general relativity). In fact we observe only a strongly deformed spacetime region, "empty" inside and redirecting our wave but apparently… we perceive a particle. Our measuring instruments and our language out of the force of habit say so. The fact that deformations of spacetime exist is generally recognized as a part of general relativity theory. By contrast, the shape, the average density gradient along with its changes and the average size of deformation under consideration are different here than in GR.

Before we proceed we need to take some assumptions regarding the spacetime properties to decide what could possibly emerge out of our reasoning:

a) the spacetime is continuous, i.e. not perforated, not torn and has a homeomorphism property
b) the spacetime has elastic properties
c) the elastic properties of spacetime are isotropic
d) any spacetime deformation is unlimited (to some extent, it deforms the entire spacetime, due to its elastic and homeomorphism properties).

Human being's perception of Strongly deformed spacetime region
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New definition of matter and energy

Taking into consideration the specific to humans perception and assumed properties of the spacetime, I propose the new definition of matter: the region in spacetime so deformed that our perception process and our language tell us we detect a matter. Or simply: the matter is only a spacetime deformation (a contraction type). This seems to support the Clifford's hypothesis that the matter is nothing more but a kind of exotic space. But what about the second element of physical reality – the energy? Following the assumed properties of spacetime we can easily deduce that the energy is just the complementary deformation (but an expansion type) to that region we perceive as the matter. A differentiation of the matter and energy depends only on the shape, the average density gradient along with its changes and the average size of deformation subject to our detection. Einstein said: "reality is merely an illusion, albeit a very persistent one".
This few sentences are obviously not enough to give the details of perception and spacetime deformations concepts. For readers, who are not satisfied with that obscure details of mentioned concepts, more can be found in Technical Endnotes or [13].

Evolving spacetime

Why it was so hard for scientists to accept the Darwin's theory? They thought that every species exist without a change and forever as we can see them right now. Nowadays the same problem concerns the matter and energy instead of biological organisms. According to the modern physics the matter and energy are quantized in the sense of taking only discrete and fixed values.
As we know the constants in the standard model of particle physics and in the cosmological standard model are determined experimentally and not theoretically. The question arises: are the constants really constant? Let us take an example.
The fine structure constant α has several physical interpretations, inter alia:

- α is the square of the ratio of elementary charge to the Planck charge
- in QED it is the coupling constant determining the strength of the interaction between electrons and photons and so on…

α is one out of 25 empirical parameters in the standard model of particle physics. But is α fixed forever or just a discrete value at the moment?
The analysis of light from distant quasars has shown that billions of years ago the laws of physics have been slightly different. The research team has found evidence that α was different at earlier times in the history of the Universe [4] (see also Oklo natural reactor research [14]) [*]. Is that a "fossil" record retaining evidence of the spacetime evolution[**]?

**Notice: a varying α does not have to contradict the general relativity or the standard model of particle physics but may be a proof of the spacetime evolution. The mentioned research results and its interpretation are not accepted by all physicists and shall be discussed and confirmed*
***Notice: an evolution notion is often used by physicists in the meaning of an object changing over time e.g. a stellar evolution. The Darwin's evolution formal approach refers to a quite different type of change: a speciation that is the process by which new species arise through successive generations (the generation notion used here is obviously not a division of the elementary particles). It means that ancestor objects (e.g. some ancestor particles) do not exist at the moment!*

Once more before we proceed we need to take some assumptions regarding the evolution of spacetime:

a) there is no fixed, not changing shape, gradient and density spacetime region *(the same deformed spacetime that we perceive as elementary particles, force fields or more complex objects)*

b) any spacetime deformation possesses a replication capacity [II]

c) the primordial spacetime before the Planck Era possessed a conformally flat character

Let us continue our "thought experiment", an observation of selected region of spacetime. This time we start from the primordial, flat spacetime and we observe a huge region. Let us imagine that a huge (the Universe size) wave packet, travelling through that spacetime, comes. The selected region begins to change along with entire spacetime. The evolution begins.

