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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.

Richard Phillip Feynman: The Feynman Lectures on Physics.

THEORY OF ORDER, PART 2

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Preamble

From the times of antiquity philosophers and scientists have been straining minds over the primeval nature of order and chaos. Modern cosmologists and philosophers still do the same. What had been at the beginning? Had it been primordial chaos, or primordial order, or there had been no beginning?

From the Stanford Encyclopedia of Philosophy we learn that Plato (born between 429 and 423 BC) was "deeply impressed with the order and beauty he observes in the universe and his project in the dialogue is to explain order and beauty. **The universe, Plato proposes, is the product of rational, purposive, and beneficent agency. It is the handiwork of a divine Craftsman ("Demiurge") who, imitating an unchanging and eternal model, imposes mathematical order on preexistent chaos to generate the ordered universe (Greek *kosmos*).**

The governing explanatory principle of the account is teleological: the universe as a whole as well as its various parts are so arranged as to produce a vast array of good effects. It strikes Plato strongly that this arrangement is not fortuitous, but the outcome of the deliberate intent of Intellect (*nous*), anthropomorphically represented by the figure of the Craftsman who plans and constructs a world that is as excellent as its nature permits it to be" (**Timaeus, Plato**).

In the much more ancient **Genesis of Old Testament the preexistent condition is not chaos**. I quote from a respectable translation of the original Genesis of Hebrew Old Testament:

*"In the beginning God created the heaven and the earth.
And the earth was without form, and void; and darkness [was] upon the face of the*

deep. And the Spirit of God moved upon the face of the waters. And God said, Let there be light: and there was light''.

In my, I believe unprejudiced interpretation what is said here is that in the beginning there had been formless, empty, bounded quasi-nothingness, **timeless dark void with nothing material**. The spirit of God had been hovering over the boundary of this dark void, "upon the face of the waters". The situation remained static, nothing live had been happening till God decreed "let there be light".

Nowhere in the Hebrew original texts had I found the imperative of chaos at the birth of Cosmos, chaos as it is understood in modern science. Newton devoted much of his life studying original Kabbalah in Hebrew. He does not mention chaos. But rather eternity and infinity are emphasized.

Fundamentals.

1. In adherence with the extraordinary vision of Sir Roger Penrose that he promoted for a number of years and summarized in the book for laymen and fans of Cosmology (Roger Penrose, Cycles Of Time,2010, London) it is suggested here that the primeval source of all order and every organized phenomenon and system, every coherent event and happening including the tiniest ones, in Cosmos can be traced literally, not figuratively, back in space/time through the billions years long sequence of intertwined particular mechanisms responsible for particular phenomena events and happenings, the intermediate chain of secondary, local in space/time sources of order, each of these sources generating relative to them chaos, eventually to the primeval source of order at the primordial origin of Cosmos itself.
2. Furthermore in accordance with the Cycles of Time vision of Roger Penrose the primordial order at the birth of our Cosmos is inherited from supreme order of the previous Cosmos last days. And further back it goes to the ordered start of this previous Cosmos and further back to the supreme order of yet another previous Cosmos and again in cycles of time ad infinitum. Reversing the time direction the same will be happening in the future. Our Cosmos at the instant of expiration will be supremely ordered. It will smoothly enter into the start of the next Cosmos and so forth ad infinitum into the future. The infinite cycles of consecutive Cosmos deaths and resurrections.
3. On the other hand chaos is entirely secondary byproduct at every link of the chain of order-chaos evolution, although vital for order self-preservation at all stages since the birth of each Cosmos. Chaos is inevitable concomitant accompanying order. Order live and inanimate, is aging. Order at every stage of evolution must cleanse itself of worked out, regurgitated matter that serves as the preceding source of order, food actually. By cleansing off the regurgitated matter/food order strives to prolong its life time span, although the main mission of order is launching evolutionary higher order descendant.
4. Developing further the vision of Roger Penrose it is suggested that the origin of order in Cosmos dying days is subsequent to the laws of general relativity and quantum mechanics in conjunction with the Second Law of Thermodynamics and **last but not least to a conjecture that our material Cosmos is embedded and expanding into the quantum Cosmos that is the**

origin of our classical Cosmos and had been of all previous ones and would be the origin of all future generations of Cosmos.

