

ORDER IN COSMOS AND MAN ON EARTH

E. Levich

Jerusalem, New York

eugenelevich@gmail.com

ABSTRACT

In 2014 I published a paper that "Theory of Order in Cosmos" ("Scientific Israel-Technological Advantages", vol. 16, no.1, 2014 under the rubric "New Concepts in Science"). Previously I had published in the same journal two letters: "Theory of order" Part 1 and Part 2". **This paper is the follow up and elucidation of the theory submitted in the preceding papers.**

The papers were written, I willingly admit it, with my mind in a state of mild confusion. Despite the valiant efforts of my editor, to whom I am greatly indebted, the confusion contributed to a number of misprints, spelling and grammatical mistakes and a couple of misprints in the Table of numerical results in (E. Levich, 2014). In the end of this paper there is a new Table with the misprints weeded out.

My confusion had been rooted in the seemingly inescapable conclusions of the theory. Some of them are embarrassingly different from certain cosmological beliefs advanced by some contemporary iconic cosmologists and physicists. I was also confused by the generality of applications of the submitted theory.

The theory follows closely the groundbreaking astronomical data of the last two decades since 1998. That year two independent groups of astronomers in the USA and Australia discovered that our Cosmos is dominated by an invisible matter. This invisible matter is called dark energy. Two decades earlier astronomers had discovered that all visible lumps of matter in Cosmos, galaxies, clusters of galaxies, filaments of clusters and so forth are dominated by another kind of invisible matter called dark matter, not to be confused with dark energy. What is left of normal visible matter in Cosmos is the mere 4.9%. All the rest 95.1% of matter in Cosmos are the invisible dark energy with 68.3% contribution and dark matter with 26.3% contribution. It is irrefutably proved by astronomers that dark energy accelerates the Cosmos space expansion and thus acts as a sort of antigravitational, repulsive force, while dark matter is contracting gravitationally.

The above extraordinary findings are fashionable to consider as the last "mysteries" of science. It is a convenient position for scientists who for several decades have been heralding their successes of being on the verge of creating a "theory of everything". The discovery of two kinds of invisible matter totally dominating Cosmos with no clue whatsoever to their nature dealt a death blow to this fantasy. Indeed, natural sciences are not a set of beliefs. Science must explain firmly established observational and experimental facts and predict the new ones. Although, recognized by a few leading physicists and cosmologists as fairly shattering I know of no serious attempts to reconsider from the beginning the prevailing approach to these phenomena. On the contrary, as far as I can judge the attempts to understand invisible matter have been focused on finding ways how invisible matter, primarily dark matter, can be explained as some peculiar manifestation of "normal matter". Much more constructive approach to dark energy has been voiced by Sir. Roger Penrose. His view that I have gathered from the lectures is that dark energy is just the Einstein cosmological constant introduced by Einstein and later refuted by him in his gravitation equations-the modified EGE. As far as the nature of cosmological constant this is just a given, fundamental property of Cosmos, say as Newton gravitational constant, or the speed of light. My view is not far to this position, but I believe that much more can be done to elucidate the nature of dark energy and dark matter. This was done in (E. Levich, 2014) and the present work is the continuation with some new results, corrections and more philosophical discussion, while the basic calculations are all in the cited paper.

It is argued that the observation of dominant invisible matter inexorably guides us to the primordial, primeval source of all order in Cosmos, galaxies and stars, our solar system and Earth; the source of life and of conscious mind of Man on Earth; *the pinnacle of order in Cosmos*. This primeval

source is the timeless continuum of dark energy-the DEC- into which our Cosmos is embedded as a subdomain. Dark energy permeates the global 4D space/time of (4dimensional)-4D Cosmos through all and every 4D space/time point of Cosmos from the birth in Big Bang 13 billion years ago until death in ten quadrillion quadrillions years from now. It is not that dark energy and dark matter are somehow the modalities of visible matter. On the contrary, the coherent visible matter, from microworld to galaxies is formed by dark energy. It is not that dark matter is some peculiar manifestation of visible matter. Dark matter is just chaos disposed by any and all visible matter entities to sustain their coherence.

I call the proposed theory the "kinetic theory of order in Cosmos", or KTOC. The KTOC starts from cosmogony, the birth of Cosmos that is briefly as follows. Cosmos is born within the *timeless, dark energy continuum*, the DEC as a supremely coherent light of Big Bang. The perfectly coherent light of Big Bang is emitted within the timeless dark energy continuum by what is known theoretically as the flux of virtual Planck particle. The Planck particle has been an object of curiosity of physicists since the advent of quantum field theories. But the Planck particle has neither been observed nor its existence proven and hence may be in doubt. Nevertheless, the birth of virtual Planck particles does not violate any of the classical laws of physics¹. These days directly and indirectly the Planck particle or Planck string is used in fashionable string/brane theories as the most elementary unit of matter and/or a minimal possible corpuscle of space/time. It also obviously appears in the acclaimed theory of quantum evaporation of black hole-BH- developed by renowned Jacob Bekenstein and Stephen Hawking in the late 20th century. The Planck particle isotropically emits a perfectly coherent light having a tremendous momentum/energy triggering the dark continuum expansion and thus the first isotropic and perfectly coherent 3D space, but not time is created. This is the Big Bang event.

Although triggering the space expansion the light speed is limited while the speed of empty space expansion by inertia is not. There is no time concept yet, the stable physical matter has not been borne yet, except of light and light by itself is not enough for measuring of time by virtue of ESR. This timeless space expansion within the dark continuum can be called the inflation stage. This name associates with the inflation hypothesis that is widely discussed by cosmologists. However, the KTOC inflation has a totally different nature from the inflation theory of Alan Guth and Andrei Linde. The KTOC inflation is caused by the perfect coherence of Big Bang².

The initial "temperature" of space is extremely high. It is not the thermodynamical temperature since the Planck particle as a tiny black body emitting perfectly coherent radiation. Perfectly coherent radiation is the quantum equilibrium of perfect order. The quantum equilibrium is the opposite of classical physics equilibrium, which by definition and meaning is the state of maximal possible chaos. In astrophysics the sources of highly non-equilibrium radiation in the primarily low frequency part of the spectrum, e.g., of quasars, pulsars, radio-galaxies are characterized by the so-called brightness temperature. Their radiation is very far from the classical equilibrium of chaos and closer to the coherent radiation of quantum equilibrium. But as there is no time yet there is no chaos, only order. Therefore the Big Bang event could not be chaotic. The KTOC asserts that the ultimate coherence of the Big Bang radiation is the state of quantum equilibrium with all photons having one Planck

¹ If a virtual Planck particle pops out from the DEC in the usual terminology as a fluctuation from the quantum "vacuum" it lives extremely short time, the shortest possible and returns back into the DEC. However, it does not mean that it cannot pop out again and again flickering with the extremely high, maximal possible Planck frequency. This virtual flickering into our 4D space/time is equivalent to the momentum/energy flux of the virtual Planck particles. *For an observer this flux would be impossible to distinguish from the permanent presence of matter in the volume through which this flux passes, since the frequency at which the observer is functioning is much lower than the Planck frequency. The observer can reach this frequency only at the black hole quantum "singularity", but then he will be just a part of the DEC because this singularity is the entry into the DEC. For those not familiar with the terminology used in this footnote it may be necessary to read through the text to understand it rather simple, but slightly twisted logic of assuming the contrary and proving that it is contradictory; that is if something is possible the consequences would be contradictory and hence this something is not possible.*

² The perfect coherence of Big Bang is the cornerstone of the "Cycles of Time" infinitely sequential Cosmos theory of Sir. Roger Penrose, e.g., (R. Penrose "Cycles of Time", 2010).

frequency. This is the state similar to Bose-Einstein condensation of photons-the BEC of photons (Ya. Zeldovich, E. Levich, 1970, R.A. Sunyaev, 2013, Klaers J., Schmitt J., Vewinger F., & Martin Weitz),, 2010),, except that the classical BEC frequency is zero, rather than the extremely high Planck frequency. But the latter is the only energy state that had existed at the Big Bang event (E. Levich, 2014).

Thus the KTOC concludes that the Big Bang ultimately coherent radiation is a state similar to the BEC of photons, but with the highest possible *brightness temperature* in Cosmos. As Cosmos space expands the initially perfectly coherent radiation thermalizes via interaction with the virtual electron/positron pairs popping out of the coherent radiation and immediately annihilated back into the radiation. But thermalization is abrupt like a break of symmetry at the birth of physical four dimensional-4D space/time.

The very fact of light emission by the Planck particle as a tiny black body asserts that the birth of Cosmos is a quantum event. Strangely a quantum event with the Planck particle may occur even if the observable time concept does not exist yet. The life time of the Planck particle is the shortest that ever has been and will be in Cosmos and hence impossible to observe. Also strangely such event can be formally described as a solution of the classical Einstein gravitation equations-the EGE (Roger Penrose, 2010)³.

As a descendant of the primordial coherent the thermal radiation has a normal temperature sufficiently cold for the first stable, not virtual bricks of matter other than photons of light to be born from the dark continuum⁴. This happens when the Cosmos space volume reaches 10^{24} cm^3 and the first building bricks of would be macroscopic matter pop out from the DEC. These are protons and/or antiprotons, it is immaterial how we call them, with a slight excess of one over another. However, if even two, say protons do not annihilate with antiprotons they appear in Cosmos as stable particles. Since now space contains protons and light the ESR requirements of the Einstein special relativity theory-for the time measuring are met. This latter is the necessary, *but not necessarily sufficient* condition for the time concept to exist.

But first it is necessary that light catches up with the space expansion that is many orders of magnitude faster than the speed of light. In the KTOC it occurs at the phase transition time $\sim 3 \cdot 10^{-3}$ sec when the expanding 3D space has the volume of 10^{24} cm^3 . This is the start of physical time, the irreversible time concept in conjunction with and inseparable from the *second law* of thermodynamics and the subsequent distinction between order and chaos with entropy as quantitative measure of chaos. Entropy S is rigorously defined in the science of statistical thermodynamics.

At the beginning of time the space is flat, since the curvature would have meant chaos and chaos does not exist prior to the physical, sensual time concept. On the other hand since the first protons are born the coherent radiation of Big Bang suddenly becomes thermal equilibrium radiation with normal, not brightness temperature appropriate for the birth of stable protons. This is the birth of 4D space/time Cosmos dominated by radiation.

The KTOC calculations show that at the beginning of physical time count from $\sim 3 \cdot 10^{-3}$ sec the matter density dominated by light is critical and Cosmos is flat from the view point of EGE and

³ It is a remarkable property of coherent phenomena, in particular of low frequency nonequilibrium radiation and BEC of photons that although quantum phenomena and would have not existed if not for the quantum structure of Cosmos, still in many aspects can be described by classical field theories. The reason for this is the rigorous cancellation in final results the quantum constant \hbar cancels out. Although, Penrose does not invoke the above reasoning he is right that the Big Bang event, as well as the death of Cosmos events can be described by a classical solution of the Einstein gravitation equations. The two are not the real singularities. However, I argue that neither would happen if not for the quantum mechanics. It is a slightly twisted reasoning, but such is the general nature of perfectly coherent phenomena. Bose condensation of photons s a classical example of such strange quantum phenomenon independent of the quantum Planck constant (Ya. B. Zeldovich and E. Levich, 1969),

⁴ The distinction between the virtual and stable matter is subtle in KTOC. It is determined by the life time which can be as small as the Planck time and as big as the life time of Cosmos. Since the KTOC asserts that all matter in Cosmos is a mapping of the dark energy flux in the 4D momentum/energy space into the physical 4D space/time this distinction is not substantial. In this context all matter in Cosmos is virtual having finite life time span prior to returning to the DEC.

Friedman equations. Thus the space expands by inertia caused by now anomalous speed of inflation. This is a phase transition of the time quality, from a formal mathematical parameter into the physical, sensual time and the subsequent phase transition of light from the perfectly coherent state of quantum equilibrium to the state of classical state equilibrium of chaos with Planck distribution spectrum.

Since the phase transition, or spontaneous break of symmetry cannot happen instantaneously there is a finite time span during which the abstract time metamorphoses into the physical time. The time transition in the quality of time cannot be observed but what can be observed is the accompanying deceleration of the space expansion adjusting to the normal rate of expansion of flat Cosmos, both the decelerating and normally accelerating Cosmos existing for billions of years of normal time. The deceleration of Cosmos expansion starts with the birth of genuine observable time. The Cosmos geometry is nearly flat with total matter comprising dark energy, visible matter and dark matter at almost the critical density $10^{-29} \text{ g / cm}^3$ (see the Table of results).

The KTOC asserts that the consciousness is born as the intrinsic quality of Cosmos in conjunction with the time concept. In about 13 billion years since the birth it is ported, "breathed: into the Man species brain, one and only species, likely in the whole Cosmos that is aware of being an intrinsic part of Cosmos, comprehending the irreversible time concept, reaches with his consciousness into the deep past, nearly to the birth of time, striving to leave mark on the future for posterity far beyond the life time of the species individuals and eternally concerned with the meaning, reason and source of our existence in Cosmos⁵. There is no contradiction with relatively recent appearance of human species, the conscious Homo Sapiens. Cosmos in KTOC is a globally phase coherent entity and consciousness per se must not be localized in 4D space/time. At a certain time, better to say in a certain subdomain of 4D space/time the consciousness is localized. This domain is the total space volume of all, or most human brains and the life time of Man species.

I would like to reiterate. From the viewpoint of Einstein special relativity- the ESR theory for the time concept to exist it is necessary that Cosmos contains at least two particles serving as clocks and the light, photons shuttling between the two for the clocks synchronization. This is the foundation of the ESR. The problem for some thinkers that they likely hold for themselves is that when there is no one to observe and measure time what meaning does the time have⁶?

As a follow up of the above question the KTOC asserts that the consciousness is born in conjunction with the birth of time as an intrinsic phenomenon of Cosmos in conjunction with protons at the mathematical, abstract time $t_{parametric} = 3 \cdot 10^{-3}$ sec that is the genuine time zero, the observable time, the birth of 4D space/time Cosmos with the *second law* of thermodynamics and the distinction between order and chaos. From now on the amount of chaos is defined by entropy.

Astronomical evidence of the Planck telescope mission indicates the age of Cosmos of about 13 billion years. The KTOC calculation shows a few hundred million years younger Cosmos⁷ (see the Table below). The KTOC asserts that the whole 4D space/time of Cosmos is one phase coherent subdomain within the DEC with all past and all future intertwined and will have remained phase coherent till the death of Cosmos and consciousness in ten quadrillion, quadrillion (10^{31}) years.

During all the preceding 13 billion years the inanimate matter has evolved in accordance with the classical theories of Ralph Alpher and Fred Hoyle respectively for the Big Bang nucleosynthesis of light elements, hydrogen, helium and lithium and nucleosynthesis in the stars generating all other elements from the Mendeleyev periodic table, stars combined into galaxies, galaxies into clusters and

⁵ I read in a brilliant book of Alan Guth that the three eternal questions that we ask are How, Why and For What. How is the task of science to determine, but the other two questions are not in the scope of what we believe science is. I as many others have speculations or the beliefs about How and For What. I will touch upon my beliefs below.

⁶ This view point was shared with me by the renowned physicist and cosmologist Isaak Khalathikov in private discussions about 15 years ago. He told me that the internationally famous physicist Lev Landau had firmly believed that time has no sense, except as a mathematical parameter prior to conscious appreciation of time by an observing and measuring entity and this can be done only a conscious being.

⁷ I do not see this discrepancy as an issue. The KTOC age is really the Hubble time that should not exactly coincide with the age of Cosmos. On the other hand the age of Cosmos determined astronomically is based on a regular Big Bang cosmological model that is empirical and not necessarily precise in this case.

so forth. But not much new is anticipated for the inanimate matter in the future. Only when the above life time span of Cosmos is nearly over the inanimate matter will start to disappearing with stars being sucked into the massive black holes-MBH and being erased by the quantum friction with the permeating dark energy, the friction that the KTOC establishes and calculates. The eventual end will be the return of all matter, inanimate and animate alike into the DEC that had given its birth and fed it with the ever existing dark energy coherent flux of momentum/energy, the primeval source of everything that has existed and been happening in Cosmos since its birth.

One of the most successful astrophysical theories of the 20th century is the evolution of stars theory, an amazingly well understood and predictive. The star evolution theory is affirmed by astronomical observations at all stages of stars evolution. Since astronomers observe a large number of stars born within a huge time period, which would be correct to call the ensemble of stars, the observation of this ensemble diversity is equivalent to observing the total life of individual stars of different types, including the majority of normal stars as probably, but I guess not exactly known is our sun, nova and supernova violently exploding stars, white dwarfs, neutron stars and pulsars, and the most enthralling for imagination black holes-BH. Indeed, the theory of star evolution based on the quantum theory of nuclear and thermonuclear reactions, fission and fusion respectively, the Einstein special and general relativity gravitation theory, plasma physics, high energy physics, fluid mechanics and shock waves physics, celestial mechanics, chemistry, the incredible Big Bang predictions of Cosmos Microwave Background-CMB- radiation and at last the top results obtained by astronomers, space scientists and astrophysicists observing the CMB since its actual discovery CMB in 1966, all this fusion and synergy is an incredible achievement of science of the 20th century. It is wonderful that so many theoretical predictions made by physicists, cosmologists and astrophysicists have been confirmed by astronomical data. We know greatly more about Cosmos in 21st century⁸.

Nevertheless, many classical problems remained unsolved. It is not known quantitatively how galaxies and clusters of galaxies and filaments of clusters and quasars were formed, although serious hypothesis based on the inflation theory do exist. It is not known, in my view even qualitatively how planets have been formed. Science has no clue how such an amazing planet as Earth could be formed. Earth is unique in Cosmos. The coherent conditions so perfectly matched with the set of requirements for the existence and evolution of carbon based life and mysterious conscious life of Man are so incomprehensibly complex and unique that one must have enormous imagination and I would say reckless courage to sincerely believe that Earth, life and conscious Man on Earth originated via random accidents, random genetic mutations and "natural", unassisted evolution driven by selection of the fittest. Indeed, scientists have been endowed not only with the gift of uncovering the amazing phenomena of Cosmos and explaining them, but also with rich imagination shaming that of the most imaginative science fiction writers. Many scientists, most probably from vested interests, as most people do, argued for Earth in the center of solar system till the times of Kepler and Newton.

It is not that the great Darwinian principle of survival of the fittest is not correct.⁹ In my view it is immensely correct and valid in a much larger realm of applications than the evolution of live species. However, this principle is the mechanism serving the dictates of the *kinetic second law* extracting order from the coherent flux of dark energy, the primeval source of order in Cosmos.

⁸ Astronomical observations are invaluable for the basic physics as has been the case in many instances. For example it had been believed that neutrinos elementary particles are as photons massless. However, the insufficient flux of solar neutrinos detected on Earth led to the prediction made by Bruno Pontecorvo that at least some neutrinos have a tiny nonzero rest mass. After the death of Pontecorvo the Japanese scientists were awarded the Nobel Prizes for experimental confirmation of this prediction by the late Pontecorvo. In recent years the science fiction has been waning and gave way to fairy tales called fantasies and computer games in which everything is possible except common sense. Although fantasies and computer games in my view are very useful for imagination and high-tech development I think that a part of contemporary science claiming it is closing on the "theory of everything" is pure nonsense on the level of pagan religions. One should smoke a lot of pot and add some hashish to believe this nonsense.

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As we discussed above the most remarkable scientific discoveries of the last decades are dark energy and dark matter. The two discoveries transformed the primeval source of order in Cosmos hypothesis from an esoteric belief into quantitative theory. In difference to many contemporary scientific beliefs that are hardly falsifiable the primeval source of order has been astronomically observed since 1998 when the above mentioned astronomical groups established that the Cosmos space expansion, the Hubble expansion, is accelerating with ever increasing speed proportional to the distance between the points in 3D space. This expansion proves that the global order of Cosmos is continuously growing as will be explained shortly. This means that there is a source pumping order into Cosmos externally and this means that Cosmos that we see is not a closed system and this source of all order in Cosmos and the progenitor of Cosmos itself is dark energy.

It is surprising that the relation between dark energy and the primeval source of order in Cosmos had not been understood prior to the publications cited above (E. Levich, 2013 and 2014). The reason I believe is to a large extent psychological probably caused by excessive distancing of contemporary leading cosmologists from religious beliefs simultaneously substituting them with their own beliefs. Fortunately dark energy and dark matter are astronomical facts as unambiguous as stars and galaxies and round Earth and the facts lead to the quantitative and predictive KTOC. From the view point of KTOC dark energy and dark matter are quite natural kinds of matter that can be quantitatively described simply by looking at the available facts strictly in the framework of existing physical theories not constrained by non-falsifiable opinions not based on experimental evidence and numbers.

The acceleration of Hubble expansion is almost universally believed to be caused by a mysterious media called *dark energy* that is usually identified with the Einstein cosmological constant term in the EGE. No one knows what this cosmological constant is except that it is associated with the fame of Einstein. Dark matter or cosmological constant matter uniformly fills the 4D space/time of Cosmos and forces it to expand with acceleration. This latter follows from the modified Friedman equations derived from the EGE with the cosmological constant term added. Dark energy cannot be seen, this is why it is called dark. But *dark energy* whatever it is irrefutably observed by anti-gravitational, repulsive action forcing all points of space and all objects in space to recede from each other not only with the speed proportional to the distance between any two points in space, the well-known Hubble expansion but to recede with acceleration that is also proportional to the distance between any two points in space. The puzzling conclusion unambiguously followed from the Einstein gravitation equations of general relativity-the EGE of EGR- that subsequent to the acceleration of Hubble expansion is the ever growing order and hence ever diminishing chaos in Cosmos. That is to say that as time goes on our Cosmos is becoming more and more coherent. Moreover astronomical observations show unambiguously that our Cosmos geometry is nearly flat and this means Cosmos space on large scales has no very orderly coherent place to live in. If our Cosmos is a closed system as had been believed for generations this would contradict the *second law* of thermodynamics, the *second law* that cannot be violated. The conclusion made in KTOC is that our Cosmos is not a closed system and this seems pretty obvious and contrary to the nostalgic vision of Cosmos that we have been taught that is all inclusive with nothing else but Cosmos. This vision is dead with the discovery of acceleration of Hubble expansion.

It has become clear for many contemporary thinkers that the most complex organization, the most orderly and coherent entity in all Cosmos is the truly divine conscious brain of Man. The enormous coherence of huge galaxies consisting of 80-90 billion stars all tied up with each other by gravitation in weakly coherent unity is a joke when compared with the coherent complexity of conscious brain cortex of Man species with the cognitive cortex having typical mass of about 1000 g. What is the source for this incomprehensible coherence of human brain? Darwinian evolution of some smart apes that came from Africa, made whoopee with robust but backward European Neanderthals and started thinking about time, Cosmos and the meaning of life? Hardly credible hypothesis on the origin of conscious Man, especially if all experimental support is a few broken skulls integrated from pieces of bones subjected to dubious genetic analysis that has nothing to do with consciousness magnified by unlimited fantasy of some anthropologists. All of the above incomprehensible coherent complexity needs the existence of a primeval source of order.

When I started suspecting that *dark energy* is a realistic candidate to be the primeval source giving birth to Cosmos and everything in Cosmos, the inanimate matter and animate matter and consciousness I proceeded with calculations using all contemporary available astronomical data on the dark energy in Cosmos. The approximate density distribution of dark energy that follows from the observed acceleration of expansion and Friedman equations was all I needed to formulate the KTOC. The KTOC started furnishing sense and the quantitative, numerical results that could be immediately compared with experimental values of classical cosmological constants and parameters that had been always believed fundamental constants of Cosmos that cannot be theoretically calculated, but only empirically determined. The KTOC shows this is a false belief.

With the quantitative numbers obtained and sincerely puzzled by their astonishing agreement and with the experimental values and the clearly improbable scenario of numerological coincidences due to the diversity of unconnected numerical results based on well formulated theoretical physics foundation I told myself that "audentes Fortuna iuvat" and submitted the above papers to the judgment of potential readers. In the present work, beside the corrected Table of results I would like to elucidate the KTOC in a more philosophical manner and report some new results. For the details of transparent and comprehensive calculations that may interest some readers I refer to (E. Levich, 2014).

I still would like to make clear the two reasons that helped justifying my audacity and do away with all traces of confusion. The first reason is that the KTOC relies strictly on the classical theoretical physics disciplines, e.g., the Einstein special and general relativity theories, the basics of quantum mechanics, statistical mechanics, etc., and is not allowed dangerous temptations of excessive imagination. The theory has an advantage of relying on the latest astronomical data of Planck telescope mission in addition to classical experimental data. Despite the lack of imagination, but maybe due to this constraint, the theory leads inexorably to explicit quantitative and predictive results. In particular, as mentioned above it furnishes the numerical values of certain most fundamental cosmological and physical parameters and constants, e.g., the mass of electron and proton and their life time span, the Hubble constant and others that I will mention shortly. Although, the calculated values of constants hitherto had been universally considered empirical fundamental constants of Universe they are not.

The genuinely fundamental constants are the speed of light $C = 3 \cdot 10^{10} \text{ cm/sec}$, the Newton's gravitational constant $G \approx 6.67 \cdot 10^{-8} \text{ cm}^3/\text{sec}^2$, the Planck quantum mechanical constant $\hbar = 10^{-27} \text{ erg} \cdot \text{sec}$, the Boltzmann constant of statistical mechanics connecting thermodynamical energy of a system and its temperature, say in Kelvin degrees $k_B \approx 1.38 \cdot 10^{-16} \text{ erg} \cdot \text{K}^{-1}$, the dimensionless fine structure constant of quantum electrodynamics $\alpha = e^2 / \hbar \cdot c = 1/137$, or equivalently the electrical charge unit e , the dark energy density, or the Einstein *cosmological quasi-constant* empirically determined as $\Lambda \approx 10^{-29} \text{ g/cm}^3$. Although, the dark energy density itself is not really constant the contemporary value of dark energy density $\Lambda \approx 10^{-29} \text{ g/cm}^3$ is fundamental for the reasons clear from the Table of results. Indeed, the total mass density calculated by the KTOC is slightly less than the critical density of flat Cosmos and the latter is with high accuracy is calculated in KTOC as the above value of $\Lambda \approx 10^{-29} \text{ g/cm}^3$. What it means is that Cosmos is approaching the state where only dark energy will be left with this density, although this approach will take the above ten quadrillion quadrillions years till the end of visible Cosmos. But during all this time all matter in Cosmos combined is equal in density to the dark matter density in the end. As soon as visible matter disappears dark matter disappears, since dark matter is the chaos disposal by coherent visible matter. But the above reasoning combined shows that visible matter consists, made up from dark energy. This was rigorously proved in (E. Levich, 2013).