Notice: some scientists have proposed the wave function of the Universe [15] however not useful here

Continuing the "experiment" we shall observe that since the Planck Era the spacetime has started to expand (in average). The first to evolve would be expansion type regions in the spacetime that we have named the dark energy. An average spacetime density gradient of the dark energy is very tiny in relation to another fundamental forces' density gradient (and similar to the gravitation). As the wavepacket has been travelling the average expansion has been increasing so the remaining interactions - electromagnetism, weak and strong nuclear, gravitation [I-i] - started to emerge out of the spacetime. It might look like they were initially unified in a one fundamental interaction (the GUT Era and the Inflation Era) but it was only a conformally flat spacetime. At the same time another objects (again in the meaning of spacetime deformations but now a contraction type) that we have called fermions, the dark matter, then atoms including not stable isotopes, chemical compounds and biological organisms have gradually started to emerge. The spacetime deformations have been evolving, resulting in creation of new mutations (so at the beginning they were different than today and the constants were also different). These processes we call natural selection. In this extended Darwinian idea the <u>common ancestor</u> of all matter and energy is the flat spacetime (see Fig. 1).

The observable objects have been originated due to the spacetime deformations <u>self-organization</u> (inside the Universe wavepacket). For details of self-organized critical systems that naturally evolve without fine tuning to critical states see the next chapter and [IV]. In the view of Darwinism the objects, like during more familiar biological evolution, have been "tending to" increase <u>replication</u> [II] capacity (we assume the process to be unconscious in the meaning the objects are not observers). As a result of the process the simpler (e.g. quarks, gluons) as well as more complex structures (e.g. chemical compounds) have been created. These objects have been successfully "consuming" another objects ("competing" for limited resources – strictly for a volume of spacetime) or they have been subject to decay. These objects have been ingredients of the Universe wavepacket.

Let us come back to the above mentioned idea that the fine structure constant α was different in the history [4][14]. As we know a proper variation in α would imply that the objects could not be stable. And the Darwin's survival of the fittest (persistence of stable forms) [8], is really special case of a more general law of <u>survival of the stable</u> [9][10].

At present, we perceive the reality quantified because the observable objects are relatively stable, and not stable ones live so short that they can be observed only in laboratory conditions.

As the constants' values in the standard model of particle physics and in the cosmological standard model are set up by the spacetime deformations evolution (non-deterministic and non-computable process), they must be "determined" experimentally and at the moment. They are the parameters of the current adaptation (the manifestation of stability and effective replication of spacetime deformations). Just like in the biological evolution we observe certain species, which nowadays simply exist, because they are properly adapted (stable) and effective in self-replication. We cannot calculate the fine structure constant α like we cannot calculate the species traits or phenotypes. The Darwin's theory does not predict them and the fact does not mean that the theory is not a proven scientific theory [III].

The future α measurements (fossil records) will eventually show the pattern of the evolution. We shall know if this is irregular, branching and/or non-directional.

Darwin started explaining his findings with an "artificial selection" in contrary to a natural one. However there is no real difference in the processes underlying artificial and natural selection. There are trials to simulate the artificial selection process [6][7]. Moreover maybe we could think about LHC as a farm, delivering a selective breeding of elementary particles?