5. The introduction of quantum laws and the above conjecture is a deviation that I would like to call a quantum footprint on the discovery by Roger Penrose of Cycles of Time solution to the Einstein general relativity equations.
6. What is further claimed is that the earliest fraction of a second development of Cosmos after its birth in the Big Bang and the final fraction of a second of Cosmos life prior to expiration are ruled by quantum mechanical laws and subject to self-similarity laws. The self-similarity and scaling are due and defined by the fundamental scaling dimensionless constant of Cosmos. This is constructed uniquely from the four fundamental dimensional constants of Cosmos, the Newton gravitational constant G , the speed of light c , the quantum Planck constant \hbar and recently astronomically determined Einstein cosmological constant $\Lambda \approx 10^{-29} \text{ g} / \text{cm}^3$ ¹, into one dimensionless Cosmos constant: $R_{\text{cosmos}} = 10^{41}$.
7. The cosmological constant has the dimension of mass density, or equivalent by the famous Einstein relation energy. It is assumed that the cosmological constant is the cosmic dark energy, or equivalent to it by Einstein relation mass²,
8. It is argued that there are only two relevant fundamental dimensionless constants in physics of Cosmos: fine structure constant of quantum electrodynamics $\alpha = e^2 / \hbar c \approx 1/137$, where e is the electron charge and R_{cosmos} . With the help of any of the **three dimensional fundamental constants** and two **fundamental dimensionless numbers, the constants α and R_{cosmos}** in conjunction with **Heisenberg uncertainty principle** one calculates the part of the rest mass of proton due to quarks contribution: $m_{\text{proton}} \approx 10^{-26} \text{ g}$ that is about 1% of the total rest mass of protons. The calculated m_{proton} value concurs well with the one that is presently believed by high energy physicists to be the quarks contribution to the rest mass of protons.
9. Also the space volume of a proton is calculated from a theory that will be the subject of Part 3 of this work. The calculated proton volume is $V_{\text{proton}} = l_{\text{proton}}^3 \approx 10^{-38} \text{ cm}^3$. This value is slightly bigger than the one usually given by high energy physicists, but definitely within possible limits. The accuracy of calculations is limited by uncertainties in the experimental values of the fundamental constants not mentioning the experimental accuracy of measuring the size of proton having fuzzy quantum boundary.
10. It is asserted that the cosmological constant or dark energy is created by the energy flux from quantum Cosmos through each point classical 4D, three space dimensions plus time, space/time. What happens is that the Planck mass

¹ Actually the acceleration of the Cosmos expansion was detected. However there is little doubt that this acceleration is caused by the positive Einstein cosmological constant $\Lambda \approx 10^{-29} \text{ g} / \text{cm}^3$ (see Part 1).

² Not to be confused with dark mass ostensibly existing, but not identified, as a halo around galaxies.

$m_p = (\hbar c / G)^{1/2} \approx 10^{-5} \text{ g}$ heavy particles³ continuously pop out from quantum Cosmos, QCosmos. The Planck particles virtually pop out randomly in space and time and each of them lives only the fleeting Planck time $t_p = (\hbar G / c)^{1/2} \approx 3 \cdot 10^{-44} \text{ sec} = l_p / c$, where $l_p \approx 10^{-33} \text{ cm}$ is the Planck length, that naively can be associated with the size of Planck particle.

11. The t_p value above is uniquely determined by the quantum mechanical uncertainty principle that in this case reads ${}_p E_p t = m_p c^2 t_p \approx \hbar$. I have used the Einstein relation between the energy of Planck particle and its mass $E_p = m_p c^2$. it should be reminded that the Planck particles if they exist are virtual in the sense that their life time is short because their mass is so big for elementary particles. But I suggest the mechanism of their birth not the usual way, such as continuous birth of say electron-positron virtual pairs and their immediate annihilation into photons. In principle anything can be borne out of QCosmos if it lives limited time in compliance with the quantum mechanical Heisenberg uncertainty principle. One cannot exclude generally that this time is long as will be seen shortly.
12. The random popping out and popping back into the QCosmos of Planck particles is fully equivalent to an energy flux passing through the space/time. The energy flows in and equal energy flows out. This is a typical steady state nonequilibrium exchange between a system, the material Cosmos in this case and its environment, the QCosmos in this case.
13. The above emphasizes the novelty of the scenario. What I suggest is our material Cosmos is not a closed system, but one in a steady state exchange with the QCosmos into which it is embedded and interacts at every 4D space/time point. It is as if at each 4D point there would be other quantum dimensions of space and time. The length and time in these dimensions in QCosmos would be discrete integers of l_p, t_p . While in our space/time if such length and time is achieved this will be dissipation into QCosmos. I suggest that it happens really only in the black holes.
14. The concomitant of the above is that Cosmos is not just the expansion of space with time, but the expansion into QCosmos. This is a different expansion. It would have not occurred if not for the quantum mechanical intrusion and more precisely the quantum dissipation phenomenon.
15. It is noted readily that the fundamental $R_{\text{cosmos}} = 10^{41} = L_{\text{cosmos}} / l_p$, where $L_{\text{cosmos}} = 10^8 \text{ cm}$.
16. The meaning of this length scale is fairly nice. The QCosmos defines a characteristic scale at which the Planck particles stabilize in our Cosmos. This is what dark energy is. To give an analogy let us consider the solar radiation passing through the Earth's atmosphere. From conservation of energy the same amount of energy that comes in gets out over a period of time, usually 24 hours. It is the flux of energy that passes through. However it maintains the temperature on Earth such as required for everything and anything that transpires on Earth. The steady state balance is established between Earth and solar radiation. In fact solar radiation also gives away its order to Earth. This

³ The Planck mass, Planck length and Planck time are well known since the times of Planck himself. As far as I know so far their meaning, or the absence of meaning has remained obscure.

will be considered in detail below. However the meaning is clear in that the average temperature over the globe should be such that over a period of time the same amounts of energy are given to Earth and passed back into space, while at the same everything on Earth goes on evolving, organizing, striving to achieve maximal possible order compatible with the mechanisms furnished by the laws of physics, chemistry and biology⁴, The same is with the exchange between QCosmos and our Cosmos. The average energy density of Cosmos should be such as it is observed by precise science of astronomy. And why it should be as it is?