Adding this value contemporary dark energy density $\Lambda \approx 10^{-29} \text{ g/cm}^3$ to the list of universal constants allows an unique and only dimensionless combination, a large number $\text{Re}_C = 10^{41}$. Together the two dimensionless numbers $\text{Re}_C = 10^{41}$ and $\alpha = 1/137$ are pivotal for the KTOC. In the end of this work there is a Table of theoretical results versus the classical experimental and latest astronomical data. It is borrowed from the previously cited article (E. Levich, 1914) with corrected misprints. Readers having no patience to read through the text can skip it and consider the final Table

below. They will find the quantitative agreement between the diverse theoretical results on one hand and available experimental data on the other fairly impressive, or so I hope.

A story tells that once Napoleon Bonaparte demanded an explanation from his general of the reasons why the general had lost a battle with the Austrians. The general defended himself by referring to nine main reasons of which the first one had been lacking artillery shells. Napoleon waved the general away commenting that this one reason is enough.

However, the second reason that convinced me to publish the above papers and the theory therein is so important that I must discuss it. Indeed, the theory explicitly complies with and relies on the second law of thermodynamics, the venerable second law, although in the *kinetic interpretation* that is novel, in particular novel for cosmology, but rigorously formulated in the cited papers and their foreshadows. The *kinetic second law, or reverse second law-RS-* is as unshakeable as the second law of thermodynamics of Gibbs, Boltzmann, Carnot and other giants who created the sciences of thermodynamics and statistical mechanics in the late 19th century, as well as the more recent nonequilibrium thermodynamics generalization developed by the late Nobel Prize recipient Ilya Prigogine. Nevertheless, the *kinetic second law* is subtly but decisively different, although follows naturally from the familiar *second law*. It is the compliance with the *kinetic second law* that furnishes the quantitative success to KTOC.

The *second law* is known for about 150 years. It was iconized as truly elemental by Sir. Arthur Eddington, an outstanding British mathematician, astrophysicist, philosopher and cosmologist who on the top of his many original contributions was the first to understand the possibility of observing the bending of light in the gravitational field of Sun during the total eclipse and decisively observed it. This is a crucial prediction of the Einstein gravitation equations of general relativity that is widely used since then for astronomical observations. Arthur Eddington thus famously spoke of the *second law*: "The law that entropy always increases, holds, I think, the supreme position among the laws of Nature. If someone points out to you that your pet theory of the universe is in disagreement with Maxwell's equations — then so much the worse for Maxwell's equations. If it is found to be contradicted by observation — well, these experimentalists do bungle things sometimes. But if your theory is found to be against the second law of thermodynamics I can give you no hope; there is nothing for it but to collapse in deepest humiliation". I hope that after acquainting themselves with this work the readers will appreciate the indomitable power of this historical statement by Arthur Eddington.

I would like to summarize the main assertions and conclusions made above. The coherent dark energy flux had given birth to our Cosmos in the ultimate order of Big Bang, has been furnishing all order of inanimate matter and life on Earth since the Big Bang, created consciousness in conjunction with time and protons. in Cosmos since and will of ever growing order of Cosmos and of Man on Earth, connects all points the locations at dark energy as the primeval, primordial and continuous source of all growing order of Cosmos, of life and conscious Man on Earth. Moreover everything that exists in Cosmos, visible matter, inanimate and animate alike and dark matter is the kinetic manifestations of primordial dark energy. Our visible Cosmos and observable Cosmos is a subdomain of the timeless continuum of dark energy, the DEC that provides the coherent flux of momentum/energy into our Cosmos while our Cosmos metabolizes this coherent flux, digests it and exudes the same amount of momentum/energy but transfigured into the chaotic one. That is to say that the DEC is the inexhaustible source of negative entropy flux into our Cosmos subdomain. While the amount of momentum/energy is conserved, momentum/energy does not accumulate in Cosmos all order is extracted from the DEC coherent flux. This order does accumulate and is the cause of growing order of our Cosmos and as importantly of growing order of animate life and conscious Man on Earth.

Dark energy flux creates and permeates all matter in Cosmos. Everything that is happening in our subdomain Cosmos is transfiguration of the momentum/energy flux from coherent state into the chaotic one that is disposed back into the DEC. This transfiguration is achieved by a long chain, a hierarchical mechanisms cascading the constant, *averaged over a large space/time chunk of our subdomain momentum/energy flux* to smaller scales in the space of inverse scales/frequencies, or the 4D momentum/energy space where it eventually dissipates as ultimate chaos at the smallest possible space/time Planck scale achieved only in the black holes-BH. This is the role and the reason, not the

mechanism of how they exist, but why the BH's exist as a sink for chaos, the regurgitated nourishment donated by the DEC to our subdomain Cosmos.

It was determined in the cited above papers that the coherent momentum/energy flux enters our subdomain Cosmos from the DEC at the typical space/time scale: $L_{DEC}^{FROM} = 10^8$ cm; $T_{DEC}^{Coherent Flux} = L_{DEC}^{FROM} / c \approx 3.3 \cdot 10^{-3}$ sec. where c is the speed of light. On the other hand the dissipation, the disposal of the chaotic momentum/energy at the quantum "singularity" of BH's is at the Planck space/scale $l_p = 10^{-33}$ cm; $t_p = l_p / c \approx 3.3 \cdot 10^{-44}$ sec. Since the amount of momentum/energy IN and OUT is the same it means that that the number of degrees of freedom flowing OUT from our Cosmos back INTO the DEC is huge by comparison with the number of degrees of freedom in the flux IN.

Indeed, $S_{DEC}^{ourCOSMOS} = R_C^3 \cdot S_{ourCOSMOS}^{DEC} = (L_C / l_p)^3 \cdot S_{ourCOSMOS}^{DEC}$, where $R_C = 10^{41}$ is the fundamental, dimensionless constant of our Cosmos as I asserted above (E. Levich, 2013, 2014). I designated the number of degrees of freedom as

$S_{ourCOSMOS}^{DEC} = 10^{41} \cdot S_{DEC}^{ourCOSMOS} = R_C \cdot S_{DEC}^{ourCOSMOS}$ on purpose to associate this number with entropy S , the quantitative measure of chaos. Entropy is the product of the Boltzmann constant $k_B \approx 1.38 \cdot 10^{-16}$ erg·K⁻¹ and the number of independent degrees of freedom. Since the flux OUT from our Cosmos into the DEC has so many more degrees of freedom it means that the flux OUT is greatly more chaotic than the flux IN. Hence entropy of our subdomain Cosmos is continuously diminishing and order grows with time.

Thus the growing order follows from the observed accelerating expansion of Cosmos and the fact is that globally Cosmos is nearly flat, although wrinkled and curved locally by the randomly distributed clusters of matter and associated dark matter. Astronomers in part correctly assign this phenomenon of expansion acceleration to dark energy, or the Einstein cosmological constant Λ , although they have no clue to what dark energy and the cosmological constant are. The EGE of EGR and Friedman equations alone are not enough.

If Cosmos expands with acceleration it means that there is some external force acting on the space inducing the space points to recede from each other with acceleration and obviously our Cosmos is not a closed system. There is no such force if the space expands with no acceleration. The space of Cosmos had been found expanding in 1929 by an American astronomer Edwin Hubble. It is only in 1998 that two groups in the USA and Australia discovered that the Cosmos expands with acceleration, as great discovery as the discovery of Hubble expansion in 1929¹⁰. If there is an external force acting on the space/time of our Cosmos it is unambiguous that our Cosmos is not a closed system but a mere subdomain embedded into something infinitely larger and furnishing order to our Cosmos from the birth as Big Bang. This order can be furnished only as a coherent momentum/energy flux, digestion mechanism and disposal of chaotic momentum/energy flux. The realization that our Cosmos is not a closed system was shocking. That the growing order of Cosmos means that it is fed with the flux of negative entropy was inescapable. Similarity with the mechanism of order on Earth and life on Earth as the negative entropy flux from solar radiation, as had been first understood by Erwin Schrödinger was then obvious. It was just necessary to develop the qualitative concept into a quantitative theory with numbers that could be compared with experimental and astronomical data. The constant momentum/energy flux cascades not in the 4D physical space of space and time but in the conjugate to physical 4D space of inverse scales/frequencies, or what is *quite* the same the 4D momentum/energy space. The mapping of this flux from the 4D momentum/energy space into the physical 4D space/time generates all the coherent matter structures that we observe in Cosmos including ourselves. Coherence of the momentum/energy flux, by definition of coherence, means the *phase coherence*. The phase coherence in conjugate 4D momentum/energy space intrinsically results in the acute intermittency of matter distribution in 4D physical space/time (E. Levich. 2009).

¹⁰ It should be noted that the Hubble expansion had been predicted by a Russian mathematician Alexander Friedman in 1922, the author of Friedman equations and the model of homogeneous, isotropic Universe that remains as the basic model of Big Bang cosmology. Later the possibility of Big Bang and expanding Universe was independently confirmed by a Belgian Priest Georges Lemaitre in 1927. Both of them based the expanding model of Universe and Big Bang possibility on, the EGE.

The momentum/energy flux is constant only in the sense of averaging over a very large space/time. On relatively small scales it fluctuates greatly. Hence the different amounts of order flow in physical 4D space/time through the different space/time subdomains. The inanimate and animate matter is distinguished by a hugely different magnitude of coherent density flux of which they consist. As strange as it may sound it is even possible to relate the dark energy flux density in conjunction with the maximal life span of Man 120 years with weight, mass of human brain cortex (see the Table of results below).

I would like to emphasize again that all matter in the 4D physical space/time actually is formed by the coherent dark energy flux cascading in the 4D momentum/energy space; former is the conjugate of the latter. It is in this sense that matter in 4D physical space/time is kinetic and transient. This may sound bizarre for some, but it is quite clear. For instance we think that our bodies are whole and almost static except that we are ageing. But we also know, at least some do, that the cells of our bodies are in a flux and renew due to the metabolism every several hours, or days or slower, or faster. Our bodies look the same as if they are composed of the same cells. They are not. We notice it with ageing and blame the genes. Indeed, our genes get tired and stamp the cells with bugs in them. The genes are the mechanism for the cells renewal. In this sense we are kinetic conglomerates of constantly renewing cells disposing old, tired, dead cells as chaos, excrements, sweat. By disposing chaos we allow order from outside sources to flow into our bodies and brain. Man species is distinguished by self-conscious awareness of being and creative activity that requires deliberate giving away of brain order. When we do it we feel very tired and need to sleep. When we sleep we dispose chaos from our brains as dreams. New order now can flow into our brains. This is the reason why all live species must sleep and hibernate. But all live species also need food as the source of coherent momentum/energy with order extracted and chaotic momentum/energy disposed as refuse. Food is the source of negative entropy.

In the same manner the molecules in the cells are in the flux of renewal, although the properties of the new ones remain nearly the same, atoms in the molecules are in the renewal flux, although the new ones have the same properties as the old ones, and protons and electrons and quarks are in the renewal flux, although their properties remain almost the same. However, even these elemental units of matter are ageing and have finite although very large life time before extinction. All visible matter in this sense is the intermittent flux of coherent dark energy of different density from the DEC into our 4D space/time. This is the kinetic concept of Cosmos and the phenomena in Cosmos that is indeed unusual, but there is nothing strange in it. This is just how Cosmos is functioning.

Since the space/time scales are enormous for astronomical entities we have a chance to observe the macroscopic evolution of these entities, their life. The renewal of the entities of microworld is on the contrary very fast and we cannot observe it; the frequency of renewal is too high and the corresponding momentum/energy is too large. In order to observe the dark energy flux forming them we must reach the Planck momentum/energy, but if we reach it we become a part of the DEC. Indeed, the only space/time domains where the Planck momentum/energy is reached are the BH and massive MBH. They are separated from the usual space/time almost entirely, except certain quantum penetrability per the theory of quantum evaporation of Jacob Bekenstein and Stephen Hawking. To reach them we must pass the surface that is called the trapping surface after (R. Penrose, 1964) and reach the quantum singularity. As soon as one touches the trapping surface there is no escape out and the daredevil who does it reaches the point of quantum mechanical singularity that in reality is the entry into the DEC. All what is left of the dare devil will merge with the DEC and this is all information that his/her body and brain carry. Information does not disappear in a closed system. Since the DEC with our Cosmos subdomain embedded is a closed system this information, including the new information that Man creates, rather than obtains from the DEC, will merge with the DEC. In this world picture the DEC creates our Cosmos as a subdomain for a purpose. Indeed, Man creates information that the DEC does not provide and brings it to the DEC. Although, the DEC is timeless continuum of order and coherent information it still can gain for more created by Man himself/herself. But this is almost a theological discussion that I would like avoiding in this work. This does not mean at all that theology is not a worthy subject. As much as I can I will return to the issue of WHAT FOR the DEC creates us in a separate work.

I note that the *kinetic second law*, or the reverse second law-RSL briefly that are the thermodynamical *second law* rigorously reformulated for kinetic systems and processes in the above cited papers, impose the inverse cascade upscale. It means the growth of structures over the scale

$L_{DEC}^{FROM} = 10^8$ cm; $T_{DEC}^{Coherent Flux} = L_{DEC}^{FROM} / c \approx 3.3 \cdot 10^{-3}$ sec. This is how the large scale structures in Cosmos grow, galaxies made of stars, clusters made of galaxies, filaments made of clusters. This mechanism of formation large lumps of matter and even the Hubble space expansion as resulting from the inverse cascade was suggested in (V. Krishnan, 1993, R.D. Prabhu and V. Krishnan, 1993) with reference to the inverse cascade in atmospheric turbulence predicted in (E. Levich and E. Tzvetkov, 1987) and totally ignored by the scientific community. It is a fundamental conclusion made in (E. Levich 2014) that all matter in Cosmos is phase correlated, or phase coherent. As strange as this may be seen the visible matter can be imagined as a string, twisted, knotted and intermittent naturally, as far as the density matter is concerned with lumps of stars, galaxies, etc., up the scale with nearly empty of matter voids in between. The bigger are the lumps of matter the larger are the voids. And still the lumps of matter and all 4D space/time are in instantaneous phase communication. This is phase coherence resembling the quantum mechanical phase entanglement and I argue are one and the same. For all the mathematical details of the above features of the KTOC I as usual refer to E. Levich, 2014 and references therein.

When astronomers peer in the sky they reach to the cosmological horizon, the last matter casually connected with us on Earth. Since our Cosmos is expanding with acceleration the farther they look the older is the matter that they, almost to the birth of our Cosmos. The distribution of matter had been then strictly uniform, since and no lumps of matter had been yet formed. Cosmos had been filled with primordial light separated from dark energy continuum and this follows quantitatively from the theory that I call the kinetic theory of order in Cosmos-KTOC.

The shocking realization that I arrived at a few years back was that the fundamental Hamiltonian equations of physics, the time reversible equations and by their time reversibility do not, cannot respect the *second law*. Although, superficially familiar from the university bench the *second law* is surprisingly neglected. If the *second law* is as special as Arthur Eddington believed how the time reversible equations of physics can be possibly adequate for describing a great diversity of phenomena in Cosmos that are obviously not time reversible? Neither Cosmos evolution itself is time reversible. In my view the awesome *implications of the second law* are not sufficiently appreciated by some researchers. The consequences can be dramatic, fatal for certain fundamental phenomena and for some this death warrant is obvious can be easily demonstrated. The rigorous *kinetic second law*, the KTOCK foundation, had not been formulated prior to the above referred publications, although on a quantitative level the principles were advanced by one of the famous creators of quantum physics Erwin Schrodinger in his profound essay "What is Life" first published as a book in 1944. I will refer to this book a number of times in this work. Sir. Roger Penrose has been outstandingly promoting and explaining the *second law* and the role that the *second law* plays in Cosmic phenomena, the Cosmos itself, its birth, life, death and the cycles of reincarnations. The ideas of Roger Penrose are exposed for laymen and professionals alike in a book of extraordinary intellectual power "Cycles of Time" first published in 2010. The above two books greatly influenced me, I am sure I am among many, in formulation of the KTOCK. In this sense I am humbly following in the steps of the two brilliant scientists and profound thinkers.

I was raised in a scientific community that held a rather conservative attitude to physical theories. It is bred in my bone that physical theories that are neither predictive nor falsified within a reasonable time span are rather beliefs and should be seen as such. Beliefs, e.g., religious can stay not falsifiable forever. If they do not they are not beliefs but facts. Physical theories need rigorous mathematical foundation, equations, group symmetries and eventually formulas and numbers. Or they are not serious theories. But on the top of mathematical clarity physical theories require experimental proof of validity within well-defined boundaries of accuracy. Some objects in Cosmos, say black holes cannot be directly experimented with. However, indirect astronomical evidence of their existence and properties must be available and there is one. This is how we know that black holes exist, although their precise nature is still debated.

Astronomers and astrophysicists meticulously observe Cosmos testing the data and analyzing it against different cosmological models. Indeed, the opinions of leading theoretical physicists and

cosmologists, as regards the origin and evolution of Cosmos, remain mere beliefs, unless predictive and verified astronomically by observations of ever increasing accuracy. Still, certain popular and widely acclaimed contemporary theories are lacking both the predictability and falsifiability. It seems impossible to verify them since they furnish no results that can be tested by observations and at the same time they cannot be refuted by a logical argument or experiment. Such are for instance the extremely fashionable string and brane theories that are not falsifiable for the last half a century and not likely will be in the future. As was noted by one of their former protagonist they are "not even wrong".

The leading Λ CDM (Lambda cold dark matter) cosmological model, called standard is much more successful. The Λ CDM model is based on the firm ground of Einstein gravitation equations-EGE- of general relativity and subsequent Friedman equations of homogeneous isotropic-HI-Universe. Nevertheless, the Λ CDM model is still empirical since it uses the constants and parameters furnished by astronomical observations, e.g., the values of Hubble constant H , the Einstein cosmological constant $\Lambda = const$ usually interpreted as dark energy, dark matter density that is the major component of matter in galaxies, clusters of galaxies and all other large lumps of matter in Cosmos, etc. With these empirical values of parameters inferred from astronomical observations the Λ CDM model is in many aspects compatible with many contemporary astronomical observations of large scale structure of Cosmos.

In many fundamental aspects Λ CDM remains unsatisfactory since it is empirical and although not contradicting most of observations does not explain many observations, e.g., the intermittent distribution of visible and dark matter in Cosmos the way it is observed. It cannot and does not pretend to explain why the values of empirical parameters it uses are such as they are. Also, the model does not try to explain what *dark energy* and *dark matter*, the biggest "mysteries of science" as it is fashionable to call them in popular media, are. The *dark energy* medium, as a rule is identified with the Einstein cosmological constant introduced, although later repudiated, by Einstein as an additional term in his gravitation equations compatible with the principles of general relativity. Since no one knows what the Einstein cosmological constant is this identification does not help much¹¹. As enigmatic is *dark matter*, the dominant component of the total matter of galaxies, clusters of galaxies and other huge lumps of matter in Cosmos.

What is this invisible media, the two types of matter that do not interact with electromagnetic waves, the visible light in particular, except by gravitation? It is a poignant question demanding answers. Indeed, it has been well established since the discovery of dark energy in 1998 and recently affirmed confidently by precise astronomical observations of the Planck telescope mission that the combined contribution of dark energy and dark matter is ~95.1% of the total matter in observable Cosmos. At the same time all visible matter, stars, galaxies, quasars, radio galaxies and X-ray sources, inter-galactic gas, planets, comets, everything that can be detected by interaction with or emission of electromagnetic waves, everything that we can see in the sky is a mere ~4.9 % contribution into the total matter of observable Cosmos.

There are other legitimate questions that can be addressed to modern physics and cosmology, although these questions are rarely raised and even considered heretical by some. For instance why the masses of electrons and protons, the two main constituent building blocks of matter are such as they are well known experimentally and why do they exist at all? The almost automatic answer of a physicist would be, at least in my case that they exist and have their masses and other properties as they do so that the familiar atoms can exist. And atoms exist so that the molecules made of atoms exist and the molecules exist so that all visible matter exist, inanimate and animate as well. But why mater, whether inanimate or live should exist at all? Is the existence of matter imposed by any fundamental law of science? Is the existence of electrons, protons, neutrons, atoms, molecules and matter made of molecules imposed by fundamental laws of science, say as solutions of fundamental equations of physics, the queen of natural sciences believed by many physicists to be able to explain all other sciences? Or does physics impose the existence of protons and neutrons and mesons

¹¹ Roger Penrose believes that the cosmological constant value is a given fundamental property of Cosmos, say as gravitational constant. This work in part supports his view, although the nature and specific value of the cosmological constant is shown to be intimately connected with the quantum mechanical structure of Cosmos.

consisting of quarks that cannot be directly observed. And as regards the quarks why do they have to be? Just in order that protons and neutrons and atoms and molecules and matter, inanimate and live exist?

One of the greatest physicists of the second half of 20th century Richard Phillip Feynman, the creator of fundamental quantum electrodynamics, the preeminent among all other field theories, in his famous lectures on physics for laymen made the following comment:

"We have just seen that the complexities of things can so easily and dramatically escape the simplicity of the equations which describe them. The next great era of awakening of human intellect may well produce a method of understanding the qualitative content of equations. Today we cannot see that the water flow equations contain such things as the barber pole structure of turbulence that one sees between rotating cylinders. Today we cannot see whether Schrödinger equation contains frogs, musical composers, or morality".

If Feynman was still with us he would be pleased to know that the barber pole structures and the uncountable diversity of other coherent entities/structures are in fact the exact solutions of the water flow equations flows known as the Navier-Stokes equations, the NSE (E. Levich, 2009). This uncountable complexity of coherence is the gist of turbulence phenomenon. However, there are indeed no frogs, composers and scientists in the Schrödinger equation or any other fundamental Hamiltonian equation of physics.

There are only two fundamental equations imposing order and coherent structures. These are the NSE, the equations describing the flows of fluids, like water, gas and all other so-called Newtonian fluids and the EGE-Einstein gravitation equations. The NSE and EGE are very different. The NSE are not Hamiltonian, *time irreversible* equations that explicitly take into consideration the friction forces intrinsic to any motion, including the motion of fluids. The truly staggering complexity of order in turbulent motion of fluids is all due to the friction forces (E. Levich, 2009). The EGE are different in a more subtle way. This is explained in detail in the cited above work (E. Levich, 2014).

It can be confidently asserted that none of the existing laws of Hamiltonian physics imposes the existence of even a single coherent entity mentioned above. None of these coherent entities is a solution of the time reversible equations of physics. Therefore a natural question is why the time reversible Hamiltonian equations of physics are fundamental if they are obviously lacking the coherent solutions that when combined make up our Cosmos?

It is true that the laws of physics and chemistry are such that they allow the inanimate matter to exist and show that if say composite protons made of quarks and gluons held together by the mechanism of strong interactions and neutrons, formed from protons by a mechanism of electro-weak theory and held together with protons by the mechanism of nuclear forces and electrons, believed to be non-composite fundamental particles, all exist they can together form atomic nuclei and atoms with the properties determined by the laws of quantum mechanics, i.e., the Schrodinger equation. Similarly as per the Schrodinger equation atoms are capable to combine via residual electromagnetic mechanisms into molecules and molecules via other mechanisms, e.g., van der Waals electrostatic forces and assisted by the symmetry mechanisms combine into macroscopic matter However, none of the time reversible physical laws imposes the existence of the constituent bricks of matter or forces their amalgamation into hierarchically larger, more complex organized entities. And what do we know about live matter? We know that live matter consists of the same hierarchy starting from the quarks literally enslaved into protons and neutrons that are combined with electrons into atoms that are combined into molecules that are combined into cells that are combined into bodies of live creatures, from viruses to cockroaches to ants to fish to mammals, to humans. Live matter is constituted of the same bricks as inanimate matter, but live matter is infinitely more complex, infinitely more coherent and primarily based on carbon, oxygen, hydrogen molecules. Ostensibly because the carbon based molecules have a large number of bonds and together with oxygen and hydrogen molecules can form extremely large and superbly coherent conglomerates, coherent structures built somewhat like Lego is built, but in the myriads of modifications and configurations that eventually combine into live cells and further into giant amalgamation of cells that make truly divine in complexity of coherence multicellular bodies of live species.

Our bodies consist of ten trillion, 10^{13} cells. They are all in perfect order with each other and each of them in constant communication with each other. How such order is possible and what

imposes it to be? Why at all our cells hold together in this divine order? Our brain and brains of other advanced mammals are made of nearly 100 billion, 10^{11} neuron cells, as many as there are stars in large galaxies. These neurons are connected by about one quadrillion, 10^{15} so-called synapses that furnish, must furnish a constant flux of information exchange, communications between 10^{11} neurons that in their turn command and hold in coherence 10^{13} cells of the body. By comparison the complexity and the level of coherence of galaxies of stars, or anything else in Cosmos is a joke.¹²

Still this is a small task by comparison with the totality of coherent work done by the brain. The *brain cortex* is the neurons and synapses between them that are responsible for all cognitive activity. Animals must live, hunt, dominate weaker fauna and flora, eat it, breed and procreate descendants fit to survive by being increasingly coherent, or at least more coherent than the lower species upon which they dominate and use as food.

However, all the above pales when we consider the Man species. Man uses his/her cortex for creation of things. Man creates technology to live better, or so Man believes. But Man is self-conscious. Man recognizes himself as a part of Cosmos and recognizes the current of time, the past, present and future. Our mind reached into the past of Cosmos almost to the beginning of time. Man tries to predict the future. Man creates art, music and mathematics.

No one really knows what consciousness that distinguishes Man from all other life is. My personal view that comprehension of the time current concept, even although we do not really know scientifically what the time concept is and creation of art, the music especially, and abstract mathematics are among the unique traits of consciousness. However, unless there is a quantitative, mathematical comprehension of consciousness, rather than intuitive, science is blind to this phenomenon of Cosmos.

Science is blind as far as much simpler phenomena are concerned. Biochemists and chemists know large number of mechanisms that allow all this growth of coherent divinity of life to occur. But they have no clue as to why it occurs, what drives and imposes the growth of incomprehensible coherent complexity. Most dramatically science has no clue what life is. How it is that inanimate matter becomes animate. Although, humans have been thinking about what life is for thousands of years scientists are as ignorant about life as our ancestors. Even more perhaps, since the ancestors had a consolation of believing in divine origin of life. Scientists while rejecting the divine suggest nothing instead except genetic engineering that has nothing to do with what life is.

However this does not make biochemists and biologists less advanced than physicists and chemists since physicists and chemists have no clue what compels formation of ever growing coherent structures of trivial inanimate matter, when compared with animate, , from quarks all the way up to filaments composed of clusters of galaxies and quasars, the largest observed coherent structures in Cosmos.

