Journal "Scientific Israel- Technological Advantages"
Vol.16, no.1, 2014

THEORY OF ORDER IN COSMOS

E. Levich
Jerusalem, New York
eugenelevich@gmail.com

CONTENTS

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[i]

ABSTRACT

There is no intellectual exploit more poignant than attempts to understand why we exist and if there is sense in our existence beyond the life of a smart animal. The awareness of being one with Cosmos is the gift of self-consciousness that only Man has. Most probably Man is unique and only in visible Cosmos. Man has been desperately searching for his roots in the origin of Cosmos. We find musings on the cause of our existence in conjunction with Cosmos in the records of the earliest literate civilizations. It is possible that those who did not invent script also that have occupied human mind as passionately as contemplated on the meaning of life, but they left no record of this and the meaning of their existence, if any will never be learned.

However, some individuals among some human subspecies had the evolutionary inexplicable conscious desire to leave imprint on the future beyond their lifespan. These individuals had left written testimonies for the descendants telling of their achievements and thoughts, but also of spiritual revelations descended upon them. Some of these testimonies have spurred the intellectual and material human creativity for thousands years to come. It is silly to deny, although there have been and will be hordes of instinctive, fanatical deniers of the obvious that the Hebrew Genesis, the 10 Commandments and other spiritual teachings of Hebrew Torah in conjunction with the natural philosophy of ancient Greeks passed over to the Indian and Persian mathematicians, astronomers and sages defined the course of all Judeo-Christian civilization till our time. Well documented sources testify of communications between the Hebrew sages and Greek philosophers in the kingdom of Alexander the Great and much earlier. The contacts between Hebrew and Indian sages were mentioned clearly by Josephus Flavius. The Hebrew Torah had depicted the origin of Arab race and thousands years later was the foundation upon which Koran and the civilization of Islam was based. Professionals in the field indicate correlations between the ancient teachings of pre-Confucius and Confucius period and Hebrew Genesis.

In the last two centuries scientists have been trying to replace Genesis with the ever shifting rational picture of creation transpiring from the natural laws. No one can seriously define who deemed such yet undiscovered laws natural. In our view no explanation better than anthropic principle has been found by the cosmologists and physicists. The anthropic principle is a sort of anticlimax. It says loosely that the natural laws are such since if they were different the scientists would have not existed to invent the anthropic principle. It is sad when the depth of crisis in scientific understanding of Creation is so profound that the discussion on the origin of Cosmos and Man is reduced to arguments between a few leading contemporary cosmologists advancing totally unverifiable conjectures while a few other as eminent scientists escape into the anthropic principle.

Surely there are many young scientists who are mum and many among laymen not satisfied with the popular hypothesis explaining the existence of the self-conscious life as an accident in our particular Universe-Cosmos that is just one among the uncountable infinity of other Universes that are the

subjects to uncountable infinity of different, unnatural laws such that we do not exist. It is also a comfortable escapism that makes unnecessary understanding what life on Earth is. Since the contemporary scientific understanding of life has not much advanced from the Neolithic age life can be declared by a piece in the science columns of the New York Times as yet another fundamental natural law in our Cosmos.

Many still believe that science, in contrast to beliefs, must have proof of validity by complying with the known experimental data, not contradicting a single one firmly established experimentally and be predictive. Science void of predictive power is shallow and has no value. Indeed based on the principles of experimental testability and falsifiability the predictive power science has extraordinary advanced our understanding of Cosmos and changed the mundane existence on Earth.

The contemporary experimental science and especially astronomy, the eternal Queen of science, are bringing new cosmological revelations of the Cosmos past relevant for the future with unabated vigor and speed. It seems that the problem is not with the science and scientific method. The theoretical cosmologists and physicists are slow explaining what astronomers and astrophysicists impeccably observe and analyze. In fact the explosion of astronomical discoveries since 1998 has not been understood at all. Instead some leading cosmologists bombard the trustful laymen via the popular mass media with their personal beliefs disguised as proven science.

There is a serious problem in contemporary science that was understood by some eminent scientists. The problem is that not a single cosmological parameter pertinent to the origin of Cosmos, even the most classical Hubble constant defining the rate of Cosmos expansion can be calculated by the existing theories. Not a single elemental particle in Cosmos is imposed by the Hamiltonian equations of physics. Nothing in these equations imposes the existence of photons, quarks, gluons, composite protons and elemental electrons, the fundamental units which all visible matter in Cosmos consists of. Neither the existence of atoms made of protons, neutrons and electrons and molecules made of atoms is imposed by the fundamental equations of quantum mechanics. The only coherent entity that must exist is the black hole imposed by the general relativity Einstein gravitation equations, the EGE. In this aspect the EGE is different from all other Hamiltonian equations of physics.

If the existence of elementary building units of matter is assumed than the nucleosynthesis theories furnish spectacular results explaining how light hydrogen and helium and heavy carbon elements came about. However none of the Hamiltonian equations of physics impose the existence of the elementary building units of matter, more correctly of what is believed to be the indivisible elementary building units of matter. To be sure the Hamiltonian equations of physics allow all the coherent entities to exist and often correctly predict their properties. But these equations do not impose the existence of coherent entities. Neither these entities are the solutions of he Hamiltonian equations of physics.

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. 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. The NSE as the EGE are different. Therefore a natural question is why the Hamiltonian equations are fundamental if they are obviously missing the most important aspects of visible Cosmos; the aspects that define visible 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 composite protons and unstable neutrons, elemental electrons, atoms and molecules from the Mendeleev periodic table all of the above are coherent entities arising from more elemental building units and growing in complexity with more components united into one coherent entity.

By far the most complex organized entity in visible Cosmos is human brains consisting of nearly 90 billion neurons and near to 1 trillion synapses working all as one coherent unit. By comparison the complexity and coherence of galaxies of stars is a joke.