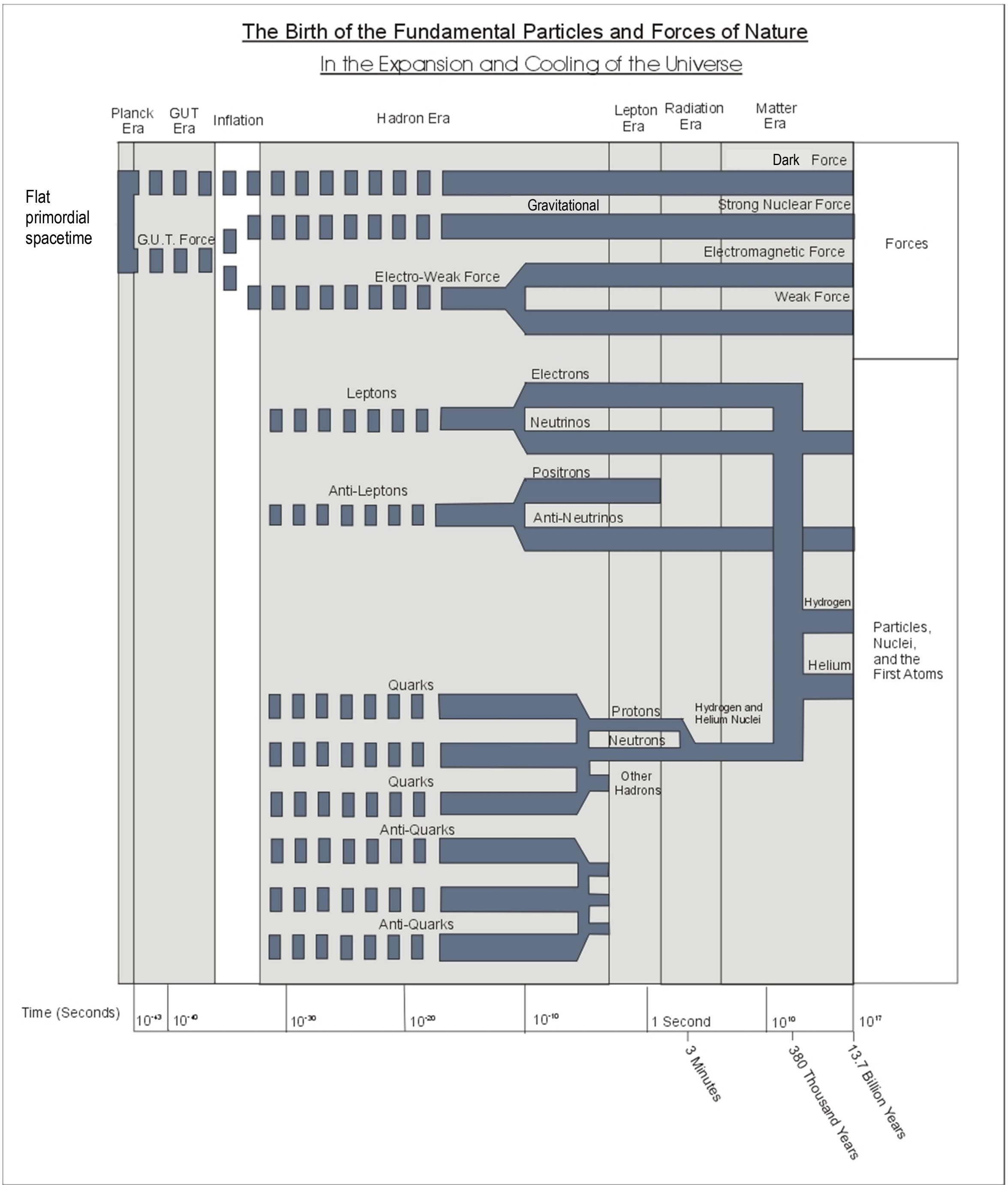

Fig. 1. Reality Evolution timeline [5] – *the genealogic tree modified by the publication author*

Notice: All the matter and energy (elementary particles, chemical compounds, electromagnetic fields, dark energy and so on) continue the evolution timeline. As well the periodic table of elements depicts an evolution episode. The biological life is also the continuation of the timeline being the Darwinian evolution at the genetic level

The Universe and its evolution modeled as a digital computation

The digital physics' point of view, in principle, is that a program for a universal computer exists that is able to compute the evolution of universe. The computer could be a cellular automaton or a universal Turing machine.

The loop quantum gravity (LQG) supports digital physics assuming that the spacetime is quantized. The theories that combine digital physics with loop quantum gravity are formulated by Paola Zizzi (Computational LQG) and some other scientists: *In the quantum computer view of space-time at the Planck scale quantum space-time is a universal quantum computer that quantum-evaluates recursive functions which are the laws of Physics in their most primordial and symbolic form. In other words, at the Planck scale because of the isomorphism between a quantum computer and quantum space-time (quantum gravity), the laws of physics are identified with quantum functions. This is the physical source of computability, and leads to the conclusion that at the Planck scale, only computable mathematics exists. We would like to make a remark: Deutsch says that all computer programs may be regarded as symbolic representations of some of the laws of physics, but it is not possible to interpret the whole universe as a simulation on a giant quantum computer because of computational universality. We fully agree with that, and we wish to make it clear that, in our view, quantum space-time is not a simulation but is itself a quantum computer, and, by quantum evaluating the laws of Physics, it just computes its own evolution.* [19] This is very interesting point of view and according to Lee Smolin (LQG) self-organized critical systems are statistical systems that naturally evolve without fine tuning to critical states in which correlation functions are scale invariant [17].