Cosmos is full of well observed complex order and coherent organization. From the wall of superclusters of galaxies at the very edge of observable Cosmos all the way down the scale to galaxies, from galaxies to stars, from our solar system to planetary atmospheres, from the great red spot on Jupiter to general circulation of Earth's atmosphere and Gulfstream, to tropical hurricanes, tornadoes, clouds in the sky and the unique order of animate matter of biological life. The beehives, the ant hills, the packs of wolves and flocks of birds, the swarms of insects and schools of fish are all the amazingly complex coherent entities. And at last Man made coherent entities, human tribes, states and empires, the human civilizations run by the pieces of paper called money, everywhere on Earth and in far Cosmos we see complex order and organization arising, evolving, reaching the peak of potency and suddenly decomposing only for other organized entities even more coherent and potent to emerge on the ruins of the fallen. As ordered is the microworld of protons and other hadrons, electrons and other leptons, matter elements from the Mendeleev periodic table all of the above are

¹² The amazing complexity of live species and Man as a pinnacle of organization and coherence in Cosmos was explained to me many years ago by a distinguished space scientist and great visionary Carl Sagan. I met him at his modest home in Connecticut in 1976. I was sincerely puzzled by what he explained to me. It triggered my passion to the problems of kinetic coherence in complex systems and I owe the debt of gratitude to the late Carl Sagan for helping my comprehension of the divine order of intelligence in Cosmos.

coherent entities arising from more elemental building units and growing in complexity with the growth of united coherent components.

Whatever is the complexity of coherent entities it is impossible not to see the oneness of complex organized entities consisting of inanimate atoms and molecules, atoms and molecules consisting of protons and electrons, manmade states consisting of human units instead of atoms and the animate matter, our bodies consisting of the live cells clinging to each other for unfathomable reason .

The oneness is obvious in three aspects. The first aspect is the cycle of life; organized entities having each its own lifespan. The second aspect of oneness is in coherence of elementary units of which the entities are made of. As long as quarks are in coherent interaction with each other protons stay stable unless broken in colliders. Even when broken rather than being free the quarks immediately unite again. Quarks are ultimately coherent and are never free. If there is tight coherence between molecules in inanimate matter the latter stays stable. Such are crystals where the molecular coherence is very high due to symmetry. The more humans in the manmade entities, states, tribes, societies and Empires are united by a coherent common purpose the longer these entities survive. The tighter is the biological coherence of a racial group the more stable and enduring it is, unless destroyed by a biologically more biologically coherent group. As long as the cells of fauna and flora or human bodies cling tightly to each other the body lives, although the molecules in the cells are in the flux and correlate with each other only weakly. As soon as the coherence of purpose between the units starts weakening the entities are waning and irreversibly on the road of no return to decomposition of chaos.

The third imperative aspect of oneness is that the organized entities are never static, but kinetic and transient. They are kinetic to start with by receiving order from external sources of order. There is no such thing as self-organization from chaos; there is always an external source giving away its own order and by sacrificing its own order imposing order, or coherence that is the same between the composite units of the entity. In their turn the kinetic coherent entities must dispose chaos that any nonequilibrium, kinetic entity inevitably accumulates with time. Kinetic coherent systems are transient by their very definition. A kinetic coherent entity exist as such as long as it receives coherent energy from an external source, has properly working mechanisms to digest it, has proper mechanisms to metamorphose this energy into the chaotic one, has properly working mechanisms to dispose this metamorphosed chaotic energy out while order from the received coherent energy remains and maintains the entities coherence. These continuous in time transfigurations are the essence of kinetic coherence. As soon as one of the mechanisms of transfiguration of order into chaos and chaos disposal is in trouble the coherent entity is sick and dies if the mechanism is not cured. As soon the source of coherent energy, the source of order is weakening the entity is waning, ageing and dying.

There are many inanimate coherent entities that are so stable that they are often thought of as static and eternal. They are not really static. It is just that their metabolism is very slow and their aging is subsequently slow. Nevertheless they all have the finite lifespan, although for instance the lifespan of protons and electrons is equal to the lifespan of visible Cosmos. However, since visible Cosmos has a well-defined finite lifespan the protons and electrons will also die. They die together, since visible Cosmos has sense only if there is visible matter in it and someone to observe it.

All kinetic coherent entities in Cosmos are aging by accumulation of chaos. The lifespan depends on the ability to absorb order from the external sources willing to donate their own order, digest order by converting it into chaos and dispose chaos outside. As long as the external source donates order and the mechanisms of order absorption, digestion and chaos disposal are functioning properly the entity lives, inanimate or animate alike. This kinetic chain of transfigurations from order to chaos rules the existence and evolution of visible Cosmos. The whole visible Cosmos is a kinetic coherent entity.

I would like to explain in a simplest possible manner what the *second law* is and how the *kinetic second law* is different from the thermodynamical *second law*. In our everyday life we experience these two laws routinely and even don't notice them as they manifest in a manner obvious for us. We should remember several words; order, or coherence on one hand and chaos on the other. Order, or more scientifically coherence is the opposite of chaos. Chaos is something that was defined

quantitatively by the great physicists and chemists who created the sciences of thermodynamics and statistical mechanics in the second half of 19th century, James Clerk Maxwell, Ludwig Eduard Boltzmann, Josiah Willard Gibbs, Nicolas Léonard Sadi Carnot, Rudolf Clausius, Lord Kelvin and their followers. I remind these great names again with their first names on purpose. If not for these scientists, their great predecessors, contemporaries and followers the modern technological Judeo-Christian civilization would have not existed.

Let us begin. Assume that an elderly man/woman, a person sick and weak lives in a room that is mostly isolated from outside world. The person spends most of the time in bed and fully dependent on a nurse who comes every week to tidy up the room. While the person is alone he/she makes mess in the room and the lavatory, all objects, glasses, plates, dress are scattered around, the bed is mess and soiled, food gets rotten in the corner, rots in the etc. If we peer into the room we would be shocked with chaos. Then the nurse comes and in 6 hours all items are nicely placed *Vis a Vis* each other, the bed cloth is cleaned, starched and ironed with no messy soiled wrinkles, garbage is taken out, the person is washed and brushed and looks lush, rotten food is disposed and everything in the room is harmonious. The person is happy. If you peer into the room you would exclaim: what a wonderful order in the room, someone was here and did a good job of disposing chaos and bringing coherence, order into the room. It is trivial what I just described, but let us proceed. The nurse gets sick and does not come. The room is closed from the outside room. The person is alone and goes on making mess in the room. Each next day the chaos grows and of all order gradually nothing is left. Eventually the poor person dies, decomposes into gases and molecules. The inorganic items in the room will also decompose eventually, but much later. When at last this happens the room will be filled with a variety of molecules. If we wait for even much longer the molecules will also decompose into the constituent elements. This will be the state of thermodynamical equilibrium, the state of maximal possible chaos. This is the manifestation of the regular thermodynamical *second law*. In a closed system such that is not influenced by anything outside of the system chaos can only grow, or remain constant but cannot get less. The room that we described is a closed system. The main consequence of the *second law* is that order cannot grow in a closed system. Subsequently if it happens that an observer notices that order is growing in a closed system it means that this system is not closed. If the person in the room wakes up and sees that suddenly the items in the room are placed differently and more esthetically the person would be sure that the nurse convalesced, entered the room and made it up. The room is not a closed system any more. This is exactly what we see in Cosmos via its accelerating expansion and global flatness.

If the nurse comes and makes up the room she has two tasks. The first task is the chaos disposal and the second task she rearranging items in the room in an orderly, esthetic fashion. But the second task cannot be implemented unless the first one is also implemented. To arrange coherence in the room chaos should be disposed. To maintain coherence, or order in the room it is necessary to get rid of chaos continuously. But where this chaos in the room comes from? Chaos is inevitable since the person is sick. All the person is doing is disposing the chaos of his/her sickness out to stay alive, coherent. But even if the person is healthy he/she must eat to remain coherent.

Meat and vegetables are highly coherent nourishment. The healthy person eats and receives coherent energy from this food. Then the person regurgitates the coherent food and excretes much more chaotic substances. But although chaotic the substances have exactly the same energy amount. If the energy balance is skewed the person would start getting obese, or on the contrary too skinny. But order remains in the body and this is why the bodies of biological species are whole with all cells holding together. The healthy person, say a sportsmen exert efforts and spend order and while exerting efforts must also get rid of chaos, e.g., via sweating to remain coherent for as long as possible till the finish.

Therefore the nurse in the room is the source of order, or the source of negative entropy that allows the person in the room to exist. She gives away her order and exudes chaos to remain coherent. Her order transforms into order in the room that helps maintaining coherence of the sick person, etc. This positively affects the mechanisms of the sick person and he/she uses these improved mechanisms to exude the chaos of sickness and so forth. In the same manner food is the source of negative entropy for all animate matter, from viruses to humans. In the same manner the coherent part of solar radiation is the source of negative entropy and positive order to Earth. All order on Earth is caused by the

coherent energy flux of solar radiation and disposal of the same amount of chaotic energy into outer space. This remarkable, yet another divine phenomenon first qualitatively understood by Erwin Schrödinger and further by Roger Penrose. Quantitatively the cascade of order from the solar radiation to life itself is considered in many details in (E. Levich, 2014).

What I described above is the *kinetic second law*, or the *reverse second law-RSL* that imposes order in open systems by kinetic mechanism. In each and every phenomenon in Cosmos, transpiring in inanimate and animate matter and in geometry of 4D space/time itself that shows growing order, or maintains order it is done by extracting it from the coherent flux of momentum/energy furnished by an external source, regurgitating this momentum/energy and disposing the same amount of chaotic momentum/energy. There is no spontaneous birth of order from chaos as some believe as there is no pregnancy without fertilization of vulated egg by the sperm.

The issue that I have not covered is the "mysterious" dark matter that contributes over 90% of all matter in large lumps of matter, e.g., galaxies, clusters of galaxies, filaments, etc., and are 26.3% mass contribution globally in Cosmos. There is no mystery in dark matter. Dark matter is the chaotic matter/energy exuded by visible coherent matter so that visible matter remains coherent. The total contribution of dark matter, as well as visible matter is calculated by KTOC in remarkable agreement with astronomical data from the Planck telescope mission published in 2013-2014. It can be seen from the Table of results below.

What is the quantum composition of dark matter it is a different issue and I assert that dark matter consists of bosons; probably the Higgs bosons. The problem is that I believe that these bosons are very hard to observe directly for the same reason as gluons are not be directly observed. The KTOC calculates what is tentatively believed as the mass associated with these bosons in uncanny agreement with the recent preliminary Higgs boson detection. But I believe that the KTOC results are even more preliminary than the detection itself at this stage. This is an open issue that will be decided by the future experiments. Indeed, it seems as if the kinetic second law, or the reverse second law-RSL is behind all non-equilibrium, kinetic phenomena and coherent entities in our Cosmos. At least I have not found a counter example and I do not find it surprising. Nevertheless, I welcome and challenge readers to find one.

In real Cosmos all physical phenomena must account for the effect of friction and dissipative losses due to friction. This had been understood clearly by Leonardo Da Vinci even prior to Newton's theory of friction. Let us consider fluids as an important case study because the all-important phenomenon of turbulence is the phenomenon in fluids. Phenomenon of turbulence is extremely well suited for understanding the imperative importance of the kinetic second law & RSL. Friction in fluids is accounted for by the so-called kinematic viscosity parameter ν , a number having the dimension cm^2/sec . Water viscosity is about $0.1cm^2/sec$ and for air it is quite smaller, but for honey it is much larger. This is obvious. Viscosity is created by molecules of which all matter including fluids consist of. In fluids molecules move randomly, free from each with different velocities for different temperatures unless they collide with each other.

When molecules collide they exchange momentum and energy and some of it is lost to heat. This is friction and a loss due to friction. Mathematically it is described by the kinematic viscosity of fluids parameter ν . There is no general theoretical way to calculate viscosity parameter, except for the most trivial case of ideal gases. Quantitatively viscosity is a very complicated parameter that is almost always an empirical number subject to precise experiments. Since friction forces and energy loss due to molecular viscosity are imperative for machinery and hardware the determination of viscosity is a wonderfully advanced experimental skill.

When a solid body moves through fluid media, or fluids flow around a solid body, say an airfoil, the molecular interaction with the solid surface is so tremendous that the fluid velocity is exactly zero at the surface. The molecules of fluids, air or water alike simply cannot disattach from the solid surface. This naturally decelerates the adjacent layers of fluids and causes the momentum/energy flow from fluids to the surface. Hence, naturally, the friction experienced by the solid body, say airfoil is fundamentally important. To be specific we will discuss an airfoil, like an aircraft flying through the air. The airfoil is driven by the engine that burns petrol and creates the propelling momentum of the airfoil. In conjunction with the equations of motion of the airfoil through the air, called the Navier-Stokes equations the source of momentum/energy, the burning petrol generates coherent motion of the

airfoil through the air. In other words the airfoil engine is the source of coherent momentum/energy manifested by orderly, coherent flight of the airfoil. This can be reformulated as a flux of coherent momentum/energy from the engine furnishes the airfoil coherent flight through the air. But by definition of Newtonian mechanics the momentum/energy flux is the force acting on the airfoil. The force must create acceleration by the second law of Newton. But we know that most of the time the aircrafts fly with constant velocity and no acceleration, although the engine works continuously and the momentum/energy flux acts on the airfoil uninterruptedly. The reason why the airfoil does not accelerate is the force/or momentum/energy flux of the same value but in the opposite direction to the flight direction. This is the friction force due to air viscosity. As much momentum/energy is spent by the airfoil engine to propel the airfoil that much is lost to heat resulting from the air viscosity and subsequent friction. This is just the momentum/energy conservation law that must be complied with since the airfoil flies with constant velocity. But if to think about it a bit more deeply the question can be asked. Indeed, where is the order, the coherence of the airfoil flight comes from? Why the airfoil does not wander about randomly, say by the action of air masses that do move randomly around the airfoil? The answer a pilot would give is that the coherence of the flight is maintained by the special devices that use different mechanisms to allow the airfoil to stay the course. This is all true, but there is a deeper reason for the airfoil flight coherence.

Indeed, the momentum/energy flux furnished by the engine is coherent. It is enough to watch the ejection of gases from the reaction engines giving coherent propulsion to the plane. The direction of this propulsion can be regulated by the devices mentioned above. But propulsion is always coherent. On the other hand the momentum/energy lost to friction is heat. Heat is chaotic. The momentum/energy lost to heat is the chaotic momentum/energy. In other words while the momentum/energy flux furnished to the airfoil is coherent the momentum/energy lost due to friction is chaotic. While the airfoil stays the course with no acceleration the very ability to stay the course is due to order extracted by the airfoil from the burned petrol. Therefore the very ability of any airfoil or a bird in the air, but also the submarines and fish to fly and swim coherently in fluid media is due to the fact that the propulsion momentum/energy generated by fuel or muscles is coherent while the momentum/energy lost to friction is chaotic. The difference in positive order or negative chaos is the source of very ability of flying and swimming bodies to fly and swim coherently. This is true provided that the mechanisms transforming coherent momentum/energy flux from a source of order into the chaotic one that can be disposed of. Fuel or muscle exertion is the source of negative entropy for the flying and swimming objects. A remarkable conclusion that can be deduced is that if not for viscosity the aeronautics and swimming would have not existed. Fish would not swim and birds would not fly. This is again the kinetic second law & RSL that makes possible aeronautics and swimming. The NSE mentioned above as imposing the uncountable complexity of order and coherent structures in turbulent fluids (E. Levich, 2009) are not Hamiltonian and in rigorous compliance with the *second law* and *RSL*

There is a special case of ideal fluids that are ideal having zero viscosity $\nu = 0$. The ideal fluids are known for the phenomenon of superfluidity and similar phenomenon of superconductivity in various materials at low temperatures. Both phenomena are purely quantum mechanical. Such fluids move with no friction and in superconductors the electric current moves through metals, or ceramics with no friction and hence there is no Ohm resistance and power loss to heat. But this is not the exact statement since in reality even superfluid liquids and best possible superconductors have some tiny losses of energy to heat. Hence a special kind of turbulence exists in superfluids. Again there is a source of negative entropy, the quantum fluctuations in this case and associated disposal of chaos. The second law and RSL are indeed the universal laws of Cosmos, as was anticipated by Arthur Eddington.

There is a greatly important, subtle property of the NSE. The motion of a media, rather a mathematical abstraction of ideal fluids with $\nu \equiv 0$ is described by the famous Euler equations. These are Hamiltonian, time reversible equations of such complexity that despite hundreds of years of efforts mathematicians do not know if they have regular, smooth solutions globally, everywhere in space/time, although likely not. Nevertheless, they have been used effectively in civil engineering for centuries with most useful results. The Euler equations are just the Newton equations modified from point like masses and objects to continuous media of fluids. This passing over to continuous media

makes them so complicated. However, as I mentioned above the most important phenomenon of turbulence in fluids is not possible in ideal fluids. Turbulence is one of the most typical phenomena in Cosmos and on Earth. With few exceptions, e.g., some capillary biological flows, the fluid flows are almost always turbulent. For us turbulence is semantically associated with erratic, chaotic motion and state of affairs in general, e.g., in life. This is totally wrong. Coherence and order of uncountable complexity and diversity is the gist of turbulence. The associated chaos is disposal necessary for the coherence to survive. It is important to reiterate over and over again that complex order itself generates chaos as a protective shield against destruction. Turbulence intrinsic order generates chaos of wondrous beauty. Similarly the coherent visible matter "string" generates dark matter and coherent quarks in protons and neutrons generate the chaos of gluons, but also dark matter. All natural atmospheric phenomena on Earth and other planets are extremely turbulent, not to say about stars, solar wind, galactic gas, etc. If turbulence in fluids would not exist the very life of Man on Earth would have not been possible. It is once again the truly divine turbulent coherence of atmosphere and oceans that creates and maintains conditions such that the carbon based life is possible. As always the prime source of order is the coherent flux of solar radiation that in the first stage of transfiguration transforms into the order of turbulent atmosphere and ocean currents, e.g., Gulfstream (E. Levich, 2009 and E. Levich, E. Tzvetkov, 1987) and into photosynthesis by plankton and by green forests¹³.

But why in ideal fluids turbulence is not possible? The ideal fluids are subject to the Hamiltonian Euler equations that do not respect the second law and RSL. By their nature the Euler equations cannot impose coherent complexity and hence turbulence cannot exist in ideal fluids.

If there would be no turbulence phenomenon in fluids the life on Earth would not exist, stars would not exist, the whole Cosmos as we see it would have not existed. It is that bad and what it tells us that we need viscosity and friction in the equations of physics to be able to understand order of Cosmos. But why turbulence in fluids exists only if viscosity and friction are taken into account? The reason is marvelous and surpasses the properties of turbulence and fluids per se. This reason is in that the Hamiltonian Euler equations and the time irreversible NSE belong to different mathematical classes. The empirical viscous term in the NSE with the viscosity parameter $\nu \neq 0$ is the higher space derivative of fluid velocity. Even if $\nu \rightarrow 0$ there always be such small scales of motion that the viscous term would be as big as the Hamiltonian nonlinear interaction term the same in NSE and Euler equations. It is not the same as in ideal fluids with $\nu \equiv 0$ and hence exactly zero viscous term. In the former case the friction dissipation of chaotic energy is always equal to the injected coherent energy for a steady flow, while in latter case there is no friction loss of energy at all. The injected coherent energy of the source is not disposed by the ideal fluid. There is no transformation of order into chaos in ideal fluids. In mathematics we say that there is no analytical transition from the NSE equations to the Hamiltonian Euler equations. The NSE respect the *kinetic second law & RSL* while the Euler equations do not. The conclusion is that there is no analytical transition from ideal fluid to viscous fluid even if the viscosity parameter $\nu \rightarrow 0$. Subsequent to this the uncountable diversity of coherent structures in turbulent flows of viscous fluids does not exist in ideal fluids.

The conclusion is general. As small as friction losses may be there is no analytical transition from Hamiltonian equations of physics paying no respect to the kinetic second law & RSL to the non-Hamiltonian ones respecting the *kinetic second law & RSL*. It applies to all Hamiltonian equations of physics, classical and quantum, except the Einstein gravitation equations-the EGE. The EGE are formally Hamiltonian of course. However, there is a problem. This problem is that the EGE are not valid in the total 4D space/time but necessarily have black hole-BH-singularity. This was shown in the classical work (Penrose, R., 1964). In difference to the event horizon the BH singularity is incurable in the framework of classical EGE is not curable. It is shown in KTOC that the BH singularities is the cause of a tiny quantum mechanical viscosity of 4D space/time. This viscosity as small as it is imperative for the compliance with the kinetic second law & RSL. The coherent momentum/energy flux furnishing order to our Cosmos is metamorphosed, simply regurgitated and disposed as chaos back into the DEC. Since the DEC is timeless ultimate order continuum it does not

¹³ Plankton plays a very special role in the order cascade, since its mass in oceans is huge and a sizeable part of coherent energy is absorbed by plankton and regurgitated by photosynthesis into oxygen (Yu. Magarshak, private communication).

distinguish between order and chaos and the disposed chaos of our Cosmos is metamorphosed back into the timeless order of the DEC.

The conclusions of KTOC narrated above will be now discussed below more philosophicallyⁱ.

Keywords: Genesis, Visible Cosmos, Kosmos, Universe, Second law and reverse second law, Dark energy, Dark matter, Light, Order and coherence, Entropy and mathematical entropy, Acceleration of Hubble expansion, Bose-Einstein Condensation of photons, Dark energy and brain cortex

DISCUSSION

בְּרֵאשִׁית

*At the beginning of Elokim's creation of heaven and earth
The earth being Tohu and Bohu, darkness over the depths,
A wind of Elokim hovering above the surface of the waters,
Elokim said, "It will be light!" and it was light.
Elokim observed this light and saw it as good,
So Elokim distinguished between the light and the dark.ⁱⁱ*

For Epigraph I chose the first verse of Genesis in faithful translation from the Old Hebrew Testament. This work is about science, not theology. In the end of the Discussion there is a *Table of quantitative results* obtained in the framework of a theory that I call KTOC, the Kinetic Theory of Order in Cosmos. The mathematical KTOC derivations are carried out in the main text of this work, or follow from these derivations in a straightforward manner. Readers are invited to study them and contribute their proven science comments. Also one finds in the *Table* the comparison of each KTOC result with the corresponding classical experimental result and/or newest available astronomical data of European Planck telescope mission made public in 2013-2014 and other latest astronomical data when appropriate.

"Cosmos, is the ancient Greek word κόσμος, means order. "It is the opposite of chaos. It implies the deep interconnectedness of all things. It conveys awe for the intricate and subtle way in which the Universe is put together." I quoted here in part from the grand bestseller book "Cosmos" by a great American space scientist and visionary Carl Sagan. This remarkable, truly iconic popular book was televised by PBS (US Public TV) and has been watched by over 1 billion people all over the world. The new updated version of the original film "Cosmos, a personal journey" has been recently recast under the hand of executive producer Ann Durant, the widow and formerly co-writer of Carl Sagan. The refreshed recast was premiered on Fox TV in March 2014. The book "Cosmos" and its televised version is a grandiose saga of Universe, the saga of astronomy and cosmology that brought the eternal mystery of Cosmos and our existence in Cosmos to millions upon millions¹⁴.

Although the work is scientific and refers to proven experimental, astronomical and experimental facts in conjunction with firmly falsified and verified classical and quantum physics, the choice of Epigraph is not accidental. Many distinguished astrophysicists and cosmologists puzzled over this verse of Genesis that clearly associates with the vision of Big Bang birth of Cosmos. Among them I can list Yakov B. Zeldovich whose profound contributions to our knowledge and understanding of Universe are cast in stone called "relativistic astrophysics". It is from Zeldovich I first had learned about this verse despite his lifelong professed atheism. The Nobel laureate Stephen Weinberg, one of the creators of fundamental theory of electroweak interactions, a phenomena among those basic ones

¹⁴ I mentioned previously that many years ago in 1976 I was fortunate to visit Carl Sagan at his home in Ithaca. I spent several hours talking to him. He impressed me as a person of enormous intellectual power and vision. It was the time of intense discussion on the future of far space exploration and the argument was between the unmanned space vehicles and the manned ones. Sagan was famous for his views that unmanned space flights are the future and efforts and spending should be focused on unmanned flights. He argued that the modern combustion engines are intrinsically not suitable for manned space exploration and new breakthroughs in science are necessary to make them feasible. This prediction seems obvious these days but 40 years ago it was not evident.

that allow all matter and us to exist in Cosmos and speculate about the meaning of life mentions this verse in his popular book the "The first three minutes". I see no reason not to humbly join their ranks. I am sure that many other cosmologists share similar attitude to the verse while not daring to admit it in the unforgiving mainstream science community. However, what attracts my particular attention in the verse is not the light of alleged Big Bang but the act of distinguishing, separation between the light and the dark. There is a good reason for this.

The Nobel Prize in physics In 2011 was divided with one half awarded to Saul Perlmutter at Lawrence Berkeley National Laboratory, CA and the other jointly to Brian Schmidt and Adam Riess in Australia. The two groups were rewarded for the simultaneous publications in 1998 of an independently made discovery that our visible Cosmos expands with acceleration. What causes the accelerating expansion of Observable Cosmos is believed to be a "mysterious" matter called dark energy.

This matter is called dark energy because it is invisible. Dark energy is entirely distinguished from light and does not interact with light at all. It seems as if dark energy is totally alien to visible matter in Cosmos and hence supposed mysterious. On the top of things dark energy acts as if is gravitationally repulsive matter and this repulsion accelerates Observable Cosmos expansion. Most recent and precise observations of the repulsive gravitational phenomenon by the European Planck telescope mission established with high accuracy that dark energy contributes 68.6% of all matter in Cosmos.

In 1929 Edwin Hubble, an American astronomer discovered that galaxies recede from each other with the speed proportional to the distance between them. Since then the Hubble expansion has been the corner stone of cosmological models known to scientists and laymen fans of astronomy. The Hubble expansion is not just the receding of galaxies from each. It is the space of visible Cosmos is expanding. The Hubble space expansion is among the very few most precious astronomical discoveries ever made.

The possibility and likelihood of Hubble expansion had been theoretically predicted prior to the Hubble astronomical observations. The prediction had been made in 1922 by Alexander Friedman, a Russian mathematician who derived what has been known since the Friedman cosmological equations directly from the Einstein gravitation equations of general relativity. Friedman fathered the very expression the "expanding Universe" and mentioned the possibility that Universe started from a point. Furthermore Friedman introduced the model of homogeneous, isotropic Cosmos-HI model of Cosmos. A few years later in 1927 the possibility of non- static, expanding Universe was again independently predicted by a Belgian priest and physicist Georges Lemaitre as a direct consequence of the Einstein gravitation equations.