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[1].

The oneness is obvious in three aspects. The first aspect is the cycle of life. The 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 it remains 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 common purpose the longer these entities survive. The tighter is the biological coherence within a racial group the more stable and enduring it is, unless destroyed by a

[1]Indeed, what holds the cells of our and animals, and insects and flora together? We invite readers to ask medical doctors or biologists that they are acquainted with if they know. We asked many and were met with the total incredulity. The biologists have no clue and we suspect attribute this phenomenon to "natural laws". To be more precise many of the biologists would refer to the osmotic forces between the cells. Indeed, osmosis and anomalous osmosis are the most probably the mechanism of the cells clinging to each other and other phenomena in live matter (e.g., Babchin A., et.al. 2012). However, forces are fictitious and osmosis among them. The cause of body coherence will be explained in what follows.

biologically more coherent entity. 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 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 and absolutely general aspect of oneness is evolution and devolution. The organized entities are never static or steady state. They receive order from the external sources of order. The external order source furnishes coherence between the composite units of the entity. In their turn the coherent entities dispose chaos that any nonequilibrium, transient entity, or system inevitably accumulates. But all coherent entities evolve and devolve and subsequently have finite lifespan. There are many inanimate coherent entities that are so stable that they are often thought of as static and eternal. They are not. It is just that their interaction with the outside environment is weak, the intrinsic metabolism is slow and their aging is subsequently delayed. Nonetheless they all have the finite lifespan, although for instance the lifespan of protons and electrons compares the lifespan of visible Cosmos. However we will see that visible Cosmos itself has the well-defined lifespan as well.

All coherent entities in Cosmos are aging by accumulating chaos. Their 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. The time dependent kinetics of the processes rules the existence and evolution of all coherent entities in visible Cosmos and of visible Cosmos itself.

We reiterate the basic prerequisites of the cycle of life of any and all coherent entities in visible Cosmos as consisting of the following constituent elements and mechanisms:

1. The external source of order donating its own order to a receiving entity consisting of elementary units.
2. The mechanism endowed to the entity enabling the receival and absorbing the donated order.
3. The mechanism of digestion enabling the entity regurgitating the received order into chaos and disposing this chaos *while order remains in the system*. Failure to absorb fresh order from the donor, regurgitate this order and dispose chaos results in accumulation of chaos. The accumulation of chaos is aging.

The external sources of order are different and the specific mechanisms of order absorption, digestion and chaos disposal are different. However, they work to the same end extending the lifespan and success of the entities and their descendants that are the fittest to survive. And who are the fittest?

It may seem that the fittest are those having the most durable coherent bond between the constituent units. This is necessary, but not sufficient. In fact the fittest must be evolving on the top of being statically coherent. These are the kinetic entities accumulating order and becoming more coherent with time. As soon as an entity enters into the static or the steady state *status quo* coherence it is on the way out. As soon as the entity stops disposing chaos and subsequently not capable of absorbing fresh order from the source it is doomed. We call this kinetic phenomenon the quasi-steady nonequilibrium state of matter. Since matter and 4D space/time are one the same applies to the latter.

We would like to make a strong statement. As soon as the coherent entity stops absorbing order from the outside source with acceleration in time it is in crisis that indicates the start of decomposition. There may be fluctuations and periods of hope but these are just the temporal reprieves. The path to oblivion when started is irreversible, like aging of live entities. Any and all coherent entities in visible

Cosmos, inanimate or animate are endowed with their respective maximum lifespan between the order of birth and chaos of decomposition and death.

There are only two exceptions in the whole of visible Cosmos. It is visible Cosmos itself and the self-conscious Man. Although they also have the finite lifespan their death is different from other coherent entities. Visible Cosmos was born in the Big Bang of light as the state of ultimate order. It accumulated chaos discharged by the coherent visible matter but as a whole visible Cosmos is gaining order on the way to the final state of ultimate order equal to the Big Bang order. The same is with the race of Man. Our bodies are decomposing and die in chaos. The information created and accumulated by Man never dies. Information just cannot die. Information can and does disappear from visible Cosmos, for instance in the black holes. The search of its final destination is one of the main subjects of this work.

The problem is that none of the coherent entities in Cosmos are imposed by the Hamiltonian equations of physics. This is a major problem requiring drastic modification of our approach to the origin and structure of visible Cosmos and life on Earth. The Hamiltonian equations of physics by definition are time reversible and subsequently do not respect the *second law of thermodynamics* and its alter ego the *reverse second law, the RSL* appropriate for the nonequilibrium, kinetic state of organized systems. In conjunction the *second law* and the **RSL** are responsible and impose the existence, formation and evolution of all coherent entities in visible Cosmos. The Hamiltonian physics equations, all of them are intrinsically void of all coherent nature of visible Cosmos.

The*second law* and in particular its grim implications for the fate of Cosmos known as Heat Death have been known since the late 19^{th} century. The *second law* is taught in technical schools to all engineers and scientists. It is amazing that the incomparable in scope implications of the *second law* and especially its kinetic alter ego are still not understood. This has stymied the progress of theoretical physics and cosmology to such an extent that the anthropic principle has become a seriously discussed "scientific" explanation of the origin of Cosmos, "natural" laws and self-conscious Man.