17. This is because chaos and its mathematical measure entropy accumulate as our Cosmos is aging. In accordance with the second law of thermodynamics entropy chaos and entropy will continue to grow forever until the statistical equilibrium is reached. The latter means the heat death of Cosmos, as it was traditionally called. However remarkably astronomers and we with them know now that the Cosmos expansion entered into the opposite gear. Cosmos is growing more ordered. This is the basic argument so clearly understood by Roger Penrose. But then the problem arises. How the accumulated entropy disappears? The usual answer is that it is disposed of into the gravitational field and later is swallowed inside the black holes (see Part1). Nevertheless as Penrose explains this explanation is not enough. There will always be stray matter in Cosmos, electrons and protons that may escape falling into the black holes. I suggest that entropy is just passed over into the QCosmos. The QCosmos has unlimited capacity to absorb it without losing too much order. QCosmos has hugely more order and less entropy than Cosmos. All order that QCosmos grants to Cosmos at the birth of Cosmos is given back to QCosmos due to the remarkable attribute of quantum friction, or quantum viscosity of space/time itself. In Part 4 the amount of order will be estimated in QCosmos as the number of coherent degrees of freedom.
18. Quantum friction is a friction between matter and space/time itself. Or it can be interpreted as friction between matter and dark energy that permeates every space/time point of Cosmos. I suggest however the dark energy is not ideal media, but similar to incompressible viscous media. The concomitant is the viscous force, or friction force.
19. The quantum friction force originates because the space expands. It is the same as expansion of dark energy. The dark energy permeates all space/time points of Cosmos. It is in a sense the space/time. It is glued to space/time. But while expanding the energy of the dark energy does not get smaller! How it can happen requires mathematical explanation. I defer it to Part 3 of this work. The dark energy is inside every elementary particle of Cosmos. As regards the dark energy the elementary particles are porous. If the particles are stable they resist the space expansion that tears them apart. But the space expansion is irresistible. Therefore the dark energy fluid, or space/time inside the particle exert expanding force inside the particle. The particle resists, but gradually the friction wins. One can imagine a porous particle fixed in space position in a flowing fluid. The fluid penetrates the particle if the pores of the particle are big enough. Hence the fluid flows through the particle. But since the fluid is

⁴ Unless some cosmic scale disaster happens order will continue to grow on Earth and chaos will continue to be disposed of into outside space. I suspect, although it is just a philosophical conjecture that order must and will grow until it reaches its maximal value equal to the final frozen order of Cosmos and then will experience its own "big bang" and enter the new cycle of evolution. Re.

viscous there is friction at the inside boundaries of the particle pores. If the particle is well fixed in space and is not carried away by the flow than it will resist the destruction by friction. As time goes on the fluid of course wins and the friction force will chip away the particles pieces from inside.

20. Roger Penrose suggested that it is essential for his Cycles of Time vision of Cosmos that the rest mass of particles, such as electrons should somehow be not conserved.
21. Indeed the quantum viscosity results in very slow and inevitable erasing of matter into low frequency radiation. This erasing is different from the Bekenstein-Hawking evaporation of MBH's. In difference to the latter the quantum dissipation, or the erasing of matter time scale does not depend on mass, since each proton, neutron and electron making the matter is permeated by the dark energy and is erased independently.
22. Coming back to the interpretation of $L = 10^8 \text{ cm}$. I notice that one Planck particle per volume $V_{\text{cosmos}} = L_{\text{cosmos}}^3 = 10^{24}$ is exactly the observed dark energy mass density, or cosmological constant value $\Lambda = m_p / V_p = 10^{-29} \text{ g} / \text{cm}^3$. I suggest that $L = 10^8 \text{ cm}$. is the size of QCosmos in the quantum dimension. This size is as fundamental as the cosmological constant itself. The two are exchangeable and uniquely connected to each other via the remaining dimensional fundamental constants. This is the scale at which energy and order from QCosmos is injected into Cosmos, while l_p is the scale of energy dissipation back into QCosmos.
23. In this sense there is deep analogy between R_{cosmos} and the Reynolds number dimensionless parameter in fluid mechanics. The whole science of fluid mechanics is based on the fact that there is only one dimensionless constant defining the flow of fluids, the Reynolds number $\text{Re} = L \bullet v / \nu$, where L is characteristic size of the flow, say the diameter of a pipe, v is the mean flow velocity, say in a pipe of diameter L and ν is the fluid viscosity. As long as Re remains invariant, although the scale, velocity and viscosity separately may be different, the flow properties remain exactly the same. This is self-similarity, or scaling property. In the case of fluid mechanics it allows to calculate the flow for one pipe only. Then for any other pipe, as long as the Reynolds number is the same the flow remains exactly the same.
24. Based on this analogy I rewrite $R_{\text{cosmos}} = L_{\text{cosmos}} c / \nu_{\text{cosmos}}$, where the velocity is the speed of light c , the only relevant one for the problem and viscosity of dark energy fluid as viscosity of Cosmos. I immediately obtain the value of $\nu_{\text{cosmos}} = 10^{-23} \text{ cm}^2 / \text{sec}$. Not surprisingly it is small. For comparison for air the viscosity is about $0.1 \text{ cm}^2 / \text{sec}$. I note that the Cosmos viscosity parameter can be calculated from the three dimensional constants and does not depend on the macro scale L_{cosmos} . Explicit dependence on this scale would have undermined this parameter meaning as intrinsic viscosity. It would have been as if say air viscosity would depend on the pipe diameter through which the air flows. However for the time scale of the matter being erased the macro scale is determining.
25. The time scale for the matter to be erased by the quantum friction, including supposedly stable, but composite proton and supposedly fundamental electron is uniquely calculated from the four fundamental constants, or three