Einstein adamantly favored the static model of Cosmo. He resisted the idea of expanding Cosmos to such an extent that advised the then most prominent physical journal "*Zeitschrift für Physik*" to reject the Friedman's paper and actually delayed its eventual publication by half a year. Unrepentant Einstein verbally attacked Lemaitre in 1927 during a science conference. Einstein accepted the fact of expanding Cosmos only in 1929 when the fact of expansion was unambiguously observed by Hubble.

I would like to mention that the HI model of Cosmos, Friedman cosmological equations in conjunction with what is usually called Friedman, Lemaitre, Roberts and Walker 4D space/time metric-FLRW-have been the mainstay of cosmological studies since that date. The HI model of Cosmos has been supported by most astronomical data collected for the last 90 years¹⁵.

The Hubble observations had been anticipated, although neither Hubble was aware of it, nor Friedman nor others anticipated the reality of Hubble observations of 1929. To the best of my knowledge no one in the history of cosmology had anticipated or predicted prior to the discovery in 1998 that Cosmos space is expanding with acceleration.

Why it is so spectacular that the space of our Cosmos not only is expanding, hence strongly indicating that Cosmos has a finite age from the birth from a singularity, an awesome conclusion by itself, but expanding with acceleration? The acceleration of expansion is doubly awesome because it means that order in Cosmos, more correctly in a part of causally connected Observable Cosmos is growing with time. The growing global order means that the global chaos and uncertainty of Observable Cosmos is diminishing with time. This seems impossible because our Cosmos is a closed system. The *second law of thermodynamics-the second law*, the highest of all known laws of science axiomatically and incontrovertibly states that order in an entirely and ultimately closed system such that is not influenced by anything from outside, a system like the whole Cosmos with no outside, cannot grow. Does acceleration of Hubble expansion mean that the *second law* is wrong? To answer this question let us consider with care why the acceleration of Cosmos expansion implies that its global order is growing with time.

Let us note that at the first glance it may seem that since the observable part of Cosmos is not the whole Cosmos and there may be something lurking beyond the observable cosmological horizon, the beyond where we cannot and will never be able to observe since this beyond is not causally connected with the observable part of Cosmos. The probability that something is different beyond the observable part of Cosmos is so outlandishly low that it is better to forget about it. This would be not science and not the science fiction, but fantasy to refer to something that cannot be ever observed. Cosmos is not different from Observable Cosmos if we observe it on very large scales and there is no central focus in Cosmos. In other words we should be concerned with the causally connected Observable Cosmos and confidently assume that the rest of it is globally the same, whether Cosmos is finite which does not seem likely or infinite in extent which seems more likely, but making no difference since it cannot be observed.

If the above is the case and Cosmos is a closed system it follows from causality that Observable Cosmos is also a closed system. There is nothing that can influence Observable Cosmos from outside. For all purposes there is no such thing as outside of Observable Cosmos. That Observable Cosmos expands does not influence the fact. Simply Observable Cosmos becomes larger all the time and we can, in principle, observe new heavenly structures that enter within the casually connected Cosmos. If there are astronomers beyond our Observable Cosmos they will see their Observable Cosmos not causally connected to ours, but on large scale they will see Cosmos in rough brushes identical to ours. And if in micro details they will see different galaxies and clusters and filaments of clusters we should not care less because will never communicate with them.

¹⁵ The recent observations by the Planck mission telescope indicate certain anisotropy of CMB-cosmic microwave background- radiation spectrum that is compatible with the previous observations WMAP data of NASA. CMB spectrum is the relic radiation that is the closest that remains of the Big Bang event. It is not really the Big Bang radiation since Cosmos was opaque to electromagnetic radiation during the stage when matter was in plasma state. Therefore the CMB spectrum astronomers see was emitted when Cosmos was about almost 300.000 years old. Nevertheless it holds imprints of much earlier childhood of Cosmos. The deviations of CMB spectrum from the exact equilibrium and isotropic Planck spectrum furnish fundamental information on the very early childhood of Cosmos. There are a few processes in the course of evolution of CMB spectrum through the whole history of Cosmos that leave genuine, inevitable imprints on the CMB spectrum that can be separated from the measurements errors. In my view the most comprehensive analysis of these inevitable imprints was carried out in "Unavoidable CMB Spectral Features and Blackbody Photosphere of our Universe" by Rashid A. Sunyaev and Rishi Khatri (2013).

It is noted that the farther we look into space from Earth we see progressively older heavenly structures and hence closer to the birth of Cosmos. We look into past and see the light of heavenly structures that could reach us during the age of Cosmos. But since space is expanding we often see the light of the structures that passed by us in a very deep past, but since space is expanding these structures are now much farther from us. Due to the Hubble expansion we peer farther and farther into the past of Cosmos. It is at this point that we encounter the event horizon paradox. Indeed if the parts of Cosmos are not causally connected how can we be confident that they are globally the same and there is nothing lurking beyond our Observable Cosmos? There is only one manner in which this paradox can be resolved. It is to assume that when Cosmos was born and during its earliest childhood it was all one and casual. Later on the parts of Cosmos diverged from each other and developed into a single Cosmos species that may differ from each other locally but are identical globally when averaged over sufficiently large subdomains of space/time.¹⁶

It has been mentioned above that matter in Cosmos does not expand relative to space, but it is the 3D space of Cosmos does. This is in the sense that distance between any two points of space grows with time and the lumps of matter in this space passively follow. However, if the constituent parts of composite lumps are held together by gravitational attraction or any other attractive force, the size of the lump does not change as a result of space expansion. The Hubble expansion is not a force that would affect coherent matter lumps, like galaxies, or stars or our bodies made of cells that are held together for reasons no one cares to ask about.

Imagine a cloth on the dining table with bread crumbs on it. After having dinner we stretch the wrinkled cloth and the bread crumbs recede from each other not because they move relative to the cloth. On the contrary they stick to the cloth material and as the cloth expands the wrinkles on the cloth, except under the bread crumbs that are held by being attached to the crumbs, are smoothed and the crumbs recede from each other automatically. Is this what happens with the space expansion? The answer is no, it does not. The model is not authentic. In difference to the cloth stretched by exertion of some effort by a house wife/husband the space wrinkles are not smoothed by Hubble expansion. The Hubble expansion preserves them. They just get larger but faithfully preserving their shapes. It is the matter lumps that neither grow in size nor change their shape since they are constrained by internal forces. But relative to the growing space volume the total volume occupied by matter diminishes. The matter density falls down in inverse proportion to the observable space volume growing as a result of Hubble expansion Space is growing desolate as a result of Hubble expansion.

The Hubble space expansion is not what happens with the table cloth stretched by external force of house wife/husband. What the external force does is smothering the wrinkles on the cloth. The wrinkles resist, since any cloth material has some elasticity even if it is very small and besides it sticks to the table surface even if it is sleek. In any event some work should be done against the forces that prevent the smoothing of the cloth wrinkles. but the external force prevails and the cloth becomes smooth This is about what happens in expanding Observable Cosmos, except that the space is 3D, meaning it has three wrinkled cloth dimensions-x, y and z, while the normal table cloth is the wrinkled 2D plane-x, y-and instead of crumbs on the 2D cloth there are galaxies and larger structures in Observable Cosmos receding from each other in 3D space.

If Observable Cosmos is the ultimately closed system the global chaos cannot get less and the global order cannot grow. This claim is uncontestable and the reason for such infallibility is the *imperative second law of thermodynamics-the second law*.

The *second law* is well known since the 19th century. It had been understood and formulated by the great creators of the science of thermodynamics and statistical mechanics. All our technological civilization would have not existed if not for the first law and second law of statistical thermodynamics. The first law is the energy conservation law, or relativistically generalized conservation of momentum/energy. The *second law* states that a rigorously defined thermodynamical quantity called entropy empirically introduced in the laws of classical thermodynamics and furnished with profound meaning in statistical thermodynamics as a mathematical measure of chaos, or mathematically more generally in my view of uncertainty in an arbitrary, but rigorously closed system

¹⁶ This cosmological principle was implicitly contained in a ground breaking paper of Alexander Friedman published in 1922 after long arguments with Einstein.

that cannot diminish. The *second law* rigorously prohibits the growth of order in closed systems. The *second law* cannot be argued with and all laws of Cosmos must be subjects to exact compliance with the *second law*.

Furthermore the *second law* is so profound that it exists also in the mathematical information theory. It was introduced by a remarkable American applied mathematician and electrical engineer Claude Shannon¹⁷.

Coming back to gravitational force I note that repulsive gravitational force as much as the attractive one is just the familiar Newtonian interpretation. The precise Einstein interpretation is that the gravitational force and field, either attractive or repulsive are fictitious. Moreover, in contrast to fictitious attractive gravitational force that has certain meaning in Newtonian approximation the fictitious repulsive gravitational force does not have much sense in either the conventional Newton gravitation equations, or the classical Einstein gravitation equations of general relativity-the EGE of EGR in what follows. At the same time the fictitious attractive gravitational force is simply the Newtonian *approximation* of the EGE curvature of 4D space/time (3 for space dimensions and 1 dimension for time), the interpretation widely used in astronomy with sufficient accuracy.

It is remarkable that the modified EGE that include the positively defined Einstein cosmological constant term does describe the dynamical possibility of diminishing space curvature. Moreover the repulsive action caused by a positively defined Einstein cosmological constant term in the EGE is similar (had it been anticipated?) by Newton when he modified his gravitation equations by adding the force term proportional to distance between two masses; the extraordinary force added from considerations entirely different from those pursued by Einstein. In other words there is a fictitious repulsive gravitational force that can be viewed as the Newtonian interpretation of small Einstein cosmological constant. It is not less remarkable that the discovery of accelerating Cosmos expansion is compatible with a very small value of cosmological constant and subsequently to the fictitious repulsive gravitational force introduced by Newton. However, the seemingly very small cosmological constant is in fact the huge coherent flux of dark energy that is responsible for all material order in Cosmos and is most likely responsible for the phenomena of life and conscious life of Man on Earth. But the origin of Einstein cosmological constant or the repulsive gravitational force of Newton is in the quantum mechanical structure of Cosmos and hence the quantum mechanics and the laws of gravitation should go step in step in conjunction and only in such a way that the *second law* and kinetic RSL are explicitly respected. Unfortunately neither of the fundamental equations of physics complies with the *second law*. The fundamental equations of physics are Hamiltonian and time reversible and hence by definition do not respect the *second law*.

¹⁷ As much as the statistical thermodynamics played a crucial role in development of technological civilization that much the theory of Claude Shannon influenced the development of modern information technology.

This interpretation is convenient and obtained from the EGE of EGR theory in the limit of infinitesimally small curvature of 4D space/time. Such are typical for the objects with small intrinsic rest mass of matter.¹⁸ In this limit matter and 4D space/time geometry can be approximately disattached. If the two are disattached matter just resides in the zero curvature, flat geometry 4D Minkowsky space/time of Einstein special relativity theory-the ESR in what follows. It is noted that, although The Minkowsky space/time geometry is flat it does not mean that it is the Euclidean geometry. Indeed, the Minkowsky space/time geometry is not at all. For matter the 4D Minkowsky space/time is like a rented house that should not be damaged or changed, or influenced. Anything you do inside makes the Landlord mad, a very uncomfortable impossible really to reside in dwelling.

It is entirely different situation if matter builds the 4D space/time residence. In EGR the curved 4D Riemannian space/time geometry is created by matter. Matter builds the curved 4D space/time dwelling, while the dwelling reciprocally acts on matter. The reciprocal adjustments achieve balance with matter and 4D space/time in optimal fit-like a well-tailored suit and a gentleman who trimmed his waist to be in perfect fit with the elegant suit. In reality the genuine flat 4D Minkowsky space/time

¹⁸ The rest mass quantity was understood and introduced by Einstein as the intrinsic mass of matter independent of the motion speed. The rest mass is connected by the famous Einstein relation with the rest energy as follows: $E_{rest} = M_{rest} \cdot c^2$, where $c = 3 \cdot 10^{10} \text{ cm / sec}$ is the speed of light, the largest speed that can be achieved in Cosmos by material entities and only by such that have zero rest mass. Such are firmly confirmed to be photons of course; the quanta of visible of electromagnetic radiation of all frequencies and wavelengths and visible light in particular. Another particle neutrino belonging to a different class of elementary particles had been thought to be massless as well. However, it turned out to be wrong. Neutrinos had been predicted by Bruno Pontecorvo to have a very tiny mass and after his death the prediction was proved correct. The small neutrino rest mass resolved a serious contradiction as regards the amount of neutrinos emanating from Sun that once had been considered a serious problem by many astrophysicists.

The rest mass is invariant, i.e. the same constant in all inertial reference frames. Therefore the rest mass is a basic parameter defining matter, the elemental matter units and composite matter alike. In EGR the role of rest mass, or rest density is less central. Matter is most generally characterized by the momentum/energy, or stress/energy tensor. The latter is a 16 components symmetric matrix-not all independent- consisting of the 4 momentum/energy vector of ESR and its fluxes. These include the matter rest density and its pressure that are connected by the thermodynamical equation of state. Taking the divergence of momentum/energy tensor In the Minkowsky 4D space/time of ESR yields zero. This is the conservation of 4D momentum/energy and angular momentum, which is tantamount to the Hamiltonian relativistic equations of motion for all types of matter each having its own momentum/energy tensor.

With the EGE of EGR the situation is more complicated since matter forms the curved geometry of 4D space/time which we associate with fictitious gravitational force and as fictitious gravitational field. It should be mentioned that fictitious nature of gravitational force is obviously seen from the fact that locally at each point of the 4D Riemannian space/time the gravitational force can be made zero by a choice of non- inertial reference frame. One of the many beauties of EGR is in that although the momentum/energy tensor of matter is local the curvature of 4D space/time is global. Hence although locally the gravitational field can be made zero the space/time curvature is global. For instance a point like mass source creates complicated 4D global curvature of space/time having unlimited range-the remarkable Schwarzschild solution of EGE- however small the curvature may be far away from the point mass. In the Newtonian limit this is consistent with the long range character of gravitational attraction force. I note that the point mass means infinite density and energy density and hence the unphysical singularity. If a heavenly body, a star is over the mass of several solar mass or more than the EGE predict inevitable self-gravitational contraction into a point like singularity. Moreover, such singularities are intrinsic for the EGE suggesting that the EGE are not valid at certain very small scales. This fundamental for the EGE result was proved by Roger Penrose in 1964. The singularities described above are the famous black holes-BH.s.

The black holes- BH's and massive black holes_-MBH's necessarily present in the centers of all galaxies will have been debated for exactly one century in 2016 and is likely the focal point of Cosmogony. Karl Schwarzschild derived his forever famous exact solution of the EGE just after the publication of EGE by Einstein. Karl Schwarzschild discovered this amazing solution in the trenches of WW1 one year before his death. This tragic historical episode is a glorious banner to the greatness of human mind.

likely does not exist since it contradicts the *second law*. The assertion that Minkowsky 4D space/time gives way to de Sitter space/time geometry is not new, but I have not seen in literature a conjecture that the noncompliance with the *second law* is the reason for favoring de Sitter Cosmos. I will explain how it comes about shortly.

The space scalar curvature may be positive like the radius of a sphere, or negative for a hyperboloid. If the curvature is zero than the 4D space/time is flat and there is no gravitational force, like there would be no gravitational pull if Earth was precisely flat and subject to the Euclidean geometry. However, the flat space geometry does not mean that the geometry is Euclidean. Neither Minkowsky space/time geometry, nor the de Sitter one is Euclidean and this is what makes the Newtonian nonrelativistic Cosmos and cosmology and the Einstein relativistic Cosmos and cosmology entirely different. In Minkowsky space/time there is no gravitational field by definition, but in de Sitter there is a strange one caused by the Einstein cosmological constant.

Astronomical bodies create curvature of space and time, i.e., the 4D space/time curvature. Earth is not a massive body and the curvature is small. Nevertheless, although small the curvature caused by matter of Earth is enough to cause the perception of gravitational pull. In fact we are embedded in the small curvature of 4D space/time; the gravitational well created by Earth and one must exceed the second cosmic velocity to disattach from Earth forever. The same is of course true for all heavenly bodies but also for the miniscule elementary particles, like electron, or proton, or photon, a particle of light. But the curvature they create is negligibly small, or so it is believed. On the other hand photons of which visible light and any electromagnetic radiation consists of have zero rest mass, but have energy. In the EGR and EGE there is no difference between the rest mass and rest energy, both intrinsic properties of matter. But with photon there is a problem since it has zero rest mass, but not zero energy. Photons are ultimately quantum mechanical and can be seen as the classical electromagnetic wave consisting of many photons or distinct photons in physical space. Even one photon has energy creating infinitesimal 4D space/time curvature and is in gravitational interaction with any other matter. The gravitational interaction between two or more bodies can be seen as if their 4D space/time curvatures overlap. The curvature as small as it may be is at the same time infinitely long range and hence the gravitational interaction is infinitely long range. The EGE and the Newton gravitational equations approximation have no scale at all at which the curvature of space/time and gravitational interaction can cease. This is a serious issue since in accordance with ESR and EGR there is a sphere called the event horizon after which light emitted say from Earth will never reach. The speed of gravitation propagation is also limited by the speed of light. On the other hand quantum mechanics has a property, actually the basic one of quantum entanglement that says that the phase coherence of matter and space/time has no bound and is achieved instantaneously. It has been shown in (E. Levich, 2014) and this is one of the essential quantitative results of this work how this problem resolves in a way that does not contradict either the EGE or quantum mechanics. It is the phase coherence that I spoke above that correlates all visible matter in Cosmos instantaneously.

For small curvatures we can use the Newtonian law of gravitation and hence the concept of gravitational force. However the space/time should not be necessarily Euclidean with the 3D space and 1D time independent from each other. In Einstein special relativity-ESR matter lives in the Minkowsky 4D space/time that is flat, but not Euclidean¹⁹. The Einstein interpretation followed from his revolutionary vision that gravitational forces are fictitious. They are just the manifestation of something completely different although can be used for adequate description for practical purposes in the limit of small space/time curvature²⁰.

The repulsive gravitational force does not exist at all. More precisely the repulsive fictitious force does not exist in the classical EGE published by Einstein in 1913. Later he added a term to his equations that since has been called the Einstein cosmological constant term. Cosmological constant designated usually as $\Lambda(\mathbf{r},t) = const$ is a kind of matter with constant density at every 3D space point \mathbf{r}

¹⁹ The ESR can be formulated in Euclidean space as well, as it was originally done by Einstein. However, the path to magnificent Einstein general relativity-EGR and his gravitation equations—the EGE was via elevation of the Minkowsky flat, non-Euclidean 4D space/time geometry to the Riemann 4D space/time geometry.

²⁰ Nevertheless the level of accuracy of military and geophysical GPS is such that the EGE corrections should be incorporated.

and at all times t from the birth of Cosmos. This is a strange matter and the purpose for which Einstein introduced this matter soon was proved to be wrong. I notice that Einstein introduced this entirely and eternally homogeneous density matter as negative density value $\Lambda(\mathbf{r},t)g/cm^3 = const < 0$, where I introduced the dimension of matter density as grams per centimeter cube g/cm^3 . If indeed this strange matter has negative density then it adds up to gravitational attraction of normal, visible matter in Cosmos, although the nature of this matter has remained a mystery.

Einstein introduced the cosmological constant term to his original EGE from philosophical considerations. He firmly believed that Cosmos is stationary, neither expanding, nor contracting. To make it stationary of fixed diameter he needed additional gravitational contraction, the additional fictitious attractive force and it is not possible to get it from his original EGE. On the other hand adding this term into the EGE is contrary to not a single physical concept of EGR. In other words the modified EGE with cosmological constant are the most general gravitation equations compatible with the principles of EGR.

When the stationary model of Cosmos was proved to be wrong, by astronomical observations of Hubble in 1929 Einstein renounced the cosmological constant. However, the history of science is not straightforward and these days the cosmological constant matter is very much in as the most probable explanation of acceleration of Cosmos expansion that I remind since 1998 discovery has been a proven astronomical fact!

The reason why Λ matter has resurrected is that if it is a positive constant $\Lambda(\mathbf{r},t)g/cm^3 = const > 0$ then its action is repulsive as if it was a fictitious repulsive gravitational force. Moreover it was shown from the EGE that in order for Cosmos to expand with observed acceleration as the value of $\Lambda \approx 10^{-29} g/cm^3$. It is obvious that if there is an acceleration there is also a nonzero fictitious, or real force. But what is the sense of fictitious repulsive gravitational force? This is easiest to understand in dynamics. The attractive gravitational force is the interpretation of weak curvature of 4D space/time. Large curvature of 4D space/time cannot be transliterated in the language of force, although semantically we do it and mathematically it can be associated with the Christoffel tensor of Riemann geometry. The gravitational action of repulsive force caused by positively defined cosmological constant acts on the contrary to flatten the curvature of 4D space/time. If there is no normal matter in Cosmos and only $\Lambda(\mathbf{r},t)g/cm^3 = const > 0$ remains the EGE would describe a most peculiar space/time, the de Sitter Cosmos. Although the geometry of de Sitter Cosmos is flat it is not at all Euclidean, as the Minkowsky space/time geometry is not.

As was said the de Sitter Cosmos is a solution of the generalized EGE with positive cosmological constant and otherwise empty space with no normal matter. This Cosmos is expanding with constant acceleration proportional to the distance between two arbitrary points in Cosmos. In this sense it is like Cosmos that is observed since 1998 with the difference that our Cosmos has plenty of normal matter, Filaments of galaxies, clusters, galaxies, stars, planets, intergalactic shining matter, life on Earth and Man with what we believe is the conscious mind, although, as mentioned above there is no quantitative definition of what the conscious mind is. Definitely consciousness, the awareness of being one and inalienable part of Cosmos is not the aspect of modern physical sciences would it be even the of a theory of everything. The remarkable peculiarity is that de Sitter Cosmos geometry allows exclusion of time by a well-defined and rigorous mathematical procedure. On the other hand it is the expanding, flat geometry space. Moreover it has the event horizon dependent on the cosmological constant Λ value. It seems as a paradox, but it is not. The physical explanation is simple. It was explained by Einstein in his ESR theory that in order for the time concept to exist there should be a pair of clocks synchronized by light. Since there is no normal matter in de Sitter Cosmos there are no clocks by which time can be measured and there are no observers to measure it.

The maximal possible attractive gravitational force is the infinite space/time curvature in 4D space/time, the black hole, BH local singularity or singularities; hence precluding the flat global space geometry of Cosmos. The repulsive gravitational force however, dissolves all local BH singularities and imposes flat global geometry of Cosmos in finite time. That the time is finite is important, but does not follow from the classical EGE. The finite time is obtained only when matter that creates 4D space/time is treated quantum mechanically and even then this is a tricky physics and mathematics. The finite time for achieving the non-Euclidean flat 4D space/time is a crucial issue for cosmogony

and cosmology. The analysis carried out in (E. Levich 2014) shows that the time is finite. Furthermore this time although indirectly, but convincingly confirmed by the available experimental data having little to do with cosmology at the first, inattentive glance. However, a fairly thoughtful analysis relates this time uniquely to the rest mass contribution of three quarks confined in protons. The latter is known from the quantum chromodynamics theory-QCD. Also the life time of visible Cosmos was shown in the above paper to the rest mass of electron well known for the last one hundred years. Cosmos is complicated and often the properties of 4D space/time and matter that forms its geometry are intertwined in a non-trivial and unexpected manner.

Both gravitational forces are fictitious, although subject to measurements. But fundamentally the gravitational forces are fictitious and in are manifestations of the 4D space/time curvature dynamics, the profound understanding achieved by Einstein in his EGE of EGR. However, the reality of Cosmos is even a step deeper than the curvature of 4D space/time geometry interpretation. This deeper reality is what the KTOC to uncovered and employed for profound calculations that are as a matter of basic principles not possible with the previous interpretations and theories, while at the same time KTOC does not contradict the firmly established theories and is in highly satisfactory agreement with the well-known up to date experimental and astronomical data.

American astronomer Edwin Hubble in 1929 discovered the Cosmos space expansion by direct observations of receding far away from each other galaxies and established the speed of this expansion proportional to the distance between two arbitrary points of space at a large distance from each other. It was an incredible discovery. Prior to the Hubble discovery in 1922 a Russian mathematician Alexander Friedman had derived the cosmological Friedman equations directly from the Einstein gravitation equations, the EGE. These equations describe the time evolution of the global Cosmos geometry in the framework of EGE as a function of matter stress/energy, or momentum/energy tensor. Friedman made a fundamental assumption that our visible Cosmos is globally homogeneous and isotropic, the HI model of Cosmos. The HI model predicts that if the average matter density in Cosmos is less than a certain critical one Cosmos will be ever expanding and generally the visible lumps of matter, stars, galaxies, clusters, etc., should be running away from each other, unless their peculiar velocities relative to space expansion are large and in the opposite to the expansion direction . If the average matter density is less than critical than Cosmos expands for some finite time after its birth in Big Bang, this expansion gradually getting slower, eventually coming to the stop sign and followed by contraction of Cosmos back into a single point from which it had been borne presumably in the violent Big Bang event. At last if the average matter density is exactly the critical density the Cosmos space is globally flat. The EGE and subsequently the Friedman equations are time reversible. It means that if we change the sign of time from plus to minus the equations will describe the reversed dynamics. Instead of telling us what will be in the future the equations tell us the history of what has been before in the past of Cosmos. This is how astronomers, cosmologists and astrophysicists study the past history of our Cosmos.

Since our contemporary observations show Cosmos isotropically expanding in all directions, like a spherical balloon with the time arrow pointing into future when we reverse time, i.e., substitute, the time arrow points back into the past. Then it is obvious that in some distant past Cosmos was just a point from which the balloon 4D space/time bloated like an elastic balloon when air is blown into it through the orifice. The point started to expand driven by the great momentum of Big Bang and this inflating point what our 4D space/time is now. There is nothing else except this swollen point continuing expansion as time goes on. The inside of the bloated point is the 4D space/time of our Cosmos with all visible matter and light undergoing processes within the swollen point and expanding with it unless constrained by its own gravitational or other forces. The expansion if not accelerating does not exert force and if an entity, like a star or a galaxy or humans are held together by internal forces the nonaccelerating space expansion does not care about them and us. In fact the space points flow through the matter with no friction or any other interaction. Indeed, if it was it would have meant that there is nonzero force acting on the inner structure of entities supplementary to the force that holds together the constituent units of the entities. By the second law of Newton, not to be confused with the kinetic second law & RSL, this would have meant that there is an acceleration of the expansion, but the classical Hubble expansion does not accelerate. There are no forces associated with the Hubble space expansion. The space expands simply as if by inertia.