To avoid confusion it should be reminded that the second law in equilibrium thermodynamics states that in a rigorously closed system not influenced at all by anything outside order cannot grow and on the contrary chaos cannot be decreasing. Therefore what connection the second law can have with the growth of order? No connection at all. Any system if established the growing order and diminishing chaos is unambiguously the open system absorbing order from an outside donor source. It is the kinetic, nonequilibrium system and instead of the *second law* the alter ego *RSL*rules in this system. However, the total System is now the system and the donor source together and the System is a closed. It is just that the system is a subdomain of the System. Chaos in the System does not diminish and order in the System does grow since the System is the closed one and the straight *second law* should be complied with. The two subdomains, the system and the source must arrive at the thermodynamical equilibrium between each other. Subsequently the excessive order of the source flows into the system lacking order and the system disposes chaos into the source. Eventually the amount of order and chaos will equalize between the system and the source. If the System is finite the real thermodynamic equilibrium

The situation becomes interesting when the source is infinite in capacity and ultimately coherent reservoir of order and also has the infinite capacity to absorb chaos. In this case the equilibrium between the subdomains will be achieved only when the state of ultimate order is achieved in the total closed System. In other words the state of equilibrium is when the system subdomain is subsumed within the total closed System.

Why are the NSE and EGE do impose the existence of coherent entities? The NSE are not the Hamiltonian equations. The NSE are phenomenological and contain the friction force and subsequent viscous dissipation of energy. Therefore the NSE automatically are in compliance with the second law, although until very recently it was not in any way utilized by the fluid mechanical community. As a result the phenomenon of turbulence in fluid flows has remained the last mystery of classical physics, as it is often called by eminent physicists and mathematicians. This is not a mystery any more. As soon as the second law is recognized the turbulence in fluid flows becomes the magnificent phenomenon of visible Cosmos and not the intractable mathematical problem that in all truth is not possible to solve mathematically ever. Even the posing of this problem as a mathematical does not have sense.

The reason that the EGE impose the existence of black holes coherent structures has more complicated explanation. The black holes are the EGE solutions that are singular at least at one space/time location in the 4D space/time. In fact the EGE must inevitably have a singularity somewhere in the global 4D space/time as was proved in (Penrose R., 1964). What it means is that there is a location in the 4D space/time where the EGE are not valid with the mass/energy density and curvature infinite. It is widely believed that the intrinsic malicious black hole, BH singularity in the EGE can be handled quantum mechanically but no quantitative attempts to do this have been published.

What quantum mechanics can do is smothering the singularity over the Planck space/time scales. Such smothered singularity would mean very large but finite mass/energy and corresponding large but finite curvature of the smothered singularity. We will see in what follows that when the BH singularity is smothered the consequence is the effective quantum mechanical viscosity of the 4D space/time. This viscosity is very tiny but all significant since it furnishes the attribute of time irreversibility to the EGE dynamics and the subsequent compliance with the *second law and RSL*.

The motivation for this work came from the recently observed puzzling astronomical facts and numbers that frankly we have first learned from popular media. This and inability of contemporary cosmology and physics to quantitatively justify most of the recently observed facts, or even qualitatively understand their nature except taking refuge in tiresome platitude of "natural laws" and continuous heralding of dubious breakthroughs, with few understanding and many hesitant admitting incredulity about, prompted us to look for the general reasons that would impose coherent organization on matter beyond particular mechanisms. We were greatly inspired by the books of extraordinary intellectual depth written by Sir Roger Penrose (e.g., Penrose R., 2011 as well as by the nearly forgotten pioneering book "What is Life" by Erwin Schrodinger (1944 and 1953).

The astronomical facts that we allude to are as follows:

1. The space/time of Cosmos is expanding with acceleration. The Hubble Cosmos expansion from a single point had been anticipated first by Alexander Friedman from his iconic model of homogeneous and isotropic Universe in the frame of the fundamental equations that he derived from the Einstein gravitation equations. His work was published in 1922. It took Friedman quite an effort to convince Einstein resisting the publication of his work to reluctantly admitting in the letter to the publishers of his mathematical mistake. Later in 1927 and apparently independently Albert Lemaitre published similar conclusions. In 1929 the expansion of space/time was actually proved for a fact in the extraordinary observations by Edwin Hubble.
2. In 1998 the two independent groups in USA and Australia published the results of the many years observations indicating that the Hubble expansion is accelerating. Since 1998 this monumental discovery has been reaffirmed irrefutably. The astronomers were rewarded, deservedly indeed, with the Nobel prize in 2011.

3. The cause of acceleration of the Hubble expansion is ascribed to the invisible matter named *dark energy*uniformly distributed and permeating all and every locality of the 4D space/time of observable Cosmos. The latest precise analysis of CMB, the Cosmos microwave background radiation and other data carried out by the European Planck mission telescope in 2009-2013 shows with high accuracy that 68.3% of the total matter content in observable Cosmos is invisible dark energy. The only observable impact of dark energy is accelerating the space Hubble expansion. However, the consequences of this acceleration are enormous. Indeed, the global geometry of the 4D space/time of visible Cosmos is almost flat and getting even flatter as time goes by. The continuous flattening of the space/time geometry unambiguously proves that the global order of visible Cosmos grows with time. Could it be that visible Cosmos is on the way to perfect, ultimate order? This is what we believe is the case.
4. Many years long astronomical observations confirm that about 90% of gravitating matter in galaxies, clusters of galaxies and larger structures in Cosmos is invisible **dark matter** the nature of which is widely considered an enigma of modern science. Dark matter however contributes much more, to the total matter content of observable Cosmos. The Planck mission has established that the contribution of dark matter is 26.8 % of the total matter in visible Cosmos. We note that when we talk about the total matter content that includes the invisible matter it is proper to use the terminology of causally observable Cosmos within the event horizon rather than visible Cosmos.
5. In contrast with *dark energy* having constant mass/energy density distribution in almost all of the 4D space/time from now till the end of lifespan of visible Cosmos *dark matter* was found by the Planck mission distributed nearly randomly but intermittently in space/time with obvious density concentration associated with the lumps of visible matter.
6. The above findings mean that the normal matter, i.e., visible matter contribution is merely 4.9% of the total matter content in observable Cosmos. Barring the nonproductive fantasy that something might be lurking in a part of visible Cosmos behind the event horizon which is not observable this is a shocking finding. Most of the matter content in observable Cosmos is invisible except its gravitational impact on visible matter and on the geometry of 4D space/time.
7. The global 4D space/time geometry is dominated by dark energy and almost *flat.* The*global 4D space/time* is expanding with exponentially fast acceleration. The *local 4D space/time curvature* is caused by the intermittent, randomly distributed in the quasi-fractal manner lumps of *visible matter* and associated intermittent dark matter spots. Dark matter acts as if it was an attractive gravitational force and increases the gravitational pull of visible matter. Dark energy acts as if it was the repulsive force. It should be reminded that the forces are *fictitious.* The attractive fictitious force contracts the local visible matter lumps and hence increases the local curvature of the 4D space/time around these lumps. The homogeneous fictitious repulsive force of dark energy decreases the global curvature of the 4D space/time by causing the accelerating Hubble expansion of visible Cosmos.
8. We note that the dark energy acceleration causes acceleration of visible matter in the lumps tearing them apart. If it was not for dark matter associated with these lumps the latter would been torn apart by acceleration and no galaxies and other grandiose concentrations of visible matter would have existed. We will see later that at the largest scales where the acceleration of expansion is the largest the lumpiness disappears as it should to.