fundamental constants and R_{cosmos} . Not surprisingly this time that I denote $T_{\text{of cosmos}}^{\text{life}} = L_{\text{cosmos}}^2 / V_{\text{cosmos}} = t_p \text{Re}_{\text{cosmos}}^2 = 10^{39} \text{ sec} \approx 10^{30} \text{ years}$. After that time the size of the visible Cosmos up to the event horizon will be

$L_{\text{final}}^{\text{eventhorizon}} = l_p R_{\text{cosmos}}^2 = L_{\text{cosmos}} R_{\text{cosmos}} = 10^{49} \text{ cm}$. The results should have been expected. Indeed there is only one physical time in the problem, the quantum mechanical Planck time, and there is only one dimensionless number R_{cosmos} .

26. I note that it is not known experimentally if protons are eternal or just long living particles. However the experiments, to the best of my knowledge indicate that their life time is not less than $10^{28} - 10^{29}$ years. Hence the above theoretical estimate does not contradict the existing experimental evidence.
27. After this time all the matter in Cosmos will be only extremely long wavelength photons, radiation and dark energy. Photons do not interact with dark energy. There is no friction between the two. Photons are indeed fundamental and indestructible⁵.
28. On the other hand the attribute of mass that matter is endowed with is due to the matter friction with the dark energy. On quantum mechanical level I conjecture that the exchange by virtual Planck particles is the cause of the mass attribute and attraction force. If it is the case than the Planck particle is the real Higgs particle. It would be not possible ever to detect such experimentally since this would mean that the experimentalist entered the QCosmos. I suspect that to do this one has to be at the center of black hole and nothing material would be left of such individual.
29. The point is that protons and electrons, the main constituent particles of which the matter consists of are themselves composed of the Planck particles, albeit in a highly nontrivial manner.
30. This is how it happens. Let us estimate how many Planck particles would fit inside the proton. Apparently $N_{\text{Planck}}^{\text{proton}} = V_{\text{proton}} / l_p^3 = 10^{-38} / 10^{99} = 10^{61}$. If it were that by a wonderful fluctuation $N_{\text{Planck}}^{\text{proton}}$ Planck particles would stabilize inside the volume of 10^{-38} cm^3 and hold to each other fast then it would a particle having the mass equal to $m_p N_{\text{Planck}}^{\text{proton}} = 10^{-5} \text{ g} \cdot 10^{61} = 10^{56} \text{ g}$, a huge mass indeed. The solution to this paradox is simple. Each Planck mass is uncorrelated with another and the life time of all this conglomerate is exactly the same as for one and any Planck mass, that is $t_p = 3 \cdot 10^{-44} \text{ sec}$. But we calculated above the life time of real proton as

$T_{\text{of cosmos}}^{\text{life}} = L_{\text{cosmos}}^2 / V_{\text{cosmos}} = t_p \text{Re}_{\text{cosmos}}^2 = 10^{39} \text{ sec} \approx 10^{30} \text{ years}$. It is the factor $\text{Re}_{\text{cosmos}}^2$ bigger than $t_p = 3 \cdot 10^{-44} \text{ sec}$. Now I apply the Heisenberg uncertainty principle: Indeed, $m_{\text{proton}} \cdot c^2 T_{\text{of cosmos}}^{\text{life}} \approx \hbar$, from which I derive for the rest mass of proton immediately:

$m_{\text{proton}} = m_p N_{\text{Planck}}^{\text{proton}} / R_{\text{cosmos}}^2 = 10^{-5} \text{ g} \cdot 10^{61} / 10^{82} = 10^{56} \text{ g} / 10^{82} = 10^{-26} \text{ g}$. This is a very realistic number for the contribution of 3 quarks into the rest mass of protons. As is believed by high energy particles physicists the rest 99% of the rest mass of protons come from the kinetic energy of sub light speed velocity

⁵ Newton saw photons as indestructible.

of fluctuating from vacuum quarks and gluons that facilitate the strong interaction of quarks.