On the other hand normal, visible matter in Cosmos and light by which the normal matter is visible are gravitationally attractive. This is the external to space force that can stop the expansion if the density of matter is big enough and moreover make the space to contract back into the point. If the matter density is small it continues fast declining in inverse proportion to the space volume, i.e., in inverse proportion to the Cosmos space diameter cube. In this case the gravitational contraction will never catch up with the inertial expansion and the latter will continue forever. There is a critical matter density right in between the two densities such that for a certain sphere diameter the inertial expansion force exactly equals the gravitational contraction force. The Cosmos space sphere stops expanding at this diameter and does not contract, but it takes infinite time to terminate the space expansion. This critical density expanding Cosmos has zero curvature flat 3D space geometry, while the over critical density matter expanding Cosmos and the subcritical density matter contracting Cosmos have respectively some spherical positive space curvature or a hyperbolic negative space curvature. All three models are the Friedman cosmology models in a simplified common sense exposition. The simplification is primarily in that the space and matter embedded into space are treated as independent from each other and this is inconsistent. The space and time are inseparable in **both** the Einstein special and general relativity theories, respectively the ESR and the EGR and Cosmos is the dynamical evolution of 4D space/time in rigid affinity with matter since matter creates the geometry of 4D space/time and not the evolution of 3D space and matter in it as independent functions of time, even if formally it sometimes looks as if it was the case as it does in simplified Newtonian treatment of Friedman cosmological models. The EGE makes matter and the properties of 4D space/time inseparable, but as will be seen in what follows extraordinary different. However, it is useful sometimes to describe things simply relying on our common sense. Naturally often it is a superficial exposition and the real one must rely on indispensable mathematics.

No more than assiduous reliance on the very basics of quantum mechanics, trusting the basics of Einstein special and general relativity and simple mathematics are needed for the derivations. The novel physics is the uncompromising adherence to the *second law* and the kinetic *reverse second law*, the *RSL*. The *second law* is hardly a new hypothesis. The reverse *second law* for open systems driven by sources may seem as novelty for many, although the physics is rigorous and obvious.

Indeed, the novelty is modest in that both the *second law* & *RSL* are respected in the kinetic sense of fluxes of these quantities in the presence of a source of negative entropy and a sink for positive entropy disposal for thermodynamically open systems in a quasi-steady state with active environment. What should be borne in mind is that order does not spontaneously self-born from chaos. This strange and ridiculous concept is total nonsense. Even Plato knew it 25 centuries ago and introduced Creator imposing mathematical order on chaos.

What was shockingly novel for me is the extent of damage dealt to physics and cosmology by the fact that the time reversible fundamental equations of physics intrinsically pay no respect to the kinetic *second law* & *RSL*. Moreover, For the case study of turbulence in viscous and ideal fluids I have demonstrated that there is no analytical transition from the equations of physics containing friction forces caused by viscosity and subsequent viscous terms and the ones that do not viscous forces terms, even if viscosity tends to zero, but is not zero. Friction and viscosity intrinsically make the equations of physics complying with the kinetic *second law* & *RSL*. The solutions of an unknown proper equation with a friction term cannot be obtained post factum as corrected solutions of the respective Hamiltonian, time reversible equations. The former and the latter are not analytically connected. The consequences are dramatic. Literally the contemporary physics equations forego generation of all order in Cosmos, inanimate and animate. Order and coherence of matter and space/time that are intrinsically intertwined with and crucially dependent on rigid compliance with the *kinetic second law* & *RSL*. All coherent entities in Cosmos from quarks, protons, neutrons and electrons to stars and galaxies, life and conscious mind of Man would have no reason to exist if not for the *kinetic second law* & *RSL*. Visible Cosmos itself would have not existed if it was not for the *kinetic second law* & *RSL*ⁱⁱⁱ.

In fact the assiduous, quantitative respect to *kinetic second law*&*RSL* in conjunction with and supplementing the basic mechanisms of time reversible equations of physics results in fundamental simplifications and new vision of order in Cosmos, of life and conscious life all intertwined as one coherent Cosmos.

The KTOC allows simple calculation of some of the most fundamental physical and cosmological parameters that hitherto have not been ever considered not as empirical and given by "Providence". For instance such as the rest mass of electron and proton and their life time, the Hubble constant and relative contribution of visible matter, dark energy and dark matter into the total matter content in Cosmos. The latter turns out to extremely close to the critical density and hence as expected Observable Cosmos is flat.

Other parameters have been calculated and among them the typical mass of conscious human brain in conjunction with the 120 years maximal lifespan of Man. This may sound like a science fiction, but in fact is fairly rigorously proved in the framework of KTOC and not difficult to explain.

Fortunately the mathematical essence of KTOC is remarkably simple and should be fairly easy to follow for many. The logical thread leading to the quantitative results and proofs is consistent step by step deduction but greatly more complex than the mathematical calculations per se; Cosmos and life in it are complex and this cannot be helped. However, the logical deductions do not require much special knowledge and can be handled with no more than unbiased common sense and curiosity, not always granted, to learn more about ourselves and the meaning of our life on Earth and in Cosmos.

Nevertheless, let us proceed with the model of an elastic balloon and see where it will lead us. To organize the Cosmos balloon it is necessary to have someone or something blowing, say air into the orifice. The balloon cannot be blown from inside. Only someone or something outside can force air into the balloon. The balloon is elastic and resists expansion. Hence the force that is the momentum flux by the blower must exceed the contracting elastic force. The balloon is not a closed system since it has the open orifice and someone/something blowing air into the orifice and this someone/something is the external source, a parent of the smooth, coherent entity we will enjoy as the final balloon. It took energy for the parent source of the balloon to blow air in it and if it is a very big balloon it takes a lot of effort to make this balloon float in the air and carry passengers or equipment. Also the balloon at the beginning was all wrinkled like a fetus, with random wrinkles all over its surface from inside and outside of the balloon. But very soon it becomes shapely, round and remains like this and grows out of all its childish chaotic wrinkles, becomes an orderly, nice looking entity, smooth and with no, random curves on the elastic surface. It will remain like this till the end until all air seeps out and the balloon becomes the chaotically wrinkled old balloon ready for disposal.

But where does the orderliness of the balloon come from in its prime age? Naturally from the "someone" who shared his orderliness with the balloon. It was a deliberate act of generosity when this someone blew his orderly, coherent energy into the balloon to give it the chance of life. But the balloon turned out to be short-lived. As soon as someone stopped furnishing it with orderly, coherent energy with periodic breathing, the exertions of air through the orifice the balloon starts withering and decomposed into the wrinkled dead body, unless the orifice is tightly closed making the balloon a relatively closed system. But even if the orifice is closed tightly on small scales there are always tiny holes in the elastic material chaotically spread over the balloon surface. Practically it is impossible to hermetically isolate the balloon from the environment and sooner or later all air that was breathed in by the source by injecting air portions of the size of orifice will leak out through the tiny holes having the size much smaller than the size of open orifice. The balloon cannot remain smooth, coherent and healthy unless it receives fresh portions of orderly energy from the outside source.

But what happens if the source is inexhaustible and goes on blowing air in measured bursts through the orifice? The balloon will go on larger and larger, prettier and prettier and will become so pretty that not a single wrinkle will be left on the inside and outside unless we look under a microscope with good resolution. Note that the molecular size randomly distributed deficiencies always remain and this is final, finite size curvature defects that can be discovered on the surface of the balloon. Hence, there is the upper limit of perfection and orderliness of the balloon.

If the source continues blowing air in the balloon it will just grow in size but nothing else will change, except that it can burst. The balloon now is ultimately beautiful, ultimately shapely and ultimately coherent with the accuracy of molecular size little curvatures. From now on all the future balloons are just the larger copies of the previous ones. We call them the self-similar balloons since each of them can be obtained from any other by dividing or multiplying the balloon's radius by one or another constant number, or more scientifically by dilating or contracting the balloons without changing their spherical shape. We note however that we can contract it only to the lower limit size

diameter that is much, much larger than the molecular size ripples or tiny curvatures on the surface. Otherwise it will not be a balloon, but a sieve that is not at all perfect to look at.

However, the dilation will not dilate the size of random deficiencies, like dust particles sticking to the balloon surface. The elasticity will not allow them to dilate.

The problem with the balloon is that eventually it bursts. The material cannot hold the pressure. It does not happen with 4D space/time. The 4D space/time is smart. It behaves like a live organism does and this is how.

Consider predators like humans are. We must eat to feel energetic and whole. To be whole is to be organized, to be coherent. Our body consists of live cells. For some reason the cells hold together. Moreover all these countless cells of a body work in unison together or at least supposed to. We define it by saying that the cells of live species are highly coherent and organized in a way such that the live entities are whole acting as whole with all cells coordinated so that the body does not fall apart while we are jogging, or acting in any way. Inanimate matter is also whole on the level of molecules and atoms. Animate matter, from plants and viruses and bugs and mammals and us are all coherent on an unimaginably higher level that is called by the mysterious word life. No one knows what life is, but biologists convinced themselves and us that they are approaching life by doing genetic engineering.

In fact they even don't think, may be some do, about what is life, but are primarily concerned with preservation of lives from early demise. To this end they must understand not what life is but the mechanisms of life functioning.

In other words biologists are studying the mechanisms of life like genetic engineering, which is extremely important. But this is not the same as creating life, creating an animate matter from the inanimate one. The days of Faust and thousands of years of trying to understand what life is have gone and are replaced with the enormous progress of modern research on the mechanisms of life functioning²¹.

Biologists get confused and so are doctors if asked the simplest possible question why we and say cockroaches hold in one piece for about lifespan. I have seen in my small experience only bewildered reaction, or advices not to ask stupid questions, but also a sophisticated answer that the cells are held together by osmotic forces. The osmotic forces may be the correct mechanism for holding our cells linked, but again this is just the mechanism and not the reason why the trillions of cells hold the same shape of body and brain, although subject to aging and genetic replication deterioration,, for up to 120 years for humans, but never more. If it the genes replication then the question is how do the genes know about the osmotic forces and how to control them with such incomprehensible precision of kinetic order by comparison with which all order of inanimate matter in Cosmos together with galaxies, clusters thereof, black holes, etc., is a joke. There should be some deeper reasons and laws of awesome power that command this order of live entities to be.

The reason has little to do with the biology as science per se. The biology studies the mechanisms of immense complexity, but not the cause of biological coherence.

If we overeat and don't relieve ourselves we will die of overeating, we will burst like in the old black humor French comedy *La Grande Boeuf*. The same is with the balloon meaning that it should relieve itself of extra air nourishment. The density of air should stay at some maximum and optimal level so that the pressure on the inner boundary of the balloon is compatible with the material ability to expand. If the material of which the balloon is made is perfect it can go on expanding even if the inner boundary of the balloon becomes thinner and thinner. However, the pressure of air inside should be over the critical one. If it is below the critical the elasticity of the balloon material will force it to contract. If pressure is above the critical one the balloon expands forever by inertia. Even if the source stops blowing air in the material will have lost elasticity and hence the ability to resist the inertia. If there is no outside resistance by the first law of Newton it will go on expanding even if the source takes a nap and does not blow air for a time. However, with time air will seep out from the balloon

²¹ It is obvious to anyone that genetic engineering has nothing to clear up the mystery of life. Genetic engineering is sophisticated experiments on transformation of live matter into another live matter, something that in agriculture they have done for thousands of years. But genetic engineering allows doing this much faster and thus we eat the genetically modified food.

through the tiny scale pores in the material even if they are no more than the molecule size. What it means is that during the nap the source should continue breathing into the orifice to hold air density in the balloon at the critical level, such that as much air seeps out that much air is breathed in. However, this is not the end of the story. The matter is that the air inside the balloon seeps out on a molecular size level. On the other hand the source pumps in air through the macroscopic orifice. One breath in between the two naps is enough to hold the air density and pressure averaged over the time between the naps constant.

But there is a problem. The source injects a momentum flux with the breathing and the momentum flux is the same as force. There is no opposing force since no one opposes the balloon expanding from outside and there no elasticity any more. Thus there is net force acting at the balloon inside boundaries. By the second law of Newton it means that there is acceleration. As soon as the material lost elasticity the balloon starts expanding with acceleration.

This is the incredible Big Bang concept that follows from the Einstein general relativity, EGR, or equivalently from the Einstein gravitation equations, the EGE and subsequent Friedman equations. The Big Bang tells us that there had been the beginning of time $t = 0$ when everything started and it had been the start of Cosmos borne as one point. It is not easy to comprehend that the total Cosmos is just the inside of a bloated point which goes on inflating with acceleration. I note that this is not a bloated point within something else. There is no outside the point and this point is everything that there is, the whole space/time and everything that is happening in our Cosmos is happening inside the bloated point that goes on expanding. Our Cosmos is absolutely rigorously closed system in this scenario. It cannot be influenced by anything outside since there is no outside, neither space nor time.

Scientists in the field got so used to this concept that for a period of time it was not questioned; especially after the discovery of cosmic microwave background radiation, CMB that had been previously predicted by Ralf Asher Alpher and Robert Herman in a sequence to the prediction of Big Bang birth of Cosmos (Ralph, Asher Alpher, Hans Bethe and George Gamow, 1948). There are problems with the Big Bang. The problems are both scientific and ideological. The main physical problem, but not the only one, is that at the Big Bang all 4D space/time of Cosmos is one infinitesimal point. The densities of physical quantities such as energy and matter density become infinite, singular. This is against science and reason. The evident conclusion is that at the singularity of Big Bang the classical laws of GR and EGE are not valid. And if they had been not valid at the Big Bang there was no space/time and it gives additional credence to the convention of not asking what had been before the Big Bang as there had been no before.

It is psychologically interesting that when we try to explain this concept to a curious child who likes asking awkward questions the child is perplexed. Unless the child cannot be distracted by a new computer game he/she would necessarily ask awkward questions; "but what had been prior to the Big Bang and what is outside this bloated point that we call Cosmos". Such questions till a few years ago belonged to a class of forbidden questions, like asking why the speed of light is the maximal possible in Cosmos. A child who asks too many questions would be patted on the head and explained that when he/she grows up this will become obvious for him/her. That such are the natural laws of physics for adults. However, thinking as a layman the Big Bang concept is absolutely mystical and as much as scientists try convincing the laymen and themselves it is impossible to resign to the prohibition of asking the above childish questions. Sooner or later the prohibition laws are counterproductive.

Extraordinary, in the last decade adult scientists started asking the forbidden questions and publishing papers and books on the subject. Conjecturing what had been "Before Adam", prior to the start of time gained legitimacy. Especially extraordinary when the questions are asked and given answers, perhaps correct, or maybe not by distinguished prime line scientists.

Sir. Roger Penrose has pioneered the concept of cycles of time. Moreover, Penrose not just conjectured the existence of "Before Adam" reality, but found a marvelous solution of the EGE for Cosmos empty of normal, visible matter, but with positive Einstein cosmological constant and very cold radiation/photons perfectly adequate for this reality. The solution describes the Cosmos infinite cycle of time, aeons, with the end of each consecutive finite lifespan Cosmos smoothly matching the Big Bang of the next one. The Big Bang initial conditions are conformally invariant with the end of the previous Cosmos. But at the end of Cosmos there no singularity and the energy density of photons is finite. This means that the Big Bang solution to the EGE is a regular one. The singularity is

spurious. This is a bit difficult, but straightforward mathematical manipulation often used in physics and definitely adequate. Penrose masterfully used the conformal invariance for the cosmological EGE empty of normal matter. Apart from philosophical significance the solution obtained by Penrose shows that the Big Bang event is not a malicious black hole type singularity of the EGE, but an innocuous one that can be smoothly bypassed without violating the basic principles of physics.²² It is truly puzzling how the most extraordinary extensions of firmly established physical theories can be developed instead of escaping into esoteric hypothesis having small chances to be falsified in the foreseeable future.

I note that the Penrose Super-Cosmos relies on a conjecture that after a long time period all visible matter will be swallowed by massive black holes, the MBH's. Subsequently after another incomprehensibly large time span the MBH's will evaporate into extremely low temperature photons due to the Bekenstein-Hawking effect. Hence visible Cosmos will cease to be visible since there is nothing to see and no observers to see and all its content will be the ubiquitous cosmological constant and extremely low temperature photons. Neither of these two types of matter is suitable for constructing clocks measuring time and it means that the concept of time has no meaning except as a mathematical abstraction. Therefore the Penrose Super-Cosmos is timeless. Its timelessness is similar, but not identical to the de Sitter Cosmos, Since the Penrose Super-Cosmos is timeless it is ultimately coherent and does not know the second law & RSL, or chaos.

²² The conformal invariance is one of the mainstays of aerodynamics. The famous example is the Nikolai Joukowski and Martin Wilhelm Kutta airfoil theorem for circulation of inviscid fluid around cylinder. This theorem literally paved way to practical aircraft building industry. The beauty of this theorem is in that the circulation does not depend on fluid, e.g., air viscosity and can be derived from the Euler equations for perfect fluids that are conformally invariant. On the other hand, and this is a fine point that remains hazy and often bypassed the circulation would have not existed at all if not for the nonzero value of fluid viscosity. The deep reason for that is that the perfect fluids do not respect the second law&RSL and do not exist in nature. Despite the fact that with no viscosity there would be no circulation and no aeronautics viscosity cancels out when proper calculations for the circulation are carried out. This is a remarkable peculiarity of important classical and quantum physical phenomena that has been understood by few until recently (see Boris Svistunov for a nice historical exposition in "From Einstein to Gross Pitaevskii and back to Einstein" , 2014).

In particular there is no analytic transition from viscous media to the perfect one. After a proper conformal transformation the non-analyticity is smoothly avoided and the Joukowski and Kutta theorem holds as if it was valid for perfect fluids. We will see below how general this phenomenon far beyond the flows of fluids and aerodynamics is. The truth is that there is no analytic transition from respecting the second law&RSL and not respecting. But all fundamental equations of physics are the time reversible Hamiltonian ones. Subsequently they do not respect the second law & RSL! It naturally results in fatal consequences and especially for Cosmology.

Although, the Penrose "cycles of time solution" is the classical EGE solution, but quantum mechanical independence is spurious. Radiation as photons is the subject to QED, the quantum electrodynamics. It seems it is still unclear whether the QED is conformally invariant. However, what is absolutely clear is that there is only one ultimately coherent state of radiation and this is a purely quantum mechanical state. This state is the Bose-Einstein Condensate of photons, the BEC of photons^{23, 24}. From the viewpoint of thermodynamics the quantum BEC of photons is a quantum state of equilibrium. This is opposite to the classical physics equilibrium that by definition is the state of maximal entropy and ultimate chaos. The BEC of photons is the state of ultimate order.

As enigmatic is the concept of Stephen Hawking conjecturing that there had been no beginning of Cosmos and will had been no end as it is the case with the surface of a sphere which has no beginning and no end extended to four dimensional, 4D space/time.

The concepts of Penrose and Hawking are the cosmogonies drastically different from the Big Bang cosmogony. They negate or rather bypass the uncomfortable issue of the Cosmos beginning. The beginning is indeed an uncomfortable notion because the natural question it inspires in a curious child, but also in a reluctant adult is why there was the beginning and who or what is responsible for this beginning. As much as we courageously wave the banner of natural laws explaining everything the uncomfortable residue of doubt remains in the conscious brains of even the staunchest materialists.

The contemporary most fashionable alternative to the Big Bang scenario is the inflation concept launched by Alan Guth and Andrei Linde. Alan Guth and Andrei Linde conjectured that the initial state of Cosmos is an extremely dense hypothetical matter named inflaton that pushes the extraordinary fast accelerating expansion of space by dozens of orders of magnitude faster than the speed of light. The inflaton of space/time can be modeled by a large value of cosmological constant at the beginning gradually receding to become such as corresponds to the observed value of expansion acceleration. Such extremely fast inflation would explain a serious paradox of classical Big Bang cosmology known "the event horizon problem".

In simple words the problem is as follows. It is an established fact that that the contemporary Observable Cosmos on cosmologically large scales is amazingly identical everywhere including the regions very distant from each other. The point is that the light that passed one region never passed other very far away regions. The distant regions have never been connected by the same light signal. These regions of space have never been causally connected by light because they receded from each other much faster than the speed of light and light passing one region cannot catch up with the others receding faster than the light speed. Nevertheless, Observable Cosmos is highly HI having the same cosmic background radiation CMB temperature, etc. so that conditions in one part of Cosmos are the same as in any other. In other words the distant parts of Cosmos are strongly correlated with each other. But how can they be if they are causally disconnected? The inflation conjecture simply resolves this problem and also explains why the contemporary Cosmos is apparently nearly flat.

²³ The kinetic BEC of photons was predicted and analyzed many years ago in 1968-1969 by Ya. Zeldovich and E. Levich (1969). The possibility of astronomical value of the phenomenon was briefly mentioned in their paper, but the lasting significance of the phenomenon was recognized by R. Sunyaev along with the Sunyaev, Zeldovich effect. Ostensibly the kinetic traces of photonic BEC is among very few distortions of microwave cosmic background, MCB that is unavoidable, survives evolution of 13.8 billion years old visible Cosmos and can be traced analyzed in the review of by Rashid Sunyaev, Rishi Khatri & Jens Chluba (2013). It took a long time, but at last the phenomenon was observed experimentally in laboratory conditions in a highly elegant setup by Jan Klaers, Julian Schmitt, Frank Vewinger & Martin Weitz (2010).

²⁴ The 4D space/time with no matter except cosmological constant is the de Sitter space/time geometry. Light does not harm the conformal invariance, since if considered quantum mechanically the light is photons and the equations of quantum electrodynamics are conformally invariant. However, the Lorentz space/time has sense only if there is normal, visible matter in the space/time to construct a pair of clocks that after synchronization by light will be measuring meaningful time. The same issue arises with de Sitter. This is a contradiction. The cosmological constant is a sort of matter, albeit definitely not composed of field theoretical elementary particles. It will be argued the other way around in this work. It cannot measure time in the usual.

Indeed, even if the initial inflaton microcosm state is totally inhomogeneous and anisotropic full of 3D space ripples the superfast expansion will smother all of them by stretching and within an extraordinary short time space will be ironed into the flat space/time geometry Cosmos, similar to the way Cosmos is now. However, this space is now one and no questions about causal connectedness arise. In other words the inflation concept kills two innocent birds with one shot, the causal connectedness of Cosmos is explained and the flatness of Observable Cosmos is established.

The inflation scenario has been made all worked out in a very careful and smart way by hundreds of followers of Alan Guth and Andrei Linde. Furthermore, the inflation theory makes predictions that in principle can be subject to astronomical testing. Indeed, the superfast Cosmos space expansion should generate huge gravitational waves perturbations that in their turn can be in principle observed as certain miniscule polarization of CMB. So far no conclusive observations have been made and hence the inflation theory should be still qualified as a hypothesis, albeit a beautiful one.

On the other hand Roger Penrose showed convincingly that for the inflation theory to be correct the initial state of Cosmos must be so extraordinary low probability special one that there is no rational reason why this would be like that. Penrose has openly and publicly expressed his opinion that the inflation theory is fantasy. Instead he suggests that the Cosmos beginning had been perfectly coherent Big Bang in exact affinity and smoothly matched with the perfectly coherent end of the previous Cosmos.

I would like mentioning that the KTOC cosmogony marries the perfect coherence of the Big Bang event with inflation. The KTOC inflation follows the perfect Big Bang coherence and does not need hypothetical inflaton matter necessary for the inflation theory.

And yet how the Big Bang could have been a perfectly coherent event if it was the equilibrium Planck radiation with the usually accepted temperature of 10^{32} Kelvin? Obviously the Big Bang was not the equilibrium Planck radiation. But then what kind of radiation it had been? Cosmos remains mysterious as far as the firmly established modern science is concerned and distinguished cosmologists disagree with each other with no astronomical test in sight that would favor one conjecture over others. Contemporary cosmogony and in part the theoretical cosmological theories are rather hypothesis and cannot be seen as affirmative or falsified science unless a decisive experimental evidence favors one of them²⁵. The KTOC furnishes self-consistent explanation of the Big Bang ultimate coherence.

Nevertheless, the event horizon is a real problem in the original Big Bang and the discovery of acceleration of Cosmos expansion and black energy repulsive influence demands a lot of rethinking of modern physics and cosmology as well as our understanding of life and consciousness, the two phenomena intrinsically intertwined with global Cosmos. I believe that KTOC may be the solution of the event horizon problem.

The marvelous Big Bang event following from the Friedman equations and explicitly expressed by Lemaitre led to real theory predicting the microwave cosmic background radiation, the CMB the testimony and remainder of the Big Bang violent event. The CMB prediction and the post Big Bang theory of nucleo-synthesis of light chemical elements was initially developed in his Ph.D. thesis by Ralph Asher Alpher, a student of George Gamow in his turn was a former student of Friedman in Sanct Petersburg. The theory was published under the names of Alpher, Hans Bethe who had nothing to do with the work except his prominence and Gamow. Some years later Ralph Alpher and his student Robert Herman went further and not only predicted the existence of CMB, but even calculated its contemporary temperature as 5 degrees Kelvin. It was almost the same as the measured 3 degrees Kelvin temperature of CMB that was somewhat accidentally discovered by Arno Penzias and Robert Wilson.

It was eventually recognized that most of the heavy elements observed in the present universe are the result of stellar nucleosynthesis in stars, a concept first suggested by Arthur Stanley

²⁵ From time to time Internet brings news of experimental breakthrough either about dark matter, or dark energy, or inflation concept, like in March 2014. These sensations have been short lived so far and disposed into Internet chatter.

Eddington, with contributions from Hans Bethe, and quantitatively developed by Fred Hoyle and a number of successors.

However, the work of Alpher, Bethe and Gamow correctly and quantitatively explains the relative abundance of hydrogen, deuterium and helium in Cosmos²⁶.

Particular case of the flat space 4D geometry is such that the time coordinate can be effectively eliminated by a covariant transformation and hence it is effectively time independent Cosmos geometry. We discussed this geometry as the peculiar de Sitter solution of the EGE void of normal matter, but with a nonzero value of Einstein cosmological constant. The peculiar time independent EGE solution is called de Sitter Cosmos by the name of mathematician Willem de Sitter. Although, the de Sitter Cosmos is expanding and has the event horizon, but since time coordinate can be eliminated from geometry of 4D space/time the expansion is illusory. The event horizon of de Sitter Cosmos is significant for our visible Cosmos since it is directly connected with the cosmological constant.

Let us discuss in more detail the postulate of Einstein special relativity, the ESR concerning the time concept. It is clear that for the time concept to exist time should be measured. One clock is not enough for this purpose since clocks must be synchronized to produce meaningful time. Therefore it is necessary to have at least a pair of clocks that should be synchronized by light. And why the latter should be by light? This is because the speed of light is maximal possible for signal amplitude propagation, a signal that carries information. And synchronization is a signal that carries information. To summarize for the concept of time to be meaningful it is necessary to have in Cosmos at least a pair of clocks and light.