It follows that less than 5% of all matter in Cosmos is coherent visible matter with photons making it visible and neutrinos is believed by modern science to be reasonably well understood. The rest, over 95% of the material content of Cosmos is considered mystery explained neither by the meek rather than far reaching hypothesizing by a few leading cosmologists nor by the fantasies of amateurs.

The incredible observational capabilities of astronomers and their findings made clear by the subsequent astrophysical analysis furnish specific observed numerical values of physical parameters totally disattached from the quantitative ability of contemporary theoretical physics. The latter with

the exception of inflation theory have not made a single prediction in anticipation of the experimental findings. As we have pointed out the cosmologists have not theoretically calculated a single value of the specific quantities furnished by the astronomical findings since 1998. The nature of dark energy and dark matter are declared mysteries and subjects of unsubstantiated speculations not producing numbers.

This is in stark contrast with the manner that far reaching predictions were made from the analysis of Einstein gravitation equations, the EGE and subsequent Friedman equations and Lemaitre analysis anticipating the Big Bang, the actual Big Bang prediction by Ralph Asher Alpher and Georges Gamow, the nucleosynthesis and CMB parameters in the aftermath of the Big Bang predicted and calculated by Alpher and Herman and finalized by Fred Hoyle for the nucleosynthesis of heavy elements in stars, or the inevitable anomalies of MCB, such anomalies being among the main tools for gathering data on the past of observable Cosmos (Sunyaev, R A. and Khatri R. , 2013).

We reiterate that the great, fatal fault of modern theoretical physics and cosmology is the non-compliance with the *second law of thermodynamics*for the closed systems and its alter ego the*reverse second law, the RSL*the fundamental cause of order in the nonequilibrium open systems fed by the outside sources of order**.** There is little doubt that the *second law* and the *RSL a*re the most general laws in Cosmos. There is no doubt at all that all order in visible Cosmos is the kinetic, transient order in nonequilibrium open systems, from the most elemental microworld to clusters of galaxies, from Gulfstream to animate life on Earth. We will argue that the self-conscious brain of Man and the growing order of visible Cosmos have the common origin behind them. This origin is the timeless dark energy continuum, the DEC into which visible Cosmos is embedded as a subdomain. We observe it since dark energy manifests astronomically via the accelerating expansion of the 4D space/time of visible Cosmos. We will further argue that both visible matter and dark matter in Cosmos are two other manifestations of the DEC. We will argue that visible Cosmos has a finite lifespan as all other transient nonequilibrium phenomena in it and when this lifespan expires visible Cosmos acquires equilibrium of ultimate order becoming one with the DEC.

Scientifically the DEC is the inexhaustible source of negative entropy for visible Cosmos via the flux of coherent momentum/energy, while being the sink where visible Cosmos disposes the chaotic momentum/energy. This is in same manner as Sun is the almost inexhaustible source of negative entropy flux for Earth and subsequently the cause of all order on Earth and evolution of species and as food the animal life consumes is the source of negative entropy flux maintaining the coherent organization of animate matter of life. The above assertions become clear when we understand that the non-compliance with the *second law and the RSL is fatal***.**

The noncompliance with the *second law and RSL* in contemporary physics and cosmologyis undeniable since the fundamental equations of physics are Hamiltonian and time reversible. The reality of Cosmos and our mundane experience is unambiguous and obvious in that time is irreversible. Paying no respect to the *second law and RSL* is not less than negating the irreversibility of time that is one with the *second law and RSL*. This is not an innocuous offense and the price paid is unimaginable. It is not possible to account for the *second law and RSL* post factum or approximately. These laws enter non-analytically into the dynamical equations of physics via the parameter of media viscosity. Viscosity is causing friction. As small as the viscosity parameter may be, say tending to zero, its contribution to the formation of coherent structures is decisive, although remarkably the final results do not depend on viscosity. The compliance with the *second law and RSL* necessarily implies that the correct dynamical equations have the nonlinear coupling terms and the dimensionless coupling parameter. The final results may depend on this dimensionless parameter into which viscosity enters, but not on viscosity itself.

It is asserted with confidence and we see this assertion as fairly obvious that no coherent structures of visible matter and associated chaos expelled by the coherent structures of matter, e.g., dark matter exhaled by coherent visible matter, or chaotic gluons disposed by the coherent component of hadrons,

no heavy bosons of weak interaction, no elemental electrons and composite protons of microworld, no atoms and molecules, no atmosphere and oceans, no Gulfstream, no tropical hurricanes, no beehives and ant hills and no manmade states and Empires and chaos of wars for survival of the fittest, the most coherent entities, no struggle for survival of the fittest among species and Man would exist in visible Cosmos subdomain that until the discovery of dark energy and dark matter was falsely perceived as all inclusive Cosmos if not for the second law and RSL The visible Cosmos itself would not exist if not for the *second law and RSL* .