31. How does it happen that the above construct stays stable? I can invoke the usual thesis of strong interaction between quarks, etc. But I want to remain in the scenario of Planck particles alone. I will show in Part 4 of this work that the gravitational attraction of Planck particles within the protons size domain is the one that contains protons whole for their allocated life time. In fact I conjecture that protons and electrons are the exact solutions of certain unknown so far equations that unite Einstein general relativity and quantum mechanics.
32. I note that if to assume that the electrons classical size volume $V_{electron} \propto r_{electron}^3 \approx 10^{-39} cm^3$ has the meaning of the volume of space filled by the fluctuating Planck particles then it is possible, not surprisingly using the same arguments as for the protons to obtain the mass of electron as $m_{electron} = 10^{-27}$, a nice value indeed because it is the real electron mass.
33. The positive cosmological constant as above strongly indicates that Cosmos is entering the stage of exponential expansion approaching flat De-Sitter Cosmos. This particular case of Cosmos is such that time as concept disappears. Mathematically it is well known that time can be just excluded from the De Sitter space/ time metric tensor. Physically it is clear. When the rest mass of matter is erased by the quantum friction Cosmos will be filled with dark energy and photons. There will be no observers left. Not a single electron or anything else will be left. Photons moving with the speed of light cannot measure time. For the time measurement it is necessary to have an observing particle with non-zero rest mass. Then time can be tied up to it and starts ticking. But such will not be left. I repeat that all the matter will disappear into QCosmos, either inside MBH's, or much faster by the mechanism of quantum friction.
34. When it happens then the arguments of Roger Penrose are inescapable. The final state of Cosmos will be total order, no entropy at all, just as no time at all. If there is no time in Cosmos there is no **second law of thermodynamics** and no **entropy**. In a certain sense, not much of a sense in my view, Cosmos goes on expanding, but actually it is static, as there is no time.
35. It is suggested that this final state of Cosmos is diffeomorphic, can be continuously mapped into the initial state of Cosmos when there was only dark energy, the eternal cosmological constant and light from the Big Bang. The huge Big Bang light is just the compressed final light of Cosmos. We compress the scale $L_{cosmos} \leftrightarrow l_p$ and diminish the quantum viscosity, a calculated parameter and hence not basic, so that $R_{cosmos} = 10^{41}$ remains invariant. But the light density becomes huge when this is done increasing by the factor R_{cosmos}^3 to become $\rho_{photons}^{bigbang} = \Lambda R_{cosmos}^3 = 10^{-29} g / cm^3 R_{cosmos}^3 = 10^{94} g / cm^3$. I used the fact that in the final days of Cosmos the photon density becomes of order of the dark energy mass density. But the dark energy mass density is the same always, independent on time and space, while the photon density is not.
36. The remarkable achievement of Roger Penrose is that he discovered an exact solution of the classical Einstein equations of gravitation such that allow smooth, invertible mapping of the end of one Cosmos into the start of the next

one despite the fact that the density of photons becomes infinite. It was done by appealing to the conformal invariance of Einstein equations that I will explain in Part 4.

37. My arguments are slightly different in that I believe that the quantum effects smooth the singularity in photon density into just a very large density. I appeal to much simpler scale invariance of Cosmos dynamics, a particular case of conformal invariance. What allows me to do this is the existence of dimensionless number R_{cosmos} that is the fundamental attribute of Cosmos evolution. Thus while conformal invariance allows smooth mapping of zero density at the end of Cosmos into the infinite density at the start of new Cosmos, the scale invariance maps the state of very small photon density about $10^{-29} \text{ g} / \text{cm}^3$ at the end of Cosmos into the large, but finite density of photons about $10^{94} \text{ g} / \text{cm}^3$.
38. The above scheme allows also the calculation of the time of birth of the first proton. The birth happens when Cosmos expansion reaches the event horizon space/time 4D

$$\text{Volume} \left\{ \begin{array}{l} V_{\text{cosmos}} T_{\text{cosmos}} = R_{\text{cosmos}} l_p \cdot R_{\text{cosmos}} \cdot t_p = L_{\text{cosmos}} T_{\text{cosmos}} = \\ 10^{24} \text{ cm}^3 \cdot (3 \cdot 10^{-4}) \text{ sec} \end{array} \right\}.$$

The time $T_{\text{cosmos}} = 3 \cdot 10^{-4} \text{ sec}$ is actually when the time starts ticking. I do not understand how the mess of popping out quarks/antiquarks that immediately annihilate back into vacuum can serve as an observer. I also note that the Big Bang classical model predicts the date of birth for protons within the interval between one millionth of a second and one second after the Big Bang. The above estimate therefore is comfortably inside this interval.