My own view seems to support the view of Smolin in the meaning that the universe is a dissipative coupled system [VI] that exhibits self-organized criticality. The structured criticality is a property of complex systems where small events may trigger larger events. This is a kind of chaos where the general behavior of the system can be modeled on one scale while smaller- and larger-scale behaviors remain unpredictable. The simple example of that phenomenon is a pile of sand [V].

When QM and GR are computable and deterministic, the universe evolution (naturally evolving self-organized critical system) is non-computable and non-deterministic. It does not mean that computability and determinism are related. Roger Penrose proves that computability and determinism are different things [11].

Let me try to summarize: the actual universe is computable during Lyapunov time but its evolution is non-computable.

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Technical endnotes

I. Some implications of the spacetime deformations concept

i. Any interaction between spacetime deformations we perceive as a force: we have named them GRAVITATIONAL, STRONG and WEAK NUCLEAR, ELECTROMAGNETIC and DARK ENERGY (in my concept this is different type of interaction and the gravitation is only emergent from the strong). Any spacetime deformation (a physical object) interacts (a force) with all other objects. A differentiation of forces depends only on the shape, the average density gradient along with its changes and the average size of deformation subject to our detection. In brief: all interactions (forces) are only spacetime deformations with different geometry

ii. We assumed the following spacetime properties:
   a) the spacetime is continuous, i.e. not perforated, not torn and has a homeomorphism property
   b) the spacetime has elastic properties
   c) the elastic properties of spacetime are isotropic
   d) any spacetime deformation is unlimited (because, to some extent, it deforms the entire spacetime, due to its elastic and homeomorphism properties)

   Some results of the assumptions are given below.

   A spacetime deformation must not relocate itself on a distance significantly greater than its average size. In the result it would cause an unlimited spacetime density gradient (an unlimited potential energy accumulation). That is the reason why any spacetime deformation can move only as a wave. In brief: every particle (spacetime deformation) movement is a wave and every particle is a wave (wave packet) and not: it only possesses a wave properties.

   A gravitational wave is commonly defined as a fluctuation in the curvature of spacetime which propagates as a wave, traveling outward from the source. The spacetime deformations concept gives quite different outlook. In brief: every "massive" object e.g. the earth is a gravitational wave itself. And the wave is not traveling outward from the source. There is no source e.g. the Earth is a gravitational wave orbiting the Sun along the geodesics.

   Copenhagenists claim that interpretations of quantum mechanics where the wave function is regarded as real have problems with EPR-type effects, since they imply that the laws of physics allow for influences to propagate at speeds greater than the speed of light. Einstein–Podolsky–Rosen paradox refers to a dichotomy, where either the measurement of a physical quantity in one system affects the measurement of a physical quantity in another, spatially separated system or the description of reality given by a wave function is not complete. The EPR effects are not paradoxical when we look at the listed above properties of spacetime (iid). The systems in question have never been spatially separated as they have been entangled since the creation moment as two halves of an apple taken away.

iii. The matter and energy do not exist as separate and spacetime independent objects. They are only notions describing human being's perception of spacetime local deformations having different geometry[2][3].
   The matter and energy transformation becomes clear and natural as the spacetime is dynamic.
   Neutrino oscillations can occur only if neutrinos have mass, making it very difficult to explain using current theories. An explanation of neutrino oscillations is natural using the spacetime deformations concept.

iv. The objects we call particles (or any other objects) do not have sharp (distinct) boundaries because they are spacetime dynamic deformations . They are wave packets.

v. An observer consists of matter and energy so is a set of spacetime deformations (a wave packet) and also constitutes a frame-of-reference (a coordinate system). Only a conscious observer is able to interpret his detections (spacetime deformations' transformations) creating some interpretations called physical theories.
   There are theories of perception, which discuss the general phenomenon of biological perception of so called reality by an observer, but without specifying its physical basis [2]. Within the spacetime deformations concept we can find a perception theory that specifies its physical basis.

vi. The phenomenon we call the spontaneous symmetry breaking (however speculative) may be the result of spacetime deformations evolution.