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.* Among the vocal exceptions are the famous creator of quantum wave mechanics Erwin Schrodinger in his book "What is Life" (1944 and 1953) and Sir. Roger Penrose in his lectures and books of extraordinary intellectual depth.

As soon as recognized that the accelerating expansion of observable visible Cosmos proves that visible Cosmos is not a closed all inclusive system but merely a subdomain embedded into the timeless ultimate order of DEC it is not against the *second law* that order of visible Cosmos subdomain can grow. The visible Cosmos is a nonequilibrium subdomain receiving coherent momentum/energy flux from the DEC and disposing back the equal but chaotic momentum/energy flux, All order of visible Cosmos is extracted and absorbed from the coherent momentum/energy flux from the DEC.

The DEC is the source of negative flux of entropy or the positive flux of order for the visible subdomain. This order creates all coherent visible matter, stars, galaxies and all other visible inanimate and animate matter. Dark matter is just chaos disposed by order furnished to visible matter by the DEC and digested by visible matter. The digestion mechanism converts coherent energy into the chaotic one. Subsequently the chaotic energy is disposed by visible matter is dark matter while visible matter remains coherent.

The digestion mechanism in visible Cosmos plays the same role as the food digestion by live organisms. The latter, say animals or humans alike consume highly coherent food and dispose much less coherent substances. The difference in order between the two is what gives order to the live bodies. If chaos of digested order is not disposed the coherent entities cannot absorb fresh order. Chaos is subsequently accumulating and this is the process of aging. The source of negative entropy flux, the conversion of order and disposal of chaos are the general prerequisites for existence and evolution of coherent entities, in microworld and macro world, in inanimate matter and life. Order and chaos are inseparable in coherent entities. Unless the inevitably accumulating chaos is not disposed the coherent entities cannot absorb fresh order, sicken and die.

The above are very remarkable phenomena. There is nothing mysterious about them from the scientific viewpoint warranting outlandish conjectures. They are just complex order nonequilibrium, kinetic phenomena. For instance exactly in the same manner as order in visible Cosmos is created by the DEC the solar energy order extracted by Earth creates all coherent formations and entities on Earth, from tornadoes to Gulfstream, from flora and viruses to insects and fauna. In the same manner the beehives and wolves packs are formed and cockroaches form communities and wasp spiders spawn larvae.

The mechanisms for holding coherent animate matter and our bodies and Gulfstream on Earth and galaxies in the sky and viruses are the fictitious forces converting coherent momentum/energy into the chaotic one. They are different for different systems. But their role is absolutely the same. As one unified fictitious force we can call it the *unified digestion force*. The main five fictitious forces of physics, the gravitational, strong, electro-weak and the Euler force are all the components of the order digestion force. As long as the digestion works well order will be extracted from the source and accumulate and chaos disposed while the momentum/energy density remains optimal. The goal is creating as much order as possible and hold it for as long as possible in as much as it serves the higher goal pursued by the DEC.

The global primeval source of all order above including all local sources of order is the timeless DEC. The local sources of order are created hierarchically, by various mechanisms. Remarkably all these multiple scale organizations are correlated. They are not independent but phase coherence. From largest scales of organization to the smallest ones they are in instantaneous interaction with each other. The phase coherence interaction speed is not limited by the speed of light. The phase coherence if disturbed is restored instantaneously. The fictitious forces convert monochromatic momentum/energy flux into the multicomponent one having many ore degrees of freedom and subsequent high entropy.

The phase coherence is imposed by the easily perceived fact that the fictitious forces cannot implement the conversion if all the intermediate organization from the top down is not phase coherent. Preserving the phase coherence is in the nonlinear structure of fictitious forces. The unified digestion force preserves the phase coherence from the DEC primeval source all the way down the scales to the Planck size domain at which the reverse quasi-chaotic momentum/energy flows back into the DEC. In numerical terms the order digestion unified interaction preserves the phase coherence from the DEC injection scale $\mathbf{L_c = 10^{41}\cdot l_p = 10^8}\ cm$ all the way down to the Planck scale $\mathbf{l_p} = 10^{-33} cm$ at which the momentum/energy flows back into the DEC.

The unified fictitious force creates the cascade of momentum/energy in the space of scales down the scale preserving the phase coherence at each intermediate scale being the integer of the Planck scale $\mathbf{l_p} = 10^{-33} cm$. But what happens with the order that is injected at the scale $\mathbf{L_c = 10^{41}\cdot l_p = 10^8} cm$? This order is passed to the scales larger than the injection scale $\mathbf{L_c = 10^{41}\cdot l_p = 10^8} cm$. As long as the DEC furnishes coherent momentum/energy and negative entropy flux the size of visible Cosmos will be growing exponentially fast. The exponentially fast growth of the phase coherence scale is indifferent to the specific nature of fictitious forces. In the end all visible Cosmos will become the quantum ground state merged with the DEC. There is only one such quantum equilibrium state known in physics. It is the Bose-Einstein condensate of photons. The photonic Bose condensate is the intrinsic attribute of dark energy. We note however that this is not the Bose condensation at the zero momentum/energy state as it is usually defined. For the relevant situations of the Big Bang and the final breath of visible Cosmos the quantum ground state is defined by the Planck momentum/energy value.

Summarizing the momentum/energy flux consists of hierarchy of phase coherent structures correlated at all scales. The smallest are the Planck size domain structures. The largest scale is growing exponentially fast. The latter phenomenon is observed as the exponentially fast visible Cosmos expansion. The Planck size components dissipate the high entropy momentum/energy back into the DEC. There is no momentum/energy flux up the scales. The exponentially fast expansion of visible Cosmos is the growth of the phase coherence scale transforming visible Cosmos into one phase coherent entity

In the same manner all complex coherent entities are formed absorbing order from the local donors of order, like Earth from our Sun, converting order into chaos and disposing of this chaos, while order on Earth is continuously growing. We will show rigorously below that as long as Sun exists in its current stage of evolution the global order on Earth will be growing.