39. The above reasoning allows simple calculation of The Hubble constant at the present time. It is determined by three fundamental dimensional constant and R_{cosmos} . It turns out to be indeed approximately $H \approx 10^{-18} \text{ sec}^{-1}$. Similarly follows the acceleration of exponential expansion at this stage of Cosmos evolution $a_{\text{cosmos}} = 10^{-29} \text{ cm} / \text{sec}^2$. The details of the calculation will be furnished in Part 4 of this work.
40. How is it that the Planck masses making up the dark energy result in Cosmos expansion, while say in protons they are attractive, as any mass should be? The answer that I see is that the Planck particles pop out randomly in our Cosmos space. This creates random force in 4D space/time of Cosmos embedded into the larger environment of QCosmos. Such force is bound to result in 4D Cosmos expansion. The mathematical support of this claim will be given in Part 3 and Part 4 of this work.
41. In this context I would like to comment that the above concept of order and chaos in cosmology has profound similarity with the concept of order and chaos in the seemingly mundane phenomenon of turbulence of fluids. In Part 3 I will show how the general approach to order and chaos exposed in this work allows breakthrough in understanding turbulence phenomenon. The phenomenon that has been for over a century considered by many, including some of the great minds to be too difficult for theoretical understanding on

fundamental level, beyond semi-empirical theories. The advantage of turbulence phenomenon is that all predictions concerning it are in principle verifiable, although notoriously difficult to test experimentally. On the other hand cosmological predictions are often not verifiable. Therefore it is gratifying that the general principle developed in this work can be substantiated by application to a hugely complex, but still earthly phenomenon.

42. Quite unsettling conclusion that I arrived at is that the fundamental equations that I hope will introduce quantum mechanics into the general relativity will not be Hamiltonian. Because they will have to account for the quantum dissipation. In many real problems of classical mechanics we add friction to the Newton equations. In fluid mechanics a fundamental branch of science we add the intrinsic viscous friction term to the Hamiltonian Euler equations for ideal fluid. Thus one arrives at the Navier-Stokes equations; the only meaningful ones to describe the flows of fluids and the turbulence phenomenon, one of the most widely spread phenomena in Cosmos.

I suspect that we will be forced to take account of the intrinsic quantum dark energy, or equivalently the space/time viscosity for correct understanding of Cosmos birth, evolution and fate. I conjecture that the Hamiltonian nature will be restored when the QCosmos environment is included.

Order on Earth

a. General

I would like to describe here briefly how order is established on Earth. More detailed description will be given in Part 3 of this work.

So where does the order on Earth originate from. Order means all organized patterns and structures, starting from day and night 12 hours cycles, seasonal cycles, organized ocean currents, e.g., Gulfstream, atmospheric stream jets that like huge rivers flow around the globe in the upper atmosphere, tropical hurricanes, tornadoes, all the way down to usual clouds and then the biological life, economy, political structures and at last our self-consciousness, the awareness of being, our thirst for abstract knowledge like mathematics and cosmology and building social structures sustained by the shreds of paper called money.

Consider for instance the oceanic and atmospheric currents or rivers that are flowing for eternity through the same media as they are composed of, air and water, without mixing with the surrounding media⁶.

The above question is posed differently from the usually asked. What usually asked from the school bench is where the energy that gives life to everything on Earth comes from. Every school student, almost, would answer immediately that energy

⁶ Imagine a man created current of water in a large pool. From our experience it is obvious that such would mix with the surrounding water very soon. Gulfstream is a slightly denser and more saline than the surrounding ocean water, but it is futile to ascribe Gulfstream extraordinary stability to these secondary factors.

comes from the Sun radiation. However where does order on Earth come from? Does it come to being by itself from chaos as some believe? Like homunculus in a glass jar as had been believed recently by most?

The correct answer is that the prime source of order on Earth, as well as of energy surely, is the absorbed solar radiation. The best explanation of how it works can be found in the recent book *Cycles of Time* by Roger Penrose (2010). Adding more specific details to his narrative this is how it really comes about.

Solar radiation is the electromagnetic waves in a wide spectrum⁷ of wavelengths and inverse to them frequencies. Part of this radiation consists of relatively short wavelengths and high frequencies energetic waves, or energetic photons. These green, violet and harder parts of solar radiation consist of photons each having more energy than the soft part of radiation, say infrared. We will quantify the above statement as follows. Hard photons have energies $e_h \geq e_0$, where the subscript h means hard photons and e_0 is certain symbolic threshold single photon energy dividing hard photons with energies $e_s \leq e_0$ from the soft ones with the energies $e_s \leq e_0 \leq e_h$, where the subscript s means soft photons. By definition of entropy the photons with the energies e_h have less entropy than the photons with the energies e_s . It takes lesser number of hard photons to add up to a given energy $E_0 \equiv N_h e_h$ than of soft photons $E_0 \equiv N_s e_h$, i.e., $N_s \gg N_h$. More scientifically the soft part of solar radiation has more degrees of freedom, simply more photons in this case and subsequently more entropy, or less order than the hard part of solar radiation. This can be expressed as follows: $S_{N_s} \gg S_{N_h}$, where S_{N_s} is entropy of soft photons and S_{N_h} is entropy of the hard ones⁸.