Light by itself cannot be used for building the pair of clocks. These can be built only from visible matter interacting with light. Such can be only if it has a nonzero rest mass. Can it be dark energy, or cosmological constant? No. it cannot since dark matter does not interact with light. If it did dark energy would not be dark. In de Sitter Cosmos there is no visible matter and no light; the stress/energy tensor is zero. There is only the cosmological constant or dark energy. In other words the time concept does not exist in de Sitter Cosmos. Hence whatever solution of the EGE exists in this case must be such that the time dependence is identically factored out. Thus it indeed happens with the de Sitter solution. I note that if light is added to de Sitter Cosmos and the stress/energy tensor of matter is not zero any more still the concept of time does not have meaning except as a mathematical parameter. The remarkable solution of the EGE obtained by Roger Penrose is based on the above rigorous

²⁶ The CMB discovery has a controversial history. Big Bang was the name given to the phenomenon by Fred Hoyle years later. Gamow was behind the idea of a point like start of Cosmos since he was a student of Friedman. The post Big Bang nucleosynthesis theory was developed by Alpher in his thesis. Gamow ostensibly asked Hans Bethe who by that time was very famous in the field to coauthor the paper to avoid possible negative reviews from potentially dumb referees. Indeed, the concept and the theory were extraordinary novel and not easy to grasp by those not intimately familiar with nuclear physics and the Friedman equations at the same time. Later the eminent Arthur Eddington suggested and Fred Hoyle quantitatively developed the stellar nucleosynthesis theory of elements in the stars as remarkable work as the work of Alpher. However, the CMB prediction and calculation of the contemporary temperature of CMB was done by Alpher and his student Robert Herman with unmatched accuracy and were forgotten. Only at his death bed Alpher received a highest reward possible for American scientist from George Bush. Herman had gone before.

If memory does not fault I in the 1960 Yakov Zeldovich and his associates rediscovered some of the Alpher's results. In 1978 Penzias and Wilson were awarded the Nobel Prize for their rather incidental discovery of CMB in 1965. Alpher and Herman were entirely forgotten and their contribution became fully appreciated only after their death. The account of the Big Bang history reflecting their own perspective can be found in a fascinating book "Genesis of the Big Bang" published by Oxford press.

In the late fall of 1976 I had a chance to visit Arno Penzias at his home. He talked a little about his work that was not completed in 1976. It was the detection of CMB for which he later in 1978 shared the Nobel Prize with Wilson. He did not mention the names of Alpher and Herman. Most probably he did not think it was relevant, to our discussion that mainly was far from scientific topics, or he did not know of Alpher's work. `

reasoning. As soon and if the nonzero rest mass visible matter vanishes from Cosmos by one or another mechanism and only photons left the concept of time does not have sense.

Also there are no observers made of visible matter in de Sitter Cosmos and hence no one observes de Sitter Cosmos expanding and not expanding. Hence, there is no paradox. The same is true for the Penrose Cosmos. If there is no time concept the *second law* does not exist and if the *second law* does not exist there is no entropy and subsequently no distinction between order and chaos. There is only order and both the deSitter Cosmos and cyclic Penrose Cosmos are the states of ultimate order.²⁷ Furthermore if acceleration of Cosmos expansion proves that the global order of our visible Cosmos is growing than inevitably as time tends to infinity visible Cosmos will tend to the state of ultimate order. But it means that all visible matter should vanish from visible Cosmos and this will be the end of visible Cosmos. The end may be the beginning of the next Cosmos as in the solution of Penrose, or it may be the de Sitter solution that does not have light. But what could happen with light? It has nowhere to disappear even if the mechanism of visible matter extinction is found.

It is shown in (E. Levich, 2014) that there is a mechanism of extinction of visible matter in the fabric of visible Cosmos different from the Penrose mechanism of MBH's quantum evaporation and much faster. As far as photons are concerned the only state of ultimate order for them is the state of Bose-Einstein condensation, the phenomenon known as BEC of photons. This is a purely quantum mechanical state that remarkably can be described in terms of classical field as was first shown in (Ya. Zeldovich and E. Levich, 1969). However, the BEC of photons is only possible if not a single electron or proton or the respective antiparticles is left in Cosmos.

Einstein resisted the scenario of expanding Cosmos and favored the stationary Cosmos model with no expansion and no contraction. Incidentally the stationary Cosmos is a particular case of the de Sitter Cosmos, although the ideology of Einstein behind the stationary Cosmos was wrong. To obtain a stationary solution of the EGE for Cosmos Einstein introduced additional term in his gravitation equations, the EGE, the cosmological constant Λ term²⁸. Choosing the cosmological constant value negative $\Lambda < 0$ Einstein balanced the inertial expansion of Cosmos after the Big Bang by uniform attraction constant in 4D space/time and stopping the expansion after a period of time. Einstein was so opposed to the idea of ever expanding Cosmos that as referee only reluctantly conceded the publication of Friedman's equations in 1922 admitting his own mathematical mistake in the end, but still insisting that the physics of dynamical Cosmos models is wrong. In 1927 he publicly showed his wrath against Georges Lemaitre, a Jesuit priest and marvelous physicist who independently arrived at the same conclusions as Friedman before him.

Although Einstein resisted the scenario of expanding Cosmos and favored the stationary Cosmos model after the astronomical observations of Hubble all doubts vanished and Einstein belatedly admitted the fact of Cosmos expansion. It is said that ironically Hubble had doubts concerning the interpretation of his discovery as Cosmos expansion. He believed that he observed some yet unknown phenomenon of Cosmos that remains to be explained. Nevertheless, the Hubble expansion and the EGE/Friedman cosmological equations for the HI model of Cosmos have been the mainstay of cosmological studies inseparable from the fundamental physics and philosophy of the 20th century.

However, serious questions remained unanswered. The first question is the value of the actual average matter density in Cosmos. Hubble determined that the speed of expansion between two

²⁷ Adding radiation does not lead to emergence of time since a pair of clocks cannot be built from the zero rest mass photons and hence in accordance with the Einstein special relativity, the ESR time cannot be objectively measured and thus does not have sense except as a formal mathematical parameter. Great Plato and Aristotle tried to understand the nature of time associating it with change and processes requiring change. The next leap in understanding of time was the relativity theories. The relativity theories paved way to new attempts of understanding the nature of time (e.g., N. Kozyrev, A.P. Levich, R. Penrose, this wok).

²⁸ This term is Λg_{ik} added to the momentum/energy, or energy/stress tensor of normal matter T_{ik} in the r.h.s. of the EGE, where Λ is constant in 4D space/time and g_{ik} is the metric tensor defining the invariant length interval in 4D space time, i.e., $ds^2 = g_{ik} dx^i dx^k$, (i, k) are indices denoting (x, y, z, it) the three space coordinates and imaginary time. For a very brief excursion into the EGE see Chapter 9 of (E. Levich, 2014).

points in Cosmos separated by a large distance $D_{1 \leftrightarrow 2}$ is equal to this distance multiplied by a constant having the dimension of inverse time, i.e., $V_{Hubble} = H_{sec^{-1}} \cdot D_{1 \leftrightarrow 2}$, where $H_{sec^{-1}}$ is the famous Hubble constant. Multiplying this constant by the distance between, say two galaxies $D_{1 \leftrightarrow 2}$ one gets the speed with which these two galaxies recede, run away from each other due to the space expansion²⁹. The value of $H_{sec^{-1}}$ is unambiguously tied up with the critical average matter density in Cosmos by virtue of Friedman equations. Therefore if we know $H_{sec^{-1}}$ from astronomical observations we also know the all-important critical matter density in Cosmos. The astronomical determination of $H_{sec^{-1}}$ is very difficult, but nevertheless is possible with relatively good accuracy, although discrepancies and the spread in the values of $H_{sec^{-1}}$ remain sufficiently big to be important. Assuming that $H_{sec^{-1}}$ is known astronomers have to determine astronomically what the actual average matter density per volume unit of Observable Cosmos is. Prior to the discovery of dark matter and dark energy this had been done by astronomical observations of visible matter in Cosmos, stars, galaxies clusters, superclusters, intergalactic gas, etc. By visible is meant all matter that can be detected by the electromagnetic radiation emanating from matter, or interacting with it in other ways. Matter can be visible to eye in the optical part of spectrum, as X-rays, infrared, radio waves, hard γ radiation; the whole spectrum is accessible to the wonderful skills and knowledge of astronomers and astrophysicists.

In the last 10-15 years the sum of astronomical observations, the direct ones by electromagnetic radiation and by gravitational anomalies led to a suspicion among many astrophysicists that the actual matter density in Cosmos is close to the critical one determined from the knowledge of observed $H_{sec^{-1}}$ and that subsequently the global Cosmos space geometry is nearly flat. In 1998 came the shock of discovery that Cosmos is expanding with acceleration. It is noted that the acceleration of Cosmos expansion together with the Hubble law yields exponentially fast Cosmos expansion rate. The KTOC originated from recognition that as much as the Hubble expansion discovery in the context of EGE and Friedman HI model of Cosmos had dominated the modern cosmogony and cosmology for

²⁹ One can imagine two crumbs of bread lying on a wrinkled table cloth. We stretch the table cloth to straighten the wrinkles and these two crumbs naturally will recess from each other. The cloth is two dimensional, 2D and by stretching we increase the area of the cloth so that all sites on the cloth recess from each other. Since the crumbs are attached to the cloth they recess from each other as do the sites of the cloth to which they are attached. Stretching of the table cloth is analogous to the stretching of 2D space. The crumbs can also move relative to the table cloth, say shifted by a whiff of draft. This would be their peculiar motion.

The same is with the two galaxies as if they are crumbs attached to the sites in three dimensional- 3D space. The analogy is nearly complete. As the 3D space expands the sites and the galaxies attached to them diverge from each other. The crumbs on the table cloth and the galaxies can also move relative to the sites respectively in 2D and 3D spaces. For large distances the Hubble recession velocity is usually large compared with other peculiar velocities of galaxies. This is definitely the case for the distances approaching the event horizon. The Hubble velocities can and do exceed the speed of light and this does not contradict the special relativity. The space expansion has nothing to do with the intrinsic velocities of galaxies in space.

For light the space expansion leads to shifting the radiation frequencies into the lower part of the spectrum since the light geodesic trajectory in space is stretched by the space expansion. The effect is called the red shift and is perhaps the most basic astronomical tool of astronomical observations. It determines the speed with which distant astronomical objects move away from the observers on Earth and hence the distance from Earth, actually from Milky Way, our galaxy. The more distant is the object the older it is. The most distant and the reddest objects are approximately at the so-called particle horizon. The closer astronomers move to the so-called particle horizon the closer they are to the earliest childhood of visible Cosmos and hence closer to Big Bang. On the other hand the event horizon is the distance from an observer beyond which light emitted at the time of observation will never reach.

70 years till 1998 that much the discovery of acceleration of Cosmos expansion in 1998 changes dramatically the course of modern physics, cosmogony and cosmology. The whole perception of Cosmos, life and conscious life on Earth will never be the same if we know that our Cosmos is merely a subdomain embedded in infinitely larger, timeless continuum of dark energy. Although, it may take time for the scientific community to fully appreciate how dramatic are the consequences of acceleration of Hubble expansion and not only for physical sciences but for the entire philosophy and comprehension of inanimate material Cosmos and how inanimate Cosmos is intertwined with life and conscious mind of Man.

The Hubble expansion is in the framework of EGE and Friedman equations and could have been predicted; in fact it was by Friedman and later Lemaitre even prior to the actual astronomical observations by Hubble. Hence it was a great discovery, but well within the science of the time. The acceleration of Hubble expansion, although not in contradiction with the generalized formulation of EGE that includes positive value of Einstein cosmological constant term was unexpected, a massive surprise to physicists and cosmologists. Since then no clue has been found to the nature of matter causing the acceleration of expansion. Nothing in modern quantum field theories shows what this dark energy matter is. However it exists and is invisible. Attempts to explain this matter by quantum vacuum fluctuations led to what is called sometimes the worst prediction in the history of science with theoretical value of the average matter density about 10^{20} larger than the one estimated by astronomers to comply with the observed acceleration. The astronomical evidence yields $\Lambda \approx 10^{-29}$ g/cm³. Why the cosmological constant has this value? This is quite a mystery indeed, but only to those who believe that everything in visible Cosmos should be composed of particles of normal matter that is subject to the grand unification theory of modern physics, or yet the fantasy of the theory of everything.

Quite certainly dark energy is not composed of particles in the frame and in the sense of existing physical theories. The best dark energy can be explained by modern cosmology is just as a number with the value and dimension indicated above that enters the EGE in a manner that does not violate either of the principles of Einstein general relativity. This is exactly the way that the cosmological constant was initially introduced by Einstein, although for a purpose entirely different and having the wrong sign.

Summarizing the present level of knowledge and sticking to facts it can be rather confidently assumed that the acceleration of Cosmos expansion is associated with some invisible matter called *dark energy* that permeates every location in the 4D space/time of Cosmos. A priori there is no reason to believe that dark energy does not permeate the normal inanimate matter and live matter, also us, although this is not paid nearly as much attention as it deserves. Dark energy matter is likely distributed uniformly and isotropically all over the infinite Cosmos³⁰ and can be interpreted as the

³⁰ There is no reason to believe that visible Cosmos has a finite scale. Such scale would have been a constant with dimension of length and no natural law would have been able to explain such cutoff of visible Cosmos. It would be much easier in this case to resign to divine conception of Cosmos on the level of paganism. On the other hand there is the event horizon of visible Cosmos beyond which it is not possible to see Cosmos. The event horizon is a delicate notion not to be confused with the radius of sphere that light passed since Big Bang called the Hubble horizon. The two are different since the Hubble horizon does not take into account the Hubble expansion of space of Cosmos. Forgetting the space expansion we immediately confront a contradiction with Friedman's HI model of Cosmos that says that all 4D locations in Cosmos are equivalent for observers if the distances of observation are great enough from the observer. In mundane classical physics I know only one similar model of a physical phenomenon. This is the renowned Kolmogorov model of homogeneous isotropic turbulence that has played an enormous role for understanding the turbulence phenomenon itself and beyond. The gist of this theory in my interpretation is the concept of coherent constant energy flux injected into a flow of fluid by low entropy source cascading in the space of inverse scales/frequencies to much smaller high entropy scales and eventually ejected out of the flow as chaotic heat. But as the energy flux cascades in the space of inverse scales/frequencies it maps into the real vortices having the scale invariant spectrum of energy in physical space. Although great mathematician Kolmogorov did not use and probably did not think in terms I have used this is what he actually did. As I formulated his concept above it goes far beyond the phenomenon of turbulence in generality since its modifications apply to almost all kinetic coherent phenomena in visible Cosmos. I will try to demonstrate it in this work.

Einstein cosmological constant, although it does not help much and astronomical data indicates that the cosmological constant cannot be a constant in the global 4D space/time. The KTOC solves this inconsistency. The KTOC asserts that all matter in Cosmos is kinetic, like the cells of our bodies and made up by the coherent dark momentum/energy flux cascading in the 4D conjugate momentum/energy space that is mapped into the 4D physical space/time as intermittent kinetic coherent entities.

In the accepted by many cosmologists interpretation dark energy is akin to incompressible ideal fluid with constant density but with negative pressure in the thermodynamical state equation. The hypothetical negative pressure of dark energy creates fictitious force that exceeds the fictitious force of gravitational pull of all other matter in Cosmos and causes the space expansion with acceleration. Naturally, the Friedman equations are modified to include this positive cosmological constant. This interpretation is void of any quantitative conclusions and results. It is contrary to the second law if we agree that the EGE are the time reversible Hamiltonian equations. But there is a catch in that the EGE have malicious BH singularities in the global 4D space/time (R. Penrose, 1964). Therefore they are not valid globally. The reason for this is the noncompliance with the *second law* and kinetic *RSL*. To cure the EGE it is necessary to have some friction forces. Fairly remarkably a friction force does exist. It is a purely quantum mechanical effect that generates a slight viscosity of the 4D space/time itself, or equivalently of dark energy. Dark energy in KTOC is similar to incompressible, but very slightly viscous fluid composed of quanta of space/time having the Planck space/time scale.

Dark energy flux into our Cosmos can be conveniently interpreted as the virtual Planck particles popping out from the DEC, but cannot escape back into the DEC due to an effect similar to Casimir effect for virtual photons. The life time of such virtual Planck particles is defined by the Heisenberg uncertainty principle and would be extremely short if not for the fact that they are enslaved in our Cosmos by strong interactions as composite structures such as protons, electrons and cannot escape back into the DEC. This is similar to the concept that the cosmological constant is the result of quantum vacuum fluctuations, but the calculations should be done correctly and this can be done only in the framework of KTOC. This is how I calculate the correct rest masses of quarks in hadrons, the real mass of protons dominated by gluons, etc.

One of the most surprising results is that the accelerating Hubble expansion would have not existed if not for the tiny viscosity of dark energy that is proportional to the square root of the Planck constant, i.e., $\nu_{\text{darkENERGY}} = l_p \cdot c = 3 \cdot 10^{-23} \text{ cm}^2 / \text{sec}$. This quantum nature of accelerating Hubble expansion is astonishing, but was properly proved in (E. Levich, 2014) and the contemporary value of Hubble constant calculated in excellent agreement with the value furnished by direct astronomical measurements. Notably the theoretical value results in the critical matter density extremely close to the real observed combined matter density comprised of dark energy, dark matter and visible matter hence confirming that the global Cosmos curvature tends to zero, that is Cosmos is nearly flat³¹. However, it will be precisely flat when all visible matter will disappear. The normal visible matter is essentially the fermion matter. If fermions, e., protons and electrons vanish there is nothing for bosons to exist. This is except photons that are elemental matter. Dark matter also does not exist since it is chaos disposed of by visible matter. Visible matter has a finite life time span because of the quantum viscosity above. As small as it is still it matters and will erase visible matter by the mass independent friction mechanism in $R_c^4 \cdot t_p = 3 \cdot 10^{38} \text{ sec} \approx 10^{31} \text{ years}$ We have enough time to live. I note that the vanishing of visible matter via the MBH quantum evaporation is much slower mechanism with the evaporation time $R_c^4 \cdot t_p \approx 3 \cdot 10^{113} \text{ years}$. It is important because the rest mass of coherent quarks in protons determined by the QCD and hence known should be the same as calculated by the KTOC and the latter depends on their life time span. Since the KTOC mass is extremely close to the QCD calculated mass the life time span of protons calculated by KTOC is indirectly and elegantly confirmed.

As slight as the curvature of 4D space/time may be it radically changes the rules of the game. Indeed, it is argued that even the infinitesimal, tending to zero 4D space/time curvature if neglected

³¹ Negative pressure belongs to the whole family of fictitious forces. The forces are called fictitious because they do not generate momentum/energy. The normal, visible matter entity does not exert gravitational force in space/time, but creates curvature of space/time into which it is embedded. This curved space/time and normal matter are intrinsically inseparable one from another. The space/time cannot be empty of matter; more precisely it cannot be without some form of matter. In particular even if there is no normal matter in "empty" space/time there is always present the quantum vacuum with virtual matter fluctuations; virtual matter popping out into the physical space/time and vanishing back into the quantum vacuum. If we believe in the basics of quantum theory and Einstein special relativity, the ESR there is no doubt that this quantum vacuum fluctuations do exist. Moreover they are experimentally observed, for instance as virtual photons caught between two very fast oscillating metallic plates. This is a famous effect, much underrated at the time of its prediction by the Dutch physicists Hendrik Casimir and Dirk Polder in 1948 that demonstrates unambiguously that the quantum fluctuations exert pressure, e.g., on the metallic plates in our normal space/time if they are not allowed by some experimental trick to return back into vacuum. But even if the virtual matter pops in and out with extremely high frequency and cannot be detected by experimentalist observer they still exert pressure on 4D space/time and can be seen as some permanently existing matter. At least it cannot be distinguished by experimental observation from permanent existence of visible and perceived matter in "empty" space/time. Moreover, the virtual vacuum fluctuations of matter must act as a full-fledged stress/energy or what is the same momentum/energy tensor of real matter and hence create a nonzero curvature of physical 4D space/time.

It follows then that empty of matter 4D space/time does not exist. The rigorously inaccessible to observation frequency at which and over it is impossible to detect the difference between virtual matter and what we perceive as real matter must be calculated by a correct theory. I have no doubt that the cosmological constant can be interpreted as the result of high frequency quantum fluctuations. Incorrect calculations of quantum vacuum fluctuations are the reason for the "worst prediction in the history of science" mentioned above, but there is no reason not to calculate them correctly. This is done in this work in and the result is in strict agreement with the observed cosmological constant value in contemporary visible Cosmos.

However, the quantum vacuum of quantum field theories is just an interpretation of the DEC as the quantum vacuum. The reality is much more profound. The quantum fluctuations are an interpretation of the coherent momentum/energy tensor flux from the DEC into the visible Cosmos subdomain. The latter is a kinetic description, while the quantum fluctuations are the dynamical interpretation in familiar language of Hamiltonian quantum physics that intrinsically cannot explain why the cosmological constant is such as it is. It was the task for KTOC to do it.

dramatically violates the *second law* of thermodynamics. Neglecting the space/time curvature however small it may be is to *throw the baby out with the bath water*. The reason is as follows. The gravitational field consists primarily of chaotic, high entropy degrees of freedom ejected by the normal coherent matter. In this sense dark energy and the gravitational field are similar. Both is the curvature of 4D space/time. When masses are relatively small the curvature can be calculated as the action of visible mass only because the contribution of dark matter is small. For large lumps of matter the dark matter is dominant. Their relative contribution can be calculated in conjunction with the tearing force exerted by dark energy. The fictitious force smothers the curvature created by coherent visible matter and associated dark matter. Therefore the tearing force is the source of order, or of negative entropy. Thus the dark energy is the source of negative entropy as we asserted all along and subsequent to the RSL. Eventually the DEC that gave birth to our Cosmos and all matter in it including Man on Earth will drive its baby to death within a finite time span. This death when all visible baryon matter will vanish just means melting in the DEC retuning back all information received from the DEC plus the new information created by the conscious Man species. Although superficially the final and initial states of Cosmos are connected by space/time scale invariance (E. Levich, 2014) they are not equivalent to each other. They are distinguished by the amount of information created by Man. I argue that the consciousness is eternal and was created together with the time concept and the second law&RSL, although it was ported into the human brain only recently as is manifested by the sudden appearance of writing records about 6 thousand years ago. I do not see how the progenitor of Man could be conscious prior to sudden invention of writing that carried the time casual records. On the other hand the time concept in my view has no meaning unless there is conscious perception of time, The conjunctive creation of the time concept and consciousness per se not embedded into material substance resolves this dilemma. Moreover it allows the calculation of the human brain cortex mass. It is a complicated reasoning, but supported by the calculation of brain cortex mass. However, the agreement with the actual mass of human brain cortex is achieved only if the life span of human brain is limited by the biblical 120 years. If this life span is assumed than the agreement is spectacular. is scale invariant Moreover if we do not respect the *second law&RSL* Cosmos will never reach the state of ultimate timeless order, the DEC state.

The assertion can be formulated in a fairly unusual manner. Indeed, the fictitious gravitational interaction, force and field created by the coherent matter is the ejection of accumulated of chaos, the excess of entropy by coherent matter in order to sustain its coherence for as long as possible. This chaos of gravitational field protects coherence of visible matter by preventing, for instance the lumps of matter to fall apart, dissociate into constituent pieces, say Earth into molecules that it is composed of. At the same time say two objects are attracted to each other because if united it is one coherent unit instead of two disparate units. Additional order for this more coherent single unit can come only from a source of order outside the two objects. This source of order should be universal for all uncountable diversity of matter units and composite entities. This universal primal source of order outside of visible Cosmos furnishes the coherent momentum/energy tensor flux into visible Cosmos. The total fictitious attraction force is combined from the intrinsic coherence provided by this 4D momentum/energy flux from the primal source and the protective gravitational cloud of chaos emitted by the coherent unit, as gluons for hadrons, e.g., protons and neutrons and dark matter for composite macro-matter, but also for micro-entities. Indeed, any and all material entities must emit dark matter. Dark matter is absolutely general attribute of mass and the stress/energy tensor more generally. The two can be quantitatively analyzed and their relative contribution calculated. Both are important, the distinct but conjunctive mechanisms of stability and coherence of all visible, fermion matter³².

The above assertion has consequences. Indeed, I assert that the matter ordering into lumps superficially interpreted as caused by the attractive gravitational field has its roots in the primeval source of order outside visible Cosmos, the coherent flux of momentum/energy, or stress/energy

³² Except fermion matter consisting of fermions, protons, neutrons and electrons having half integer spin there is of course boson matter consisting of bosons. But bosons are with one exception of photons are always associated with fermions. They are the carriers of interactions between fermions. Photons of which light is composed of are the only fundamental bosons. Although virtual photons are carriers of electromagnetic from dark energy.

tensor forming all order in visible Cosmos and of visible Cosmos itself. The latter two are inseparable one from another. This primeval order source of coherent momentum/energy molds all normal matter of visible Cosmos into the uncountable diversity of organized, coherent entities. In the steady, or better to say in quasi-steady state that is very different from the steady state, since the former has the beginning and the end while the latter does not, visible matter entities must give back the same amount of momentum/energy, but the high entropy, chaotic one. Order stays and is the source of negative entropy flux and subsequently of coherence of all normal matter entities in Cosmos including life and Man³³.

I repeat myself once and again because, although the logic follows a well-built highway, but with many ramps and the GPS gets confused from time to time. I reiterate that the lumping of indivisible units of matter units into composite entities is made possible by fictitious fields and forces acting at different space/time scales. These are gravitational field and force, weak but infinitely long range, very short range strong force rigidly enslaving quarks in hadrons and its residual remainder the nuclear field and force tying up protons and neutrons in atomic nuclei, electroweak fields and forces responsible for electromagnetic interaction forming atoms and weak interactions metamorphosing protons into neutrons and the other way around, the van der Waal residual force, the remainder of nuclear force responsible for atomic and molecular interactions, osmotic force ostensibly holding the cells of live species of flora and fauna in coherent shape. All these fields and forces are fictitious since they do not do work. They all are the mechanisms implementing imperatives of the *second law & RSL*.

The DEC Cosmos manifests in visible Cosmos as dark energy and looks as if it is the Einstein cosmological constant that is observed by acceleration of Cosmos expansion. The chaotic entropy disposal is manifested as different fictitious fields and forces. Quantum mechanically the disposed chaos is always bosons, or expressed via boson occupation number operators like the spin operator. All bosons except photons, such as gluons holding quarks in hadrons, dark matter holding galaxies and clusters together exist only if visible fermion matter exists. All these are local curvature of 4D space/time, chaos exuded by visible coherent fermion matter entities, from micro scales up to the largest scales of visible Cosmos.