However, the DEC is the primeval source of order manifesting and present in every one of them at every space/time location of the 4D space/time of visible Cosmos.

Does the timeless DEC pursue goals? Indeed, it does and they are fairly obvious. Visible Cosmos is created and furnished with information via the coherence of momentum/energy flux from the DEC. But the crown creation of the DEC in visible Cosmos is Man, or this is what we want to believe in. Man creates information beyond that he is furnished with. All other inanimate and animate matter of life is very complex organization but it does not create.

The mathematical information into which all creations of Man are eventually converted does not disappear. The laws of science do not allow disappearance of information in closed systems. However visible Cosmos is not a closed system. Therefore information is allowed to disappear from visible Cosmos. The final destination of information created by Man is the DEC. Hence the DEC benefits from information created by the race of Man as long as the race exists. We will argue that the self-consciousness of Man exists as long as the lifespan of visible Cosmos.

It is timely to demonstrate the quantitative results achieved by following the kinetic approach to order and chaos in visible Cosmos. In the Table below we compare our theoretical results with the latest available experimental data and astronomical observations of the Planck mission 2009-2013, the most precise observations ever done. We also indicate the rare instances where the existing Hamiltonian equations results can be compared with our results.

Theory	**Astronomical observations best fit of NASA's WMAP satellite and Planck Mission 2009-2014**	**Previous Theoretical Calculations**
1	**2**	**3**
Basic Cosmological Parameters		
Contemporary Hubble constant: $\mathbf{H} \approx 2.35 \cdot 10^{-18}\, sec^{-1}$	Contemporary Hubble constant: $\mathbf{H}^{\textbf{Plank mission 2013}} \approx 2.35 \cdot 10^{-18}\, sec^{-1}$	Do not exist:
Contemporary contribution of visible, "normal" matter to the total matter density including 1% neutrinos: ≈ 4.91%	Contemporary contribution of visible, "normal" matter to the total matter density: ≈ 4.90%	Do not exist
Absolute value: $0.0464 \cdot 10^{-29} g \cdot cm^{-3}$	Absolute value based on assumption of flat Cosmos.	
Dark matter contemporary contribution to the total matter: =26.8%	Dark matter contemporary contribution to the total matter: 26.8%	
Total matter including dark matter and dark energy: $0.9964 \cdot 10^{-29} g \cdot cm^{-3}$	Total matter ???	
Critical matter density based on theoretical Hubble constant above and Friedman equations: $0.9967 \cdot 10^{-29} g \cdot cm^{-3}$ *Compare with total matter above*	Critical matter density based on theoretical Hubble constant above and Friedman equations: $\approx 0.86 \cdot 10^{-29} g \cdot cm^{-3}$	
High accuracy flatness of the contemporary visible Cosmos is proved. Visible Cosmos is nearly in the middle of its lifespan at: $T^{visible}_{contemorary} \leq t_p \cdot R_{\mathbf{C}}^{\mathbf{3/2}}$, $T^{visible}_{lifespan} \cong t_p \cdot R_{\mathbf{C}}^{\mathbf{2}}$ where $t_p \approx 3 \cdot 10^{-33} sec$ is the Plank time unit.	Approximately observed	Qualitatively explained in inflation Theories in conjunction with the EGE

1	2	3
Hubble age: $\approx 13.508 \cdot 10^9$ *years* *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" .* *Only universal constant is:* $\mathbf{R_c} \equiv 10^{41}$ *It is obvious that for several hundred millions years of deceleration of expansion after the inflation stage it was smaller. Thus the discrepancy between the two numbers.*	Cosmos age: $\approx 13.840 \cdot 10^9$ *years* *Note that the Hubble age is not the Cosmos age. Hubble constant is not constant in the theories based on Friedman equations.*	Do not exist
Total visible matter within the event horizon $46 \cdot 10^9$ *years;* $1.38 \cdot 10^{5\,6}$ *g*	Total visible matter within the event horizon based on flat Cosmos assumption and empirical data $\approx 2.46 \cdot 10^{56}$ *g*	
Inflation stage: lasts 10^{-23} *sec* after the Big Bang. *Inflation does not require the hypothetical inflaton.* *The cause of inflation is the compliance with the second law and RSL.* *The tremendous momentum/ energy flux of ultimately coherent light of Big Bang must be separated from the DEC into the exactly flat space/time.* *The space/time should be exactly flat since the curvature of space/time is the chaotic gravitational degrees of freedom.*	*Promising astronomical observations of the inflation imprint on observable CMB are in progress.* *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.* *The initial spectrum of quantum density fluctuations of the hypothetical Inflation matter is believed may explain the density distribution of contemporary visible matter.*	Inflation stage: $\approx 10^{-35} \div 10^{-33}$ *sec* No photonic Big Bang *Einstein cosmological "constant" is not really constant in inflation theories.* *Instead "inflaton", a new hypothetical form of matter causing inflation is postulated.* *The inflation decay is the source of al all visible matter in Cosmos.*