b. Order and organization in Earth's atmosphere and oceans

Considerable part of hard solar radiation is absorbed and deflected by the Earth's atmosphere. Still the remaining photons, like green photons and softer radiation reach the Earth's surface and do useful things. The first one is photosynthesis supplying oxygen to the atmosphere⁹. Also, a part of radiation is absorbed by the oceans and seas.

The ocean and sea water heats up and accumulates heat within a certain depth upper layer. This stored heat amplified by the temperature difference between atmosphere

⁷ Essentially the black body thermal radiation.

⁸ The number of independent degrees of freedom equals the number of photons only if the radiation is thermal and not coherent as it is in laser radiation. Equivalently it means that the photons of which the radiation consists of are not correlated, or more correctly are not phase correlated. This implies that the radiation intensity for a given wavelength is below a certain one. It is not always the case, for instance for lasers.

⁹ Remarkably a fairly significant part of solar radiation consumed by Earth as a whole is used for photosynthesis. The spectrum of solar radiation is such that much of energy is in a range advantageous for absorption by plants and plankton. At the same time in this range around green light wavelength there is also plenty of order as compared with red-infrared light.

and ocean surface cause generation of convective clouds. Convective clouds are vortices of air mixed with droplets of water of many sizes, due to perspiration from the surface, rising with the vortices up into the atmosphere. These vortices stir air mixed with droplets of water in atmosphere. As a result atmosphere becomes turbulent. Turbulence in the air is not homogeneous, but comes intermittently in patches of lower and higher intensity¹⁰. It should be also mentioned that convective vortices are also dual in the sense that while fairly coherent and hold their global shape they also contain a good deal of inner chaotic motion that is usually associated with turbulence. This chaotic component of clouds is generated by the orderly component to sustain its order. It is a pile of entropy thrown out by order.

At this point let us pause and consider the following. The convective clouds globally are organized structures. All clouds are. One should not be a rocket engineer, sometimes it can be even detrimental, to observe that a cloud as a whole sustains its shape, i.e., order for a period of time at least. It can be a few minutes, but often much more. Where does this order come from? The prime source of this order in convective clouds is the relatively hard photons that were absorbed by ocean water that caused evaporation that caused orderly convective vortices/clouds. The specific mechanism how the orderly convective clouds are organized is in the specific equations of fluid mechanics in conjunction with thermodynamics. However the equations by themselves do not organize. They allow order to be consumed from the order of ocean water that in its turn had been consumed from the hard photons of solar radiation through the mechanism of absorption that is quantified by another set of appropriate equations.

Convective clouds and clouds generally are not supremely orderly. It was mentioned that in their interior there is plenty of what is usually perceived as chaos. In fact the structure of clouds is more complicated. Clouds are turbulent, but turbulence is not chaos in contrast to what is usually believed, but a complex duality of intertwined order and chaos¹¹.

It is good time to start thinking what happens with turbulent atmosphere stirred by convective clouds. The usual wisdom of geophysicists that stems from the existing chaotic perception of turbulence is that large vortices, or eddies as they are called, created by convective clouds, the "mixing propellers", decompose into progressively

¹⁰ It is enough to recall our experience on a flight when the pilot announces that the plane enters into a region of high turbulence. Although we all know intuitively what turbulence intensity means, but scientific definition of turbulence intensity is not as simple as it seems. It will be explained in Part3.

¹¹ Organized patterns of motion in turbulence, called coherent structures, CS, in literature, are known to experimentalists and just laymen observers for decades. Their nature is deemed enigmatic and badly understood. In Part 3 it will be quantitatively shown that they are in fact the essence, the core of turbulence phenomenon. It is CS that create chaos around them in order to dispose the accumulated entropy so that to delay aging and prolong their life span. The growth of coherence scale in turbulence, the growth in size of coherent turbulent eddies in simple words is a basically new phenomenon predicted by the new theory of turbulence that only can exist based on the concept of order-chaos interrelationship described above. It will be considered in Part2 quantitatively and directly from the basic equations of fluid motion.