All coherent entities in full analogy with the live entities would not stay alive for long if their mechanism for disposing the refuse of regurgitated nourishment does not work properly. If it does not a live entity suffocates in its refuse, since fresh order cannot enter the entity and replace the refuse. But the mechanisms endowed to inanimate matter are very simple by comparison with the mechanisms of live matter and as result the life time of inanimate matter is usually much longer, except the unstable elementary particles like free neutrons.

And where all the refuse of all the diversity of composite matter in visible Cosmos is disposed into? Eventually the entropic refuse accumulated in visible Cosmos is disposed by the global 4D space/time of visible Cosmos into the timeless DEC via the MBH's and BH's in general. The DEC is timeless and hence does not distinguish between order and chaos. The DEC is the ultimate order of statistical equilibrium. But is not true that the state of statistical equilibrium is the state of maximal entropy and maximal chaos?

³³ It is necessary to distinguish between the KTOC and the steady state Cosmos theory of Fred Hoyle. The latter has no beginning and no end and hence bypasses the act of Big Bang. The steady state Cosmos theory is refuted by the existence of CMB. The KTOC on the contrary predicts the beginning and the end of visible Cosmos, although it does not reject the possibility of Cycles of Times asserted by Roger Penrose.

Yes, it is true for the classical state of equilibrium. But it is not true for the quantum state of equilibrium. There is one and only one quantum state of equilibrium that is the state of ultimate order. This state is the Bose-Einstein condensate of photons, the BEC of photons. Such state cannot exist unless all electrically charged fermion matter up to the last electron or positron disappear from visible Cosmos and the temperature of photon gas is low enough. It is clear that this is when photons become again a part of the DEC. This will be the end of visible Cosmos and this end will be the state of death scale invariant with the state of birth of visible Cosmos in Big Bang³⁴. Rather than death this state is transfiguration.

It is noted that coherent flux into visible Cosmos and the chaotic one out can take place anywhere in the 4D space/time. The coherent flux into visible Cosmos and its disposal as the chaotic flux are not necessarily the causal events. Order can be borrowed by visible Cosmos from the DEC Cosmos from the future or chaos disposed back into the past. The physics of visible Cosmos and matter in it is explicitly quantum mechanical with the future and past phases are explicitly entangled. They past and future are the subdomains of one phase coherent 4D space/time. This naturally does not mean that the life of visible Cosmos is not causal. However, the infinitely larger DEC into which our visible Cosmos is embedded is timeless and hence the interaction between the two may be, or may not be casual. There is nothing strange in it and the quantum phase entanglement in space/time is a valid, experimentally confirmed fact. Although this concept is a bit uncomfortable since it means that we may be in phase coherence not only with our past but also with our future.

The KTOC conclusions are awe inspiring. That all matter and life and conscious life are the mappings of the coherent flux of dark energy from the DEC having different densities is shocking. That all order on Earth is caused by coherent flux of solar radiation that itself in the end of a chain of events is caused by the coherent flux of dark energy from the DEC is uncomfortable I believe that the main reason why these conclusions have not been recognized, or have been by some but hushed up is that the conclusions not only have serious consequences for cosmology and cosmologists, but also uncomfortable repercussion for the mundane affairs on Earth. In particular it was proved rigorously in (E. Levich, 2014) that order on Earth can only increase as long as the oceans exist and there is no reason to believe that the oceans will evaporate. This growing coherence must be accompanied by the growing amounts of chaos disposal into the outer space. Nothing can stop this process sine it is independent of our will or whatever we do on Earth. The growing coherence is inevitably conjunctive with the increasing chaos disposal. If the mechanisms of chaos disposal are overstressed, say by overpopulation with no meaning they will react with vengeance since they must obey the *second law* and *RSL*. The consequences may be the forced depopulation. In fact it is almost inevitable if KTOC is faithfully followed. There are many other consequences for Earth that the KTOC predicts, but this is a separate subject that will be discussed in later publications. In conclusion I would like to note that the KTOC decisively contravenes the prevailing consensus among most in the scientific community that life and conscious mind of Man are entirely the results of Darwinian evolution driven by survival of the fittest selection enhanced by random mutations. The cause of evolution is the coherent flux of dark energy. The cause of life and conscious life is the incredible density of the coherent dark energy flux creating these phenomena. The KTOC equally contradict conviction of most computer scientists that

³⁴ This conclusion is almost identical to the concept of Roger Penrose, except for a fine nuance. Penrose argues that the initial Bing Bang state is conformally invariant to the final end of visible Cosmos and hence the end of the n^{th} visible Cosmos is the Big Bang of $(n+1)^{th}$ Cosmos. I assert that the two states are simply scale invariant, a particular invariance a part of conformal invariance. The scale invariance however requires a dimensionless parameter and such does not exists in the EGE. I find such a parameter below, but to do this it is necessary to introduce the elements of quantum mechanics. The difference then is that the Big Bang birth is purely classical solution of the EGE and quantum electrodynamics that is a conformally invariant theory. I advance the quantum mechanical Big Bang of ultimate coherence. The ultimate coherence means that the results are rigorously quantum mechanical Planck constant independent. However this is illusionary since if it was not for the quantum mechanics the Big Bang phenomenon would have not existed. It is an example demonstrating the non-analytical nature of the phenomenon like BEC of photons. Such exists only because photons are quantum mechanical bosons, but the phenomenon itself can be described as a classical nonlinear field phenomenon. This is not just a fine nuance and the consequences are fairly dramatic. In no way it casts shadow on the extraordinary theory of Roger Penrose, but rather adds to this theory.

computers of not so distant future will become conscious by the sheer speed of calculations and memory storage.

Nevertheless, I see no manner in which the conclusions of KTOC can be escaped. Indeed, if visible Cosmos is a closed system its total chaos and entropy should be growing with time approaching "Heat Death", the classical thermodynamics state of maximal possible chaos predicted by some of the founders of thermodynamics in the second half of 19th century. This is the *second law* for closed systems and nothing can violate the *second law*. Since visible Cosmos is expanding with acceleration it is irrefutable that the global order is growing and visible Cosmos is approaching timeless ultimate order of the DEC, the quantum state similar to the BEC of photons as has been discussed above, but at the Planck frequency divided by R_C^2 , i.e., $\Omega_{Cosmos}^{End} = t_p^{-1} / R_C^2 \approx 3 \cdot 10^{-39} \text{ sec}^{-1}$.

This frequency is scale invariant to the initial Planck frequency as the end of Cosmos time is scale invariant with the Planck time. Both the photons of Big Bang event and the end of Cosmos event are perfectly coherent states similar to the BEC of photons. This is what dark energy is. There is no other alternative that would comply with the unimpeachable *second law* & *RSL* in conjunction with the firmly established fact of acceleration of visible Cosmos expansion.

It is inexplicable that although the *second law* of thermodynamics has been taught to all students of science and engineering for the last 150 years the modern leading scientists with few vocal exceptions, have their eyes wide shut and minds closed to the awe inspiring implications of the *second law*. As I emphasized a number of times the vocal exceptions are the famous Erwin Schrodinger in his book "What is Life" (1944 and 1953) and Roger Penrose bringing up the significance of the second law in his books of extraordinary intellectual depth.

RESULTS AND CONCLUSIONS

I would like to demonstrate certain explicit quantitative results that have been obtained in the framework of KTOCK. In the Table below I show the theoretical KTOCK results in the left column and compare them in the middle column with the latest available experimental data, astronomical observations data furnished by the Planck mission 2009-2013 and when needed some other most precise observations so far. I also indicate the rare instances where some results obtained from the existing Hamiltonian physics can be compared with the KTOC calculations. The KTOC calculations can be followed in (E. Levich, 2014) and fortunately they are relatively comprehensible. The Table of results is the edited version of the published one. New results have been added and several serious misprints corrected. As I pointed out above the richness of the results and above all the astonishing concurrence with diversified experimental data had confused me. However, in the course of time I have started to genuinely believe that the KTOC is a fairly natural one, despite the rather puzzling conclusions it leads to. It is much more puzzling that the kinetic second law & *RSL* have not been recognized even while lying on the surface for 150 years.

Theory	Astronomic observations best fit of NASA's WMAP satellite and Planck telescope Mission 2009-2014	Previous Theories
Basic Cosmological Parameters		
<p>Contemporary Hubble constant: $H \approx 2.35 \cdot 10^{-18} \text{ sec}^{-1}$.</p> <p><i>The Hubble constant explicitly depends on the quantum mechanical Plank constant. Were it not for the quantum mechanics there would be no Hubble expansion! Hubble expansion as follows from Friedman equations is illusory and has no meaning. Hubble expansion can be only accelerating, caused by the DEC source of negative entropy flux into Observable Cosmos. The meaning of accelerating Hubble expansion is the inexorable growth of global order of visible Cosmos. Everything in Cosmos must have common sense, rather than being random or mystical, or even worse quasi-scientific.</i></p>	<p>Contemporary Hubble constant: $H_{\text{mission2013}}^{\text{Plank}} \approx 2.25 \cdot 10^{-18} \text{ sec}^{-1}$ <i>and is ΛCDM model dependent.</i></p> <p><i>However the direct measurement disagree with this value and consistently show the values very close to the theoretical KTOC value of this work in the left column. I stand by this value of contemporary Hubble constant rather than the model dependent values</i></p>	Do not exist
<p>Contemporary contribution of visible, "normal" matter to the total matter density neutrinos: $\approx 4.91\%$ Neutrinos contribution is just 0.1%</p>	<p>Contemporary contribution of visible, "normal" matter with no neutrinos to the total matter density: $\approx 4.90\%$.</p>	Do not exist
<p>Absolute value with no neutrinos: $0.0464 \cdot 10^{-29} \text{ g} \cdot \text{cm}^{-3}$. <i>Compare with the empirical value in the middle column.</i></p>	<p>Absolute value based on the assumption of flat Cosmos, and empirical estimate of the total number of stars in Observable Cosmos: $0.0410 \cdot 10^{-29} \text{ g} \cdot \text{cm}^{-3}$.</p>	
<p>Dark matter contemporary contribution to the total matter: =26.8%. <i>Explicit calculation one finds in the endnotes of E. Levich, 2014</i></p>	<p>Dark matter contemporary contribution to the total matter: 26.8%; Planck telescope mission data.</p>	
<p>Total matter density including dark matter and dark energy: $\sim 0.97 \cdot 10^{-29} \text{ g} \cdot \text{cm}^{-3} \approx \Lambda$</p>	Total matter ???	
<p>Contemporary Critical matter density based on theoretical Hubble constant above: $\sim 0.997 \cdot 10^{-29} \text{ g} \cdot \text{cm}^{-3} \approx \Lambda$ <i>Compare with the total matter density above.</i> <i>It proves that all types of matter is one dark energy in three manifestations!</i></p>	<p>Critical matter density based on the Planck telescope Hubble constant above and Friedman equations: $\approx 0.86 \cdot 10^{-29} \text{ g} \cdot \text{cm}^{-3}$</p>	

<p>Amazing flatness of the Contemporary visible Cosmos is proved. Visible Cosmos is nearly in the "middle" of its lifespan at: $T_{contemporary}^{visible} \leq t_p \cdot R_C^{3/2}$, $T_{lifespan}^{visible} \cong t_p \cdot R_C^2$ where $t_p \approx 3 \cdot 10^{-33} sec$ is the Plank time unit.</p>	<p>Approximately observed and long suspected.</p>	<p>Qualitatively explained in inflation Theories in conjunction with the EGE , but no specific numbers follow from the theories.</p>
<p>Hubble age: $\approx 13.508 \cdot 10^9 years$ <i>Note that the Hubble age is not the age of Cosmos. The Hubble "constant" is not constant in this theory. Neither is the Einstein cosmological "constant".</i> <i>The universal constant is the dimensionless:</i> $R_c = 10^{41}$ <i>It is likely that for several hundred millions years of post-inflation deceleration of Cosmos expansion the Hubble constant was smaller. Thus the discrepancy between the two numbers.</i></p>	<p>Cosmos age: $\approx 13.840 \cdot 10^9 years$ <i>In the framework regular Big Bang theory and red shift observations.</i> <i>Note that the Hubble age is not the Cosmos age. Hubble constant is not constant in the theories based on Friedman equations.</i></p>	<p style="text-align: center;">Do not exist</p>
<p>Total visible matter within the event horizon $46 \cdot 10^9 years$; $1.38 \cdot 10^{56} g$.</p>	<p>Total visible matter within the event horizon based on flat Cosmos assumption and empirical data $\approx 2.46 \cdot 10^{56} g$.</p>	
<p>Inflation stage: lasts $10^{-23} sec$ post Big Bang. <i>Inflation does not require hypothetical inflaton fermion matter.</i> <i>The cause of inflation is the compliance with the second law and RSL</i> <i>The tremendous momentum/ energy flux of ultimately coherent light of Big Bang must be separated from the DEC into the nearly flat space/time. However coherent visible matter density should be slightly above the critical starting deceleration of expansion.</i> <i>Calculations show exactly this at the event time when the Cosmos volume is</i> $L_c^3 = 10^{24} cm^3$.</p>	<p><i>Promising astronomical observations of the inflation imprint on observable CMB are in progress.</i> <i>The observations are focused on gravitational waves caused by tremendous impact of inflation on the initial hypothetically highly inhomogeneous space/time that would smother the inhomogeneity's making the space/time flat as is contemporary observed.</i> <i>The initial spectrum of quantum density fluctuations of the hypothetical Inflation matter is believed may explain the density distribution of contemporary visible matter.</i></p>	<p>Inflation stage: $\approx 10^{-35} \div 10^{-33} sec$ No photonic Big Bang <i>Einstein cosmological "constant" is not really constant in inflation theories.</i> <i>Instead "inflaton", a new hypothetical form of matter causing inflation is postulated.</i> <i>The inflation decay is the source of all visible matter in Cosmos.</i></p>

<p><i>Flat space/time as the imperative result of chaotic nature of gravitational degrees of freedom and curvature of space/time. However, chaos does not exist prior to birth of time. The ESR time concept does not exist prior to the birth of protons, the nonzero rest mass particles.</i></p> <p><i>The two are born together in inseparable compliance with the ESR requirements for measurement of time.</i></p> <p><i>Measuring time requires at least two clocks made of a nonzero rest mass matter and light synchronizing the clocks.</i></p> <p><i>Hence inflation stage is the inevitable consequence of Big Bang light coherence</i></p>	<p><i>The imprint of inflation via the tiny trace of primordial gravitational waves caused by inflation and left on observable CMB, if such exists does not depend on a cause of inflation.</i></p>	
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Conjunctive Basic Parameters of Protons, Electrons and Physical Interactions

<p>Proton rest mass due to quarks $m_{proton}^{quarks} \approx 10^{-26} g$</p>	<p>Not possible to measure directly</p>	<p>QCD computations based on the experimental input of the total rest mass of proton results: $m_{protons}^{quarks} < 1.67 \cdot 10^{-26} g$</p>
<p>Proton total rest mass due To gluons + dark matter and quarks: $m_{proton} \approx 1.69 \cdot 10^{-24} g$</p> <p>Lifespan: $3 \cdot 10^{38} sec = 10^{31} years$</p>	<p>Proton total rest mass due to gluons and quarks: $m_{proton} \approx 1.67 \cdot 10^{-24} g$ Stability: $> 10^{30}$ years</p> <p><i>There is other data furnishing much longer stability time, but it depends on particular mechanisms and hence irrelevant.</i></p>	<p><i>Proton is extraordinary complex composite particle consisting of three quarks with total charge of opposite sign and equal to that of electron.</i></p> <p><i>This is final remarkable conclusion of the famous theory started as Ne'eman, Gel-Mann eight fold theory that later led Gel-Mann and Zweig to postulate quarks.</i></p> <p><i>Proton mass is assumed given</i></p>

<p>Electron rest mass: $\approx 0.90 \cdot 10^{-27}$ g</p> <p>Round ball of radius: $r_e = \lambda_c / \pi \cdot \alpha (1 - 4 / R_c^{1/2})$, where $\alpha = 1/137$ is the fine structure constant, filled with dark energy.</p> <p>Electron self-energy at the center $r = 0$ is: $\Sigma_e = m_p \cdot (1 - \alpha) = (136/137) \cdot m_p$. <i>Thus, the Landau pole problem does not exist resolved.</i></p> <p>Lifespan: $3 \cdot 10^{38}$ sec = 10^{31} years equal to life span of proton and visible Cosmos.</p>	<p>Electron rest mass: $\approx 0.91 \cdot 10^{-27}$ g</p> <p><i>Elementary particle.</i></p>	<p><i>Considered a given fundamental Constant</i></p> <p><i>Considered a point having no internal structure.</i></p>
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<p><i>Electron is a genuinely elemental particle inseparable from photons.</i></p> <p><i>Stable electrons/positrons are born quite late after the birth of protons.</i></p> <p><i>Electrons/positrons are whole made of the coherent flux of dark energy. Can be interpreted as "trapped" virtual Planck particles.</i></p> <p><i>The cloud of virtual photons is chaos ejected by coherent electrons/positrons to maintain coherence for the whole lifespan of visible Cosmos.</i></p> <p><i>The exchange by virtual photons is the mechanism of electromagnetic interaction.</i></p> <p><i>The latter is the first order effect in powers of the fine structure constant.</i></p> <p><i>Electroweak c forces play no less role in the structure of protons than the strong force does.</i></p> <p><i>It is the unified electroweak force defining the internal structure of protons furnishing them with two internal scales deep inside the proton curled "string".</i></p>		<p><i>Electron mass: is assumed given.</i></p> <p><i>Electron is assumed elemental and forever stable.</i></p> <p><i>The electroweak theory unifying the electromagnetic and weak forces explains everything except the large mass of W and Z bosons.</i></p> <p><i>These are fundamentally important for digging inside of protons and neutrons transforming hem one into another.</i></p> <p><i>The cause for it is obvious. Atoms nuclei would have not existed if not for the nuclear attraction between protons and neutrons.</i></p> <p><i>This attraction neutralizes the Coulomb repulsion of protons.</i></p> <p><i>Thus atoms are forced to form by the same RSL as all other coherent entities in visible Cosmos.</i></p> <p><i>The RSL is the cause. But the mechanism of the atom formation requires neutrons; Weak interaction procures neutrons from protons.</i></p> <p><i>Otherwise neutrons would have not been needed. But the coherent Planck particles flow from the DEC must build coherent inanimate matter to form stars and other useful entities.</i></p>
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<p><i>The vibration at the bigger of the two scales generates the "sound" cloud of virtual gluons, while the higher frequency sound of the smaller scale vibrations probably generates much heavier W and Z bosons. However, the boson mass above is higher corresponding to the apparently observed mass of Higgs boson. This latter assertion is preliminary! If confirmed the result is fairly remarkable.</i></p>	<p><i>W and Z bosons have been detected long ago. All other predictions of electroweak theory were confirmed.</i></p> <p>Higgs boson has been tentatively detected: $M_B \approx 125 \text{ GEV } / c^2$</p>	<p><i>One of them is Sun and Earth is circling around Sun in a good position.</i></p> <p><i>This is where the animate life will emerge and evolve out of order extracted from the solar radiation. But the fact of life emergence is revolutionary event possible only due to the dark energy flux.</i></p> <p><i>For the heavy nuclei the balance of forces cannot hold and the nuclei start decomposing radioactively.</i></p>
<p>Visible matter, MHB's and Visible Cosmos lifespan: 10^{31} years</p>	<p><i>Too early to be sure. However, the electron mass and the coherent mass of protons due to quarks are in exact agreement with this life time span.</i></p>	<p>Visible matter, MHB's and Visible Cosmos lifespan: Roger Penrose, 2010: $T = T_{\text{life span}}^{\text{MBN}} \cdot R_c^2 = 10^{113}$ years</p>
<p>Higgs boson?</p> <p>$M_{\text{boson}}^{\text{Higgs}} \cdot c^2 \approx 127 \text{ GeV}$</p> <p><i>As mentioned above I am not sure that the above is the boson recently observed and believed the Higgs boson. But it does not seem impossible.</i></p> <p><i>I mentioned above the possibility that the proton string vibrates with two distinct frequencies.</i></p> <p><i>The energy of the one corresponds to the generation of gluons with good accuracy when the energy of vibrations is compared to the rest mass/energy of protons.</i></p> <p><i>The other frequency may correspond to much more massive "sound" bosons.</i></p> <p><i>It is a preliminary assertion</i></p>	<p>Higgs boson</p> <p>$M_{\text{boson}}^{\text{Higgs}} \cdot c^2 \approx 125 \div 126 \text{ GeV}$</p> <p><i>Preliminary data. Experiments in progress</i></p>	<p>Higgs boson</p> <p>$M_{\text{boson}}^{\text{Higgs}} \cdot c^2 \approx 125 \div 127 \text{ GeV}$</p> <p><i>In the framework of Grand Unification it is believed that the Higgs bosons is defining the attribute of mass and carrier of Gravitational force.</i></p> <p><i>This concept is similar to the electroweak and QCD theories. In these theories virtual photons and virtual heavy W and Z bosons are the carriers of respectively electromagnetic and weak interactions, while virtual boson gluon is carrier of strong interactions.</i></p> <p><i>I disagree with the Concept of Higgs particles as defining the attribute of mass, although the new Higgs boson and field may exist in association with strong and other fictitious forces/interactions.</i></p> <p><i>In fact photons, W&Z and gluons are all the Higgs particles in the sense that they are the carriers of respective interactions.</i></p>

<p>Universal Unified Strong Force value: $\mathbf{F}_{\text{strong}} \approx 4.65 (e^4 / G) = 0.565 \cdot 10^9 \text{ dyne} =$ $= 0.565 \cdot 10^4 \text{ Newton.}$</p> <p><i>Properties proved:</i></p> <p><i>1. Confinement is proved from the above distance independent expression;</i></p> <p><i>2. Asymptotic freedom is obvious for the scales deep inside protons:</i> $\approx 1.97 \cdot 10^{-14} \text{ cm.}$</p> <p><i>The asymptotic freedom is caused by competing of the scale independent $\mathbf{F}_{\text{strong}}$ and electrostatic self-repulsion of the likewise charged quarks with the total charge equal the minus of the electron charge.</i></p> <p><i>Although the model is crude it furnishes excellent results for the proton rest mass due to the virtual gluons.</i></p> <p><i>It works as if $\mathbf{F}_{\text{strong}}$ compresses the quarks to the above distance and their electrical charge resist the compression thus balancing $\mathbf{F}_{\text{strong}}$.</i></p> <p><i>Therefore the asymptotic freedom seems apparent.</i></p> <p><i>More fundamentally it follows from the minimal possible length scale, the Planck scale to be sure.</i></p>	<p>Strong Force value: $\sim 10^4 \text{ Newton.}$</p> <p><i>Properties established:</i></p> <p><i>1. Confinement;</i> <i>2. Asymptotic freedom.</i></p>	<p>Do not exist.</p> <p><i>Properties:</i></p> <p><i>1. The infrared confinement at large distances and small moment has not been proved in the framework of QCD! We believe it will not be. It does not exist in the Hamiltonian physics, in particular in the QCD that does not pay respect to the second law and RSL. Hence, the great rewards announced for the proof that confinement is intrinsic to QCD will likely remain unclaimed.</i></p> <p><i>2. The ultraviolet asymptotic freedom in the QCD was proved in the perturbative QCD theory and rewarded, deservedly the Nobel prizes.</i></p> <p><i>Far from contesting the significance of this proof we would like mentioning that QCD does not have any natural scale independent coupling parameter, the problem typical for the Hamiltonian equations, except the unique quantum electrodynamics.</i></p> <p><i>Subsequently thy typical logarithmic decreasing of the coupling constant at small distances. This is an artifact of perturbation theories lacking a natural cutoff scale.</i></p> <p><i>When such intrinsic scale is lacking inside the protons there is no mechanism of ejecting the chaotic cloud of gluons of responsible for the strong force and the total mass of protons . It is this cloud that protects the coherent quarks core of protons making them so amazingly long lived.</i></p>
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<p><i>At this scale the fictitious nonlinear force, whether calculated as fictitious gravitational force or the fictitious Euler one, transforming the coherent momentum /energy flux from the DEC into the chaotic one for disposal back into the DEC is exactly equal to the quantum viscosity dissipation term. Hence protons melt within the DEC.</i></p>		<p><i>This is the reason why neither the strong force value nor the mass of proton can be calculated. This is why the primal proton is not a solution of any equation of physics.</i></p> <p><i>The QCD as all other Hamiltonian physical theories do not and cannot impose the existence of coherent entities.</i></p>
<p>The ratio of coherent visible matter and chaotic dark matter emitted by visible matter is a constant fixed in time.</p> <p>The ratio is: 0.183.</p>	<p><i>Cosmologists will be testing this prediction till the end of times. Nevertheless, it is confidently valid number.</i></p>	<p align="center">Do not exist</p>
<p><i>The asymmetry between matter and antimatter content in visible Cosmos is explained in a fairly transparent manner.</i></p> <p><i>Coherent momentum/energy flux and the corresponding negative entropy flux into visible Cosmos map into the matter content.</i></p> <p><i>The positive entropy flux, the flux of chaos would correspond to the excessive antimatter content in visible Cosmos.</i></p> <p><i>DEC is the source of negative entropy into visible Cosmos.</i></p>	<p>Well established fact.</p>	<p>Do not exist.</p> <p><i>Considered a mystery. But there are no mysteries in visible Cosmos, rather the perceptions of strange facts create mysteries.</i></p> <p><i>As soon as one accepts the primeval source of Cosmic order and the goals of this source there are no mysteries left.</i></p> <p><i>Instead we are learning various mechanisms of ever increasing beauty implementing the will of the second law and RSL.</i></p>

Self-Conscious Human Brain Parameters

<p><i>Human brain self-consciousness is related to the concept of time and the primordial DEC source of coherent momentum/energy flux forming the brain cortex.</i></p> <p><i>The coherent dark energy flux forms all matter in Cosmos, inanimate, animate and conscious.</i></p> <p><i>However the flux is highly intermittent in physical 4D space/time and different in value, both as the total flux per unit of time erg / sec and the flux density per unit of time, erg / cm³ · sec .</i></p>	<p><i>The attribute unique to Man is well known.</i></p> <p><i>It is proclaimed in Genesis in the eternal verse that Man is made in the image of Creator.</i></p> <p><i>In the mundane sense Man creates order, is endowed with abstract comprehension of time. Not only of material time, but also of the time "Before Adam" and the future beyond his/her lifespan.</i></p>	<p>Concept does not exist.</p> <p><i>The closest was promoted by Roger Penrose in his profound quantum mechanical concept on the nature of self-consciousness and nonalgorithmic thinking of Man</i></p>
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<p><i>The flux forming the cortex of human brain within the typical volume of $\sim 10^3 \text{ cm}^3$ has the extraordinary density:</i></p> $F_{HB}^{DE} = 10^8 \left(\frac{1}{R_c^2}\right) <F> = 3 \cdot 10^{63}$ <p><i>erg / cm³ · sec, where the average dark energy density flux in Cosmos is:</i></p> $<F> = 3 \cdot 10^{35} \text{ erg / cm}^3 / \text{sec}.$ <p><i>The flux F_{HB}^{DE} is non-interrupting furnishing the maximal possible phase coherence with the DEC throughout the Man's lifespan.</i></p> <p><i>The flux $<F>$ kinetically maps into the dark energy density $\Lambda \approx 10^{-29} \text{ g / cm}^3$.</i></p> <p><i>causing acceleration of Cosmos expansion.</i></p>	<p><i>The ability of nonalgorithmic thinking is also obvious.</i></p> <p><i>Nevertheless, the persistence with which many scientists are anxious to delegating Man to smart computers, or the other way around are truly monumental and unceasing despite clear realization that Turing like computers cannot resolve NP problems</i></p>	
<p><i>The birth of self-consciousness coincides with the birth of proton and the time concept at</i></p> $t_{event} = 3 \cdot 10^{-3} \text{ sec}.$ <p><i>This takes away the conflict on the nature of time prior to the birth of Man capable of conscious understanding of time and causality, perception of the past future not based on instinctive experience.</i></p> <p><i>The above argument are not in conflict with the evolution of inanimate matter in visible Cosmos, trans and the evolution of life on Earth.</i></p> <p><i>Except the emergence of life and consciousness singularities evolution has proceeded at its own pace in accordance with the laws of physics and mechanisms of absorbing order from the solar radiation, disposal of species not fit for survival as prescribed by Darwin's selection of the fittest</i></p> <p><i>At an appropriate time the self-consciousness is ported into the most suitably evolved animal body and brain.</i></p> <p><i>This is the birth of the whole conscious Man that probably coincides with the 4th millennium BC.</i></p> <p><i>Since then the evolution goes on and the amount of order on Earth will be ever growing which may be not perceived by particular generations.</i></p>	<p><i>The pioneering work of Roger Penrose on quantum nature of consciousness encouraged me to relate consciousness with the coherent flux forming the human brain as it does all other inanimate and animate matter.</i></p>	

As will go on the weeding out of the species, races, individuals not fit for survival as well as manmade coherent entities; societies, ideologies, states and Empires.