1	2	3
Chaos does not exist prior to the birth of time. Time does not exist prior to the birth of protons. *The two are born together in inseparable compliance with the ESR concept of the time measurement.* *Measuring time requires at least two clocks made of a nonzero rest mass matter and light synchronizing the clocks.* *Hence inflation is inevitable subsequent to the ultimate coherence of Big Bang light*	*We suspect, but are not qualified to argue that the imprint of inflation via the tiny trace of primordial gravitational waves caused by inflation and left on observable CMB may be not able distinguishing different causes of inflation.*	
Conjunctive Basic Parameters of Protons, Electrons and Physical Interactions		
Proton rest mass due to quarks $m_{proton}^{quarks} \equiv \mathbf{10^{-26}}\, g$	Not possible to measure directly	QCD computations based on the experimental input of the total rest mass of proton results: $m_{protons}^{quarks} < 1.67 \cdot 10^{-26}\, g$
Proton total rest mass due to gluons and quarks: $m_{proton} \approx 1.69 \cdot 10^{-24}\, g$ Lifespan: $3 \cdot 10^{38}$ *sec* = 10^{31} *years*	Proton total rest mass due to gluons and quarks: $m_{proton} \approx 1.67 \cdot 10^{-24}\, g$ Stability: > 10^{30} years *There is other data furnishing much longer stability time, but it depends on particular mechanisms and hence irrelevant.*	*Proton is extraordinary complex composite particle consisting of three quarks with the total charge of opposite sign and equal to that of electron.* *This is the final gist of the famous theory started as Ne'eman,Gel-Mann eight fold theory that later led Gel-Mann and Zweig to postulate quarks.* *Proton mass is assumed given.*
Electron rest mass: $\approx 10^{-27}\, g$ Lifespan: $3 \cdot 10^{38}$*sec* = 10^{31} *years*	Electron rest mass: $\approx 9.1 \cdot 10^{-28}\, g$ *Elementary particle*	*Considered a given fundamental Constant.* *Considered indivisible having no internal structure.*

1	2	3
Electron is the genuinely elemental particle inseparable from photons. . *The transformation between the coherent light of Big Bang and the virtual electron/positrons pairs is the "Before Adam" phenomenon.* *Stable electrons/positrons are born quite later after the birth of protons.* *Electrons/positrons are whole made of the trapped virtual Planck particles.* *The cloud of virtual photons is chaos emanated by electrons/positrons coherent core to maintain its coherence for the lifespan of visible Cosmos.* *The exchange by virtual photons is the cause of electromagnetic interaction.* *The latter is the first order effect in powers of the fine structure constant.* *Electromagnetic force plays no less role in the structure of protons than the strong force does. But actually it is the unified electroweak force is defining the internal structure of protons furnishing them with two internal scales deep inside the proton curled "string".*		*Electron mass: is assumed given.* *Electron is assumed elemental and forever stable.* *The electroweak theory unifying the electromagnetic and weak forces explains everything except the large mass of W and Z bosons.* *These are fundamentally important for digging inside of protons and neutrons transforming hem one into another.* *The cause for it is obvious.* *Atoms nuclei would have not existed if not for the nuclear attraction between protons and neutrons.* *This attraction neutralizes the Coulomb repulsion of protons.* *Thus atoms are forced to form by the same RSL as all other coherent entities in visible Cosmos.* *The RSL is the cause. But the mechanism of the atom formation requires neutrons, Weak interaction procures neutrons from protons.* *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.*

1	2	3
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. *This assertion is preliminary!*	*W and Z bosons have been detected long ago as all other predictions of electroweak theory.*	*One of them is Sun and Earth is circling around it in a good position.* *This is where the animate life will be created and evolved out of order extracted from the solar radiation.* *For the heavy nuclei the balance of forces cannot hold and the nuclei start decomposing radioactively*
Visible matter, MHB's and Visible Cosmos lifespan: 10^{31} years	*Too early to judge*	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*
Higgs boson? $\mathbf{M_B} \approx 2.23 \cdot 10^{-22} g =$ $= 132\ m_{proton} = 129$ *GeV* *We are not at all sure that the above is the boson recently observed and believed the Higgs boson.* *We mentioned above the possibility that the proton string vibrates with two distinct frequencies.* *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 of protons.* *The other frequency may correspond to much more massive "sound" bosons.* *It is a very preliminary assertion*	Higgs boson $\approx 125 \div 127$ *GeV* *Preliminary data. Experiments in progress*	Higgs boson $\mathbf{M_{boson}^{Higgs} \cdot c^2} \sim 126$ *GeV* *In the framework of Grand Unification it is believed that the Higgs bosons is defining the attribute of mass and carrier of gravitational force.* *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 carriers of strong interactions.* *We 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 interactions.* *In fact photons, W&Z and gluons are all the Higgs particles in the sense that they are the carriers of respective interactions.*

1	2	3
Universal Strong Force value: $\mathbf{F_{strong}} \approx 4.65\ \{(\mathbf{c^4/G})\} / \mathbf{R_c} = 0.565 \cdot 10^{9}$ *dyne* = $= 0.565 \cdot 10^{4}$ *Newton* *Properties proved:* *1. Confinement is proved from the above distance independent expression;* *2. Asymptotic freedom is obvious. For the scales deep inside protons at about:* $\approx 1.97 \cdot 10^{-14}$ *cm.* *The asymptotic freedom is caused by the competition between the scale independent* $\mathbf{F_{strong}}$ *and the electrostatic self-repulsion of the likewise charged quarks with the total charge equal and of opposite sign to that of the electron.* *Although the model is crude it furnishes excellent results for the proton rest mass due to the virtual gluons.* *It works as if* $\mathbf{F_{strong}}$ *compresses the quarks to the above distance and their electrical charge resists the compression thus balancing* $\mathbf{F_{strong}}$. *Therefore the asymptotic freedom seems apparent.* *More fundamentally it follows from the minimal possible length scale, the Planck scale to be sure.*	Strong Force value: $\sim 10^{4}$ *Newton* *Properties established:* *1. Confinement;* *2. Asymptotic freedom*	Do not exist *Properties:* *1. Confinement at large distances and Small momenta, the infrared confinement , has not been proved in framework of QCD! We believe it will t not be. It does not exist in the Hamiltonian physics and 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 the property intrinsic to QCD will remain unclaimed.* *2. The ultraviolet asymptotic freedom in the QCD was proved in the perturbative QCD theory and rewarded, deservedly the Nobel prizes .* *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.* *Subsequently thy typical logarithmic decreasing of the coupling constant at small distances. This is an artifact of perturbation theories and the lack of the natural cutoff scal*e. *This may be the reason for the absence o of the intrinsic scales deep inside the protons causing the gluon virtual cloud responsible for the strong force.*