smaller vortices. In the language of this work this would mean that more organized larger structures having less entropy decompose into less organized collection of smaller eddies with overall higher entropy, or more uncorrelated degrees of freedom. Eventually the size of eddies l_d becomes so small that viscous dissipation takes hold and converts the energy of eddies into heat. Heat is equivalent to low frequency, high entropy infrared radiation. This high entropy radiation returns to outer space that is given back to outer space from which the low entropy high frequency solar radiation came from. Did order disappear? No at all, it stayed on Earth. The growth of order does not stop. This is what happens. 10km over our heads the atmospheric jet streams are flowing around the globe. In Northern hemisphere they are flowing around the globe in one direction and in the Southern one in the opposite one. They are like gigantic rivers of air flowing around the globe. The speed of these jets varies with latitude to some extent because close to the equator the unidirectional jet stream cannot exist from symmetry considerations. If such air jet existed it would be at a loss into what direction to flow. At some distance from the equator there is no ambiguity. The symmetry is broken by the Earth rotation and Coriolis force that is zero at the equator. Coriolis force chooses the flow direction for the atmospheric jet streams/rivers. Why the jet streams do not mix with the air masses beneath them.¹² Instead of mixing, the atmospheric jet streams flow for thousands and hundreds of thousands years and will go on flowing¹³.

It is clear that the jet streams, as well as the ocean currents have some very basic reasons to manifest such stability, keeping their order high and entropy low.

It turns out that in the equations of motion for fluids, the Navier-Stokes equations there exists the mechanism responsible for the growth of coherence length of turbulent vortices. As long as the solar radiation is doing its job the coherence length of turbulent vortices will go on growing. Unless there is a physical obstacle, a boundary the growth will go on. Since Earth's shape is ellipsoidal there are no such boundaries. Note that if Earth would have not been flattened at the poles, were it a sphere the mechanism for the coherence scale growth in turbulent atmosphere would have not taken effect because of symmetry. The infinitesimal symmetry break is imperative. If not for the mechanism of coherence scale growth there would be no atmospheric general circulation. With no general circulation there would be no tropical hurricanes, equator/pole air masses mixing, no Gulfstream, no biological life. There would be no oceans, no consumption of order from the solar radiation; there would be nothing interesting on Earth from the viewpoint of the second law of thermodynamics. This uncomfortably reminds how special should be the mechanisms for our existence. Fortunately the Newton laws of gravitation are such that Earth is flattened at the poles. But why the coherence length of turbulent eddies grow? The

¹² Indeed, let us create a jet stream in a tub by pushing water with a hand. It is obvious to anyone that it would mix up with surrounding water and quickly disappear.

¹³ The jet streams are the reason why it takes different time to fly from Europe to the USA and back from the USA to Europe.

atmospheric jet streams and ocean currents are concomitants of the exact solutions of the fluid mechanics equations, long known, but not understood marvels of the Beltrami-Trkal solutions. It is these solutions, these flows that are order in turbulence. The same goes with hurricanes and tornadoes. Order generates surrounding chaos by excreting the regurgitated solar radiation like we regurgitate food. The ocean currents and jet streams global circulation are whole coherent organizations of amazing complexity. The dissipation length l_d is in analogy with the quantum dissipation length l_p of Cosmos. The atmosphere height $\approx 10km$ is the typical scale at which energy flows into the general circulation. It substitutes for L_{cosmos} . The maximal velocity of general circulation $v_L \approx constant$ as the lateral coherence scale grows. It substitutes for the speed of light c . The fluid viscosity substitutes the quantum viscosity of Cosmos. The large Reynolds number $Re \gg 1$ substitutes for R_{cosmos} . The ever increasing coherence length in turbulence substitutes for Cosmos expansion¹⁴. The surrounding outer space from which energy and order comes and the same energy, but chaotic is returned into substitutes for QCosmos.

The flux of solar energy enters the Earth's atmosphere and furnishes order for the whole chain of intermediate order and chaos generation. The last link in the chain is the flux of radiation emanating from Earth into space. The temperature on Earth should be roughly the same. So energy carried out by the radiation flux from Earth is the same that was carried in by the energy flux of solar radiation. This radiation is "chaotic", thermal infrared radiation having high entropy. Order was captured by Earth in exact quantity needed for every organization on Earth, past, present and future. Note that infrared radiation from Earth out takes place during the night time. If not for the Earth rotation around its axis nothing of significance would happen on Earth. Like nothing ever happens on the Moon.

The solar radiation order originates from many sources of order all the way back to the primeval order of Cosmos and farther to the supernal order of QCosmos. It follows that all order on Earth, us including, is endowed with the supernal order of QCosmos. Semantically the last suggestion can be inverted to mean that everything including us is the tiny corpuscles of the supernal order of QCosmos and Cosmos primeval order.

The above analogies between order in turbulence and Cosmos are not superficial. The fluid mechanical Navier-Stokes equations are the only fundamental equations of physics that by their very meaning are intrinsically non-Hamiltonian, time irreversible and explicitly compatible and accounting for the second law of thermodynamics.

¹⁴ Note that the coherence scale growth is the effect explicitly possible only for non-zero viscosity. Would it be not for the quantum mechanical dark energy and quantum viscosity the Cosmos expansion although mathematically valid would lose meaning. The expansion of vortical surfaces rigorous mathematically for incompressible ideal fluids, the Hamiltonian systems, acquires tremendous meaning of perpetual coherence length scale growth when viscosity is accounted for.