II. The study of artificial self-replicating structures or machines has been taking place now for almost half a century. Much of this work is motivated by the desire to understand the fundamental information-processing principles and algorithms involved in self-replication, independent of their physical realization. An understanding of these principles could prove useful in a number of ways… One of the central models used to study self-replication is that of cellular automata (CA). CAs are dynamical systems in which space and time are discrete [18]. The examples of existing software:

1.Tierra by Tom Ray. Tierra is a virtual world, consisting of computer programs that can undergo evolution. In contrast to evolutionary algorithms where fitness is defined by the user, the Tierra “creatures” (programs) receive no such direction. Rather, they compete for the natural resources of their computerized environment, namely, CPU time and memory. Since only a finite amount of these are available, the virtual world's natural resources are limited, as in nature, giving rise to competition between creatures [6].

2. COSMOS by Tim Taylor. COSMOS is a derivative of Tierra and was originally designed to investigate the evolution of differentiated, parallel (“multicellular”) programs. A program in COSMOS has a more complex, cellular-inspired structure than its Tierran counterpart; the genetic information is represented as a binary string which is decoded to active instructions using a genotype-to-phenotype mapping. This mapping could itself be allowed to evolve, although such experiments have not yet been conducted. Programs must collect "energy tokens" from the environment in order to run their code, so programs in COSMOS are therefore in <u>competition for energy as well as space</u> [7].

III. The original Darwin’s theory for many years generated no predictions. Now scientists can find a little. The evolutionary science refers to the history [12].

IV. There are several examples of physical processes that are described as self-organization:
- first-order phase transitions and spontaneous symmetry breaking (e.g. spontaneous magnetization, crystallization, the laser, superconductivity and Bose-Einstein condensation),
- second-order phase transitions associated with "critical points" at which the system exhibits scale-invariant structures (e.g. critical opalescence of fluids at the critical point, percolation in random media),
- structure formation in thermodynamic systems away from equilibrium e.g. a star formation (the theory of dissipative structures of Prigogine and Hermann Haken),
- self-organizing dynamical systems: complex systems made up of small, simple units connected to each other usually exhibit self-organization (Self-organized criticality SOC), a general organizing principle governing a class of dissipative coupled systems. The systems evolve naturally toward a critical state, with no intrinsic time or length scale. the emergence of the self-organized critical state provides a connection between nonlinear dynamics, the appearance of spatial self-similarity, and of 1/f noise in natural and robust way [16]
- a model of spin network evolution motivated by the hypothesis that the emergence of classical space-time from a discrete microscopic dynamics may be a self-organized critical process. Self-organized critical systems are statistical systems that naturally evolve without fine tuning to critical states in which correlation functions are scale invariant [17].

V. If you drop a grain of sand on top of the pile every second, the pile will continue to grow in the shape of a cone. The general shape, size, and growth of this cone is easy to predict as a function of the rate at which new sand grains are dropped, the size and shape of the grains, and the number of grains in the pile. The pile retains its shape because occasionally a new grain of sand will trigger an avalanche which causes some number of grains to slide down the side of the cone into new positions. The avalanches are chaotic. It is nearly impossible to predict if the next grain of sand will cause an avalanche, where that avalanche will occur on the pile, how many grains of sand will be involved in the event, and so on. However, the aggregate behavior of avalanches can be modeled statistically with some accuracy. For example, you can reasonably predict the frequency of avalanche events of different sizes.

VI. Dissipative systems are dynamical systems that are characterized by some sort of "internal friction" that tends to contract phase space volume elements. Phase space contraction, in turn, allows such systems to approach a subset of the space called an Attractor (consisting of a fixed point, a periodic cycle, or Strange Attractor), as time goes to infinity. A strange attractor is an Attractor that displays sensitivity to initial conditions. That is to say, an attractor such that initially close points become exponentially separated in time. This has the important consequence that while <u>the behavior for each initial point may be accurately followed for short times, prediction of long time behavior of trajectories lying on strange attractors becomes effectively impossible</u>. Strange attractors also frequently exhibit a self-similar or fractal structure. [20]