As soon as the constituent units of these entities lose coherence of purpose, the procreation drive and coherent creativity the entities are not fit for survival.

This is especially painful for races and Empires incapable of comprehending the remorseless second law and RSL.

There is no fairness and unfairness in the manner these laws prosecute their task of growing order towards the ultimate order of the DEC.

Man is given the task of bringing new information created by him to the DEC. The DEC is timeless and void by itself of material processes thus not able enriching itself unless through material Cosmos.

DEC is the infinite capacity reservoir of coherent Information. The DEC shares it with visible Cosmos and Man by the gift of life processes.

In the end Man must not only return back the debt of life but also pay interest by giving the DEC information that had not existed, and was created by Man himself.

For the enhanced creativity Man is given the free will of choice between good and evil, right and wrong.

This is a theological concept having the eternal significance for Man and his creations.

The typical weight of the Human brain is calculated in the manner I calculated the coherent mass component of protons due to quarks.

However, rather than calculating the lifespan of the human brain cortex I assume that the upper limit is the Biblical 120 years.

Then I receive for the rest mass, or weight of the brain cortex:

$$M_{\text{cortex}}^{\text{brain}} \approx 10^8 m_p = 1000 \text{ g}$$

This calculation no doubt maybe seen as peculiar to say the least.

But if to think about it with no preconceived animosity the result ties up many loose ends with the problem of consciousness giving the concept material and rational.

Most importantly it reinforces the above assertion that the extraordinary complexity of human brain is formed by and actually is the highly dense coherent momentum/energy flux.

This is a fairly rigorous result, not less than the calculation of the coherent component of proton rest mass due to quarks.

The remarkable fact is the appearance of the ubiquitous factor

$$R_c^{1/2} \approx 3 \cdot 10^{20}$$

in the calculation connecting the coherent human brain cortex component mass and lifespan with the fundamental dimensionless constant of visible Cosmos that also defines the visible matter mass in Cosmos and its lifespan.

What is special about the Biblical lifespan? It is easy to estimate that the combined space span of passing by the above 10^8 locations in the human brain is near to the distance passed by light since Big Bang.

I interpret it in a cavalier manner as the indication of the phase coherence connecting the human consciousness since its birth at the birth of time till the present time, but also with the future.

The phase coherence does not distinguish between past and future. It is the fundamental quantum entanglement serving the preservation of information.

The DEC as incompressible media is the conductor of phase coherence in the total 4D space/time of visible Cosmos.

The human consciousness scans the history of visible Cosmos from the start to the present time. But it is as phase coherent correlation with the future of Cosmos.

This is the conclusion of this review that the self-consciousness attribute of Man is timeless.

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Endnotes

ⁱ In this endnote I would like to briefly describe an aspect of growing order on Earth. This order quite despite what we may think about it during our short life time span is growing almost every day for millions of years and will have been growing as long as oceans exist on Earth and the oceans are unlikely to vanish in the next couple of billion years. Neither the Man species will disappear as long as the dark energy and a coherent part of solar radiation furnish order to Man and Earth respectively. This amazing phenomenon of growing order on Earth and subsequent assurance of human species survivability and evolution starts modestly and has its cause in divine coherence of global atmosphere and oceans on Earth. For more details and rigorous proofs I again must refer to (E. Levich, 2019, E. Levich, 2009). Briefly the mechanism of coherence of atmosphere and oceans is the ubiquitous turbulence phenomenon implementing the demand of the kinetic second law&RSL. Tropical hurricanes is an imperative component of climatic order in midlatitudes that makes possible life on Earth.

Also a number of comments will be made emphasizing the amazing similarity between seemingly unconnected nonequilibrium kinetic phenomena complying with the kinetic second law&RSL.

In (E. Levich, 2014) I show the Visual Field measurement of tropical hurricane Bonnie, a typical hurricane, carried out by NASA in August 2001 and analyzed in (Molinari J and Vollaro D, 2008). Order of the Bonnie core is shown in dense red color. Bonnie emits protective chaos around itself painted in receding depth of red. This chaos what is usually perceived as turbulence, say when the pilot on a plane tells passengers that the plane is entering the zone of turbulence.

In reality it is the disposal of chaos/entropy accumulating in the core of clouds and the large cores of tropical hurricanes alike. The disposed chaos forms protective entropic halo around the core. The entropic haloes of tropical hurricanes stretch for hundreds of miles in all directions and defend the cores coherence all the way to land. Disposal of entropy allows hurricanes maintaining organization till the time they reach land and fulfil their mission. We usually see the hurricane mission as wonton destruction. In reality this is a benign mission. To understand how necessary tropical hurricanes are it is necessary to view them in the context of global circulation of Earth's atmosphere in conjunction with the oceans currents, e.g., the Gulfstream. Atmosphere and oceans on Earth is one coherent organization of awesome complexity.

The principles upon which this organization is functioning have been understood very superficially and as a rule their complexity is greatly underestimated. The basis of atmosphere/oceans organization is the conjunctive turbulent motion of fluids, air and water of the respectively atmosphere and oceans. On the top of it there are multiple, particular physical and chemical mechanisms interacting with turbulent motion of atmosphere and oceans.

The turbulence phenomenon has remained badly understood, except semi-empirically. As a result the science of meteorology and climatology is in the fetus stage. The child is yet to be borne.

In particular the structure and life of tropical hurricanes is tremendously complex. Despite hundreds years of studies and huge empirical experience of seafaring nations the quantitative understanding of their nature is hardly more advanced than the fundamental understanding of origin of order in Cosmos. But equally we have no idea why ants organize and build ants hills, except by referring to the platitude that if they did not they would have not been ants. This work is an attempt to seed out the most general and common laws behind seemingly different types of order in visible Cosmos and on Earth.

Tropical hurricanes are not just the destructive monsters. Looking at them scientifically, it may be hard for some who experienced them *in situ*, tropical hurricanes are benign and crucial for supporting life on Earth. Tropical hurricanes bring warm air and humidity from equatorial zone to

the mid-latitudes in Northern and Southern hemispheres. If not for the tropical hurricanes temperatures would be greatly lower in the mid-latitudes and intolerably high close to the equator.

It does not mean that water and air molecules arriving on land are all brought from the tropical altitudes. Water brought to land is mostly the ocean water from latitudes far away from tropical and close to the site of hurricane landingⁱ.

Hurricanes are the perturbation passing through the atmosphere and hovering over water. Their cores drag the warm air and share the warmth with the colder air in their path. The hurricane's motion is the momentum/energy flux through and with the air fluid elements of the atmosphere and water droplets. Hurricane in physical space is the manifestation of coherent flux of momentum/energy in the conjugate space of inverse scales and frequencies. In physical space the flux is passed via the interaction of more energetic air fluid elements with the less agile and the replacement of the latter. This is called turbulent diffusion implemented by the fictitious Euler force in the Navier-Stokes equations, the NSE describing all flows of Newtonian fluids in nature. Turbulent diffusion is many orders of magnitude larger than the molecular diffusion, but would not exist with zero molecular viscosity. The latter can tend to zero but not be equal to zero. Were it zero the *second law&RSL* would be violated.

What the above shows is that there is no analytical smooth transition from the physics of turbulent flows of fluids having arbitrary small but nonzero viscosity and perfect fluids with zero viscosity. In fact the whole phenomenon of turbulence in fluids, one of the most important and wide spread in Cosmos would have not existed if not for the fact that all fluids have fundamentally nonzero viscosity resulting from the molecular, corpuscular structure of fluids. This is true even for the fluid motion on the scales arbitrary large compared with the average distance between the molecules and in this sense the fluid is a continuous media. Indeed, neglecting the corpuscular structure of any and all fluid media, i.e., neglecting viscosity however small it may be is violating the *second law&RSL* and hence necessarily a disastrous mistake.

This can be reformulated in more general terms not connected with fluid mechanics. The statement is that unless irreversible friction and subsequent viscosity of media is not zero however small these may be there is no analytical transition in the corresponding equations of physics to a perfect situation of zero friction and zero Newtonian viscosity. In the former case the *second law&RSL* are paid respect to and in the latter not. This is the basic truth that is missing in all fundamental Hamiltonian, time reversible equations of physics, except the Einstein gravitation equations, the EGE and the NSE. The NSE is the empirical since the viscous term cannot be derived. The EGE is singled out since it was proved by Roger Penrose in 1964 that the EGE have an intrinsic, incurable black hole type singularity in the global 4D space/time.

In fact they are curable if a tiny quantum mechanical viscosity is taken account of. This is the viscosity associated with Einstein cosmological constant or dark energy matter that was explicitly derived in (E. Levich, 2014). However, the dark energy viscosity is actually the intrinsic viscosity of 4D space/time and subsequently the EGE enriched by viscosity will not be Hamiltonian anymore, but kinetic and respecting the *second law&RSL*.

It is quite a blessing that the quantitative results of this work can be obtained bypassing the yet not derived kinetic equations of gravitation. Looking ahead I assert that in the kinetic EGE the cosmological constant will be replaced by the primordial DEC source of coherent momentum/energy flux into observable Cosmos, forming all three forms of matter in Cosmos with all these forms of matter, visible matter, dark matter and dark energy being the three kinetic states of the dark energy continuum-the DEC. Of course the full theory must be formulated as closed gravitation equations and this will be done in the long run since the basic physical principles seem well defined herewith. Such equations presumably will be the long sought Einstein quantum

gravitation equations- the Q-EGE- of general relativity explicitly complying with the *second law&RSL*.

Let us go back to tropical hurricanes that are complex in their own right. I would like to note that the complexity of seemingly common phenomena in inanimate matter such as hurricanes, ocean currents and atmospheric stream jets and even the usual clouds is so phenomenal that it is hard to reconcile with. And still it is infinitely less so when compared with life and conscious mind of Man.

Physically the quadratic nonlinearity Euler force standing in the Hamiltonian part of NSE is a fictitious one since it does not do work. The Euler force is a strong interaction term intertwining the different harmonics of continuous fluid motion. It does not change the total momentum/energy of the flow, but creates a constant value co-phased momentum/energy flux in the space of inverse scales/frequencies, the conjugate of the physical 4D space/time. In the particular case of hurricanes the source of coherent momentum/energy flowing into their core is convective clouds rising from the warm ocean surface in tropical latitudes.

The scale of this source is the well-known typical size of convective clouds and they serve as paddles rotating randomly the air of mid to up atmosphere injecting their momentum/energy into the turbulent motion of air. The fictitious Euler force cascades this relatively large scale, low entropy flux of convective clouds into the higher entropy smaller 4D scales without changing the flux value. This creates a multitude of smaller scales vortices with high vorticity, the latter having the dimension of frequencies, that continue to decompose into even smaller ones with their total momentum/energy remaining the same as the total momentum/energy of the large scales.

However, when the vortices are sufficiently small the molecular structure of air starts to play role manifesting as internal friction. Friction always results in energy loss into heat. Eventually at certain small scales the vortices start to dissipate the initially coherent, low entropy momentum/energy of large scales vortices into the chaotic high entropy heat. And what happens with order of the initial coherent vortices? Order cannot disappear and it does not. Order flows into the core of a hurricane and builds coherence up the scale over the initial scale of convective clouds eventually creating and maintaining coherence of the core of the hurricane. The convective clouds serve as the source of negative entropy flux for the hurricanes. The total entropy of hurricanes decreases and order grows. This is order of the coherent hurricane core that is known as the hurricane eye.

If not for the finite span and ellipsoidal shape of Earth's the hurricanes core would grow in size indefinitely. In entirely symmetric environment these would be clockwise and anticlockwise hurricanes with positive and negative helicity, or parity. However Earth is rotating around its axis. This causes the Coriolis force of opposite swirling directions in the Northern and Southern hemispheres. This breaks the mirror symmetry and thereby hurricanes in the two hemispheres are swirling in opposite directions, as is well known, but also have the opposite sign helicity (e.g., E. Levich and E. Tzvetkov, 1985, G. V. Levina 2013).

But this is not the end of the story. Eventually hurricanes will land wreaking havoc in violent convulsions of death. Therefore where does order of hurricanes disappear? We know that order and coherence cannot vanish in smoke. Order and coherence can be only passed over and metamorphose into coherence of other entities. This is a very complicated problem with most unexpected twists and the only manner to search for the vanished order of hurricanes is to consider the global problem of order and chaos on Earth. This is considered in rough brushes in Chapter 15 of (E. Levich, 2014), although deserves much more extensive analysis.

I would like to make a few pertinent comments. The first one is that Earth is round and in this sense does not have end. It means that the coherence length of turbulent atmosphere is finite and is just

equal to the Earth's circumference different for different latitudes. However, the coherence length does not have end. This is exactly how the global atmospheric periodic circulation is formed on Earth. It is called the atmospheric jet streams sometimes. What is the relation between the atmospheric stream jets and hurricanes? This is complex and elegant. The convective clouds as the source of negative entropy flux goes on pumping the negative entropy and subsequently positive order into the troposphere. The growing order forces the growth of coherence or the scale of correlated motion around the globe. Since the maximal size of the Earth' globe circumference, different for different latitudes, the growing coherence will generate rivers of air in the upper atmosphere flowing in opposite directions in the Northern and Southern hemispheres with the mean speed dependent on latitude. Clearly from symmetry the speed is zero at the equator where the direction of the Air Rivers reverses. These Air Rivers are known as the stream jets of general atmospheric circulation. They are the reason why it takes different time to travel from Europe to the USA and back.

However to stay coherent the stream jets must dispose inevitably accumulating chaos and entropy. This disposal of chaos is what hurricanes are. Although coherent in their own right hurricanes are relatively chaotic, by the number of uncorrelated degrees of freedom compared with the river like atmospheric jets. Therefore although coherent entities in terms of bringing order to land as I described above hurricanes are disposal of entropy sustaining the higher level order of general atmospheric circulation.

Note that tropical hurricanes is the disposal of chaos by the general circulation during the summer period and hence the source of negative entropy and order for the general circulation replenishing its coherence depleted during the winter time. In the Northern and Southern hemispheres it happens during their respective winter and summer times. But the excess of chaos disposed by the coherent general circulation of the Earth's atmosphere in tropical latitudes is the source of negative entropy and order for mid-latitudes .And how order is formed in oceans? Where does order of Gulfstream circling the globe as a huge water river flowing inside the ocean come from? The hurricanes spare some of their order initiating coherence of Gulfstream in tropical latitudes. (E. Levich, 2009).

This is a truly extraordinary conclusion that the flux of momentum/energy in the 4D space of inverse scales/frequencies is at the same time the flux of negative entropy and hence imposes the ever growing scale coherence in turbulence. In retrospective the conclusion seems almost obvious and could have been made in 1923 by Lewis Fry Richardson, an extravagant British scientist and visionary. It definitely could have been made by a famous Russian mathematician Andrey Kolmogorov in 1941, the year he published his seminal work on the theory of turbulence. For reasons that I will analyze elsewhere the conclusion of coherence length growth in turbulence was made quantitative only much later by E. Levich and E. Tzvetkov in their paper of 1985. It was also suggested in this paper that the phenomenon may be of general nature for kinetic systems of which turbulence is just one example. The concept however has been met with incredulity and total negation by the fluid mechanical community. I am embarrassed to admit that it influenced my common sense to such an extent that I *renounced the concept in the review paper of 2009. The concept resurrected fully in much more general interpretation only in 2014 and is the cornerstone of the theory of order in Cosmos as it is exposed in this work. To avoid misunderstanding I have met in my private discussions with some I would like to emphasize that it is not that order in Cosmos originates as it does in turbulence, but the other way around. Order in turbulence originates in accordance with the same general laws of kinetic reverse second law that rule all kinetic phenomena in Cosmos and global Cosmos itself.*

The upscale coherence length growth continues forever unless checked by external factors, e.g., the Coriolis force caused by rotation of Earth around its axis. In particular the hurricane core is one phase coherent structure with all internal rich tornadoes like content rigidly phase correlated with the large scale core itself. The speed of phase correlations propagation can be much larger than the

largest speed of material elements of air in physical space. For incompressible fluids the phase speed is infinite. This phenomenon can be observed in appropriately arranged large scale simulations of turbulence in incompressible fluids and it looks almost hard to believe. For instance the perturbed phase coherence of turbulent flow is restored instantaneously, in a few computer time steps in all infinite fluid volume that is simulated by periodic boundary conditions.

The propagation of phase coherence does not have speed limit since it does not carry full information of the event. The conclusion is that incompressible fluids cannot exist, or if they do exist they can transmit only a phase related signal, i.e., only the phase of an event signal, but not the amplitude (E. Levich, 2009). This fairly profound conclusion is the classics of fluid mechanics that few pay attention to (e.g., George Batchelor, 1967). It has important consequences in what follows and hence an explanation has been in order. In meteorology since air is compressible the reality is that even the phase correlations propagation is limited by the speed of sound. In oceans it is even faster since the speed of sound in water is 4 times higher than in air.

Phase coherent momentum/energy flux in the conjugate space of inverse scales/frequencies maps into a highly intermittent, lumpy distribution of momentum/energy flux in physical space/time domains. The lumpiness or bunching effect is seen as domains of vastly different intensity of vortical motion. The intensity of vortical motion in its turn directly connected with the flux of dissipated momentum/energy in physical space.

It was pointed out above that fundamentally the hurricane core is a vast multitude of smaller scale coherent tornados like vortices within the core that are all phase coherent with each other making the hurricane core one phase coherent entity of outstanding complexity, a task that meteorologists and mathematical physicists are involved into for at least two hundred years and unfortunately are still far from completing.

Smaller scales motion outside the core is chaotic, the entropy disposal by the core. It serves the purpose of preventing the core from suffocation in its own accumulating entropy. This enables the core receiving coherent nourishment from the convective clouds source along its path to land. This is why hurricanes have such a tricky and often unexpectedly changing direction of the trajectory. It is not that hurricanes are moved by wind, since hurricanes is the wind. Hurricanes are looking for the warm spots of the ocean for the best possible extraction of order. It is a truly amazing pattern for the inanimate entity illustrating the enormous complexity and high level of order in turbulence phenomenon.

Hurricanes have genuine metabolism, as do clouds and all other turbulent coherent structures. While hurricanes travel towards the land they are like predators seek warm spots in the ocean to prey on them. From the warm spots the hurricane vortex extracts, sucks up the warm water droplets mixed with air that replace the tired, aged fluid elements of the core. The core is a coherent vortex and air pressure inside the core vortex is lower than the atmospheric pressure around the warm spots. The sea farers have known it for thousands of years. When the eye of the storm passed their ships they were not lulled by its low pressure quiet and correctly expected the fury of the chaos around the eye of the storm coming with vengeance.

This mechanism of nourishment can be called the induced convection. The mixture of air and water droplets from warm spots on the ocean surface is the source of coherent momentum/energy for the hurricanes and thus they replenish order lost in the effort of travelling across the oceans. Eventually the aged tropical hurricanes land and due to friction at the rugged land surface start violent agony of death and decomposition. Both order and chaos is thrown upon the land. Chaos shows as destruction of local order on the ground while order is manifested in the long run furnishing the appropriate environmental conditions most propitious for life in mid-latitudes. Since life stores incredibly more order than any inanimate event and tropical hurricanes in particular it is easy to

conclude that the latter are the messengers of order over a time period. It may seem paradoxical and nevertheless sadly true that the more chaos is locally disposed, the more wreckage is done on land, the more order is transmitted to organization of life, the eventual customer of order and the storage of practically all order on Earth.

Although the source of ever growing order on Earth is the coherent part of solar radiation one should not fall under illusion that life can originate from the solar radiation source, although all preliminary organization and organization of complex carbon and hydrogen based molecules ready to serve life and replication almost certainly stems from the accumulated order absorbed from the solar radiation. However, it is asserted in (E. Levich 2014) that life and conscious life emerges from the extraordinary dense coherent flux of dark energy, the primeval source of order in Cosmos. This assertion allows quantitative calculation of the weight of conscious human brain cortex (see the Table of results above).

With the KTOC paradigm in mind it is easy to understand a profound similarity between the coherent cores of hurricanes disposing turbulent chaos for sustaining their coherence and coherent visible matter of galaxies by forming MBS's at the center and disposing chaos of dark matter haloes around them. The dark matter haloes protect galaxies against the tearing destruction by accelerating Hubble expansion. If not for acceleration the Hubble expansion is neutral to galaxies coherence. Acceleration of Hubble expansion tries to smooth the space curvature caused by galaxies by tearing away stars from each other. The two fictitious gravitational forces of attraction and repulsion must balance each other till the time when all stars will be absorbed by the inner MHB's.

Also, there is profound similarity between the growth of coherent scale of turbulent structure and the growth of coherence scale and lumps of matter in Cosmos. The global phase coherence of atmosphere and oceans is a particular analogue of the global phase coherence of our Cosmos. The latter repeats itself likely in all particular nonequilibrium, kinetic phenomena in Cosmos, from turbulence to microworld and phenomena of life, such as ant hills, flocks of birds and most incredibly the growth of human societies and Empires.

Since 2001 many tropical hurricanes have been observed and analyzed and they all have the same distinct separation of coherent core surrounded by protective entropic haloes (e.g., G.V. Levina, 2013). Although, the above phenomena were predicted long ago (E. Levich, E. Tzvetkov, 1985) it is only in the past few years the first seeds of understanding of intrinsic coherence and order of turbulence and atmospheric turbulence in particular has started percolating into the geophysical and fluid mechanical community. The life and death of tropical hurricanes their correlation with Gulfstream, the general atmospheric circulation on Earth and great red spot of Jupiter is the unfinished thrilling saga of great complexity and cannot be given proper attention in this work. I refer to multiple works of Keith H. Moffatt since 1985 and the review (E. Levich, 2009).

- ii Faithfull translation into English of the first verses of Old Testament Genesis in accord with the original Hebrew texts and its interpretation by ancient and contemporary Judaic sages by Rabbi Tzvi Freeman, director of "Ask the Rabbi for Chabad.org".
- iii Modern science assumes that elemental units of matter, radiation, quarks, electrons and protons, etc., exist because there is nothing in known laws of nature prohibiting their existence. Subsequently the Hamiltonian laws of physics reduced to two types of basic interactions between the elemental units, i.e., electroweak and strong mediated by exchange of transient, virtual bosons; photons, gluons, W and Z bosons facilitated by fermion neutrinos. Henceforth the residual interactions, via pions between the elemental units are manipulated for consistent scenarios uniting the to superclusters of galaxies, filaments, etc. The electroweak and strong interaction are elemental units, i.e., protons, neutrons and electrons into nuclei, atoms, molecules and macroscopic lumps of molecules. At the last stage of macroscopic organization the weakest of all gravitational

interaction creates large lumps of matter, stars, galaxies of stars and all the way upscale to clusters of galaxies, superclusters, filaments, etc. This last stage is terra incognita. Although, the laws of gravitation, the EGE and Newtons equations are well known it is quite a mystery how all this upscale growth of lumps of matter occurs. On the other hand the microworld seems to be better understood. The electroweak and strong interactions between the corresponding groups of elementary particles are reduced into one standard theory unifying these interactions and placing the particles into appropriate classes united within these classes by well-defined groups of transformations. Thus has emerged the science of quantum chromodynamics, the QCD, a set of mathematical equations apparently adequately describing a large variety of experimental facts. The elemental units first of all *are* distinguished by their quantum spin that is half integer for fermions and integer for bosons. In accordance with the Pauli principle fermions repulse each other in the momentum/energy space and hence only one fermion can occupy a quantum momentum/energy state. On the contrary bosons attract each other in the momentum/energy space and hence given right environment collect in one momentum/energy quantum state. This phenomenon is called BEC-Bose-Einstein condensation. In some cases and fermion electrons, but also other fermions are forced by external conditions, e.g., free electrons in metals at very low temperatures, but also in other materials to unite into pairs that as pairs are now bosons with the integer spin and behaving as bosons. Roughly speaking these correlated pairs form the nearly coherent state of BEC. This is the phenomenon of superconductivity in metals and certain carbon based materials. On the other hand the original bosons, such as helium4 atoms in fluid state at low enough temperature undergo the BEC like phase transition to superfluid state. In superfluid state the helium fluid becomes almost perfectly coherent and subsequently having nearly zero viscosity. The electron pairs in superconducting state are similarly almost perfectly coherent and propagate in the media with almost zero resistance. And even genuine BEC can be observed for certain rarified gases of cold atoms, e.g., metastable helium atoms 4He .

However, I note again that order, like superfluidity can be only imposed by quenching temperature or more generally in open systems fed with coherent momentum/energy flux from and external source and subsequent disposal of the same amount of chaotic momentum/energy. From inanimate phenomena to life and consciousness this principle is one and the same having no alternatives. The Hamiltonian laws of physics intrinsically are not capable of generating coherent entities.