1	2	3
At this scale the fictitious force transforming the coherent momentum /energy flux from the DEC is exactly equal to the quantum viscosity dissipation term and protons decay into the Planck particles, or more correctly melt within the DEC.		*This is the reason why neither the strong force value nor the mass of proton can be calculated. This is the reason why proton is not the exact solution of any equation.* *The QCD as all other Hamiltonian physical theories do not and cannot impose the existence of coherent entities.*
The ratio between the combined density of coherent visible and chaotic dark matter and the dark matter density alone is constant. This ratio is: ≈ 1.83	*Cosmologists will be testing this prediction till the end of times*	Do not exist
The asymmetry between matter and antimatter content in visible Cosmos is trivially explained. *The coherent momentum/energy and the corresponding negative entropy flux into visible Cosmos.* *The positive entropy flux, the flux of chaos would correspond to the excessive antimatter content in visible Cosmos*	Well established fact.	Do not exist. *Considered a mystery. But there are no mysteries in visible Cosmos, rather the perceptions of strange facts create mysteries.* *As soon as one accepts the primeval source of Cosmic order and the goals of this source there are no mysteries left.* *Instead we are learning various mechanisms of ever increasing beauty implementing the will of the second law and RSL.*
Self-Conscious Human Brain Parameters		
Human brain self-consciousness is related to the concept of time and the primordial DEC source of coherent momentum/energy flux of dark energy through the brain cortex.	*The attribute unique to Man is well known.* *It is proclaimed in Genesis in the eternal verse that Man is made in the image of Creator.* *In mundane manner Man creates order, is endowed.* *With comprehension of time. Not only of material time, but also of the abstract time "Before Adam".*	Concept does not exist. *The closest was promoted by Roger Penrose in his profound quantum mechanical concept on the nature of self-consciousness and nonalgorithmic thinking of Man*

1	2	3
The dark energy flux passing through the cortex of human brain with the volume of ~$10^3 cm^3$ is maintaining the extraordinary dark energy density of times over the average density of $\mathbf{R_c^{1/2} \approx 3 \cdot 10^{20}}$ *times over the average density of dark energy in visible Cosmos.* *The flux is non-interrupting and causing, potentially, the ultimate phase coherence with the DEC throughout the Man's lifespan*	*The ability of nonalgorithmic thinking is also obvious.* *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.* *The popular concept among somein the scientific community says that the self-conscious Man evolved from apes in Africa*	
The birth of self-consciousness is in in conjunction with the birth of proton and the time concept at $\mathbf{t_{event}} = 3 \cdot 10^{-3}$ *sec* *This takes away the conflict on the nature of time prior to the birth of Man capable of conscious understanding of time perceiving past and forecasting future not based on experience.* *The above argument has nothing to do and not in conflict with the evolution of inanimate matter in visible Cosmos and animate matter on Earth.* *The above have proceeded at their own pace in accordance with the laws of physics and mechanism of absorbing order from the solar radiation and the subsequent Darwinism; the survival of the fittest unshakeable principle.*	*This seems to be so out of touch with reality and absurd that it's hard to contest rationally.*	

1	2	3
At an appropriate time the self-consciousness is ported into the most suitably evolved animal body and brain. ***This is the birth of the whole Man**.* *Since then the evolution goes on and the amount of order on Earth will be ever growing which may be not perceived by any particular generations.* *As will go on the weeding out of species, races, individuals not fit for survival as well as manmade coherent entities; societies, ideologies, states and Empires.* *As soon as the units of these entities lose the coherence of purpose and coherent creativity the entities are not fit for survival.* *This is especially painful for 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 reaching the ultimate order of the DEC.* *Man is given the task to bring new information created by him to the DEC. The DEC is timeless and void by itself of material processes.*		

1	2	3
It is the infinite capacity reservoir of Information and light. 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 the theological concept having the eternal significance for Man and his creations.*		
The typical weight of the human brain is calculated in the manner we calculated the coherent mass of quarks in protons. *Rather than calculating the lifespan of the human brain we assume that the upper limit is the Biblical 120 years.* *Then we receive for the rest mass, or weight of the brain cortex:* $\mathbf{M}_{\mathbf{cortex}}^{\mathbf{brain}} \approx 10^{8}\mathbf{m}_{\mathbf{p}} = 1000\ g$ *This calculation no doubt may appear peculiar to say the least.* *But if to think about it with no preconceived animosity the result ties up many lose end that are quite rational.*		

1	*2*	*3*
Most importantly it reinforces the above assertion that the extraordinary complexity of human brain is caused by the highly dense coherent momentum/energy flux passing through the human brain. *This is a fairly rigorous result, not less than the calculation of the coherent component of the proton rest mass due to quarks.* *The remarkable fact is the appearance of the ubiquitous factor* $\mathbf{R_c^{1/2}} \approx 3 \cdot 10^{20}$ *in the calculation .* *It connects the coherent human brain component with the fundamental dimensionless constant of visible Cosmos, the constant defining the Cosmos evolution and lifespan*		
What is special about the Biblical lifespan? It is easy to estimate that the combined space span of dark energy passing by the above 10^8 locations in the human brain is near to the distance passed by light since the Big Bang. *We interpret it as the indication of the phase coherence connecting the human self-consciousness since its birth in conjunction with birth of time till the present, but also the future.* *The phase coherence does not distinguish between past and future. It is the fundamental quantum coherence serving the preservation of information.*		

1	2	3
The DEC as incompressible media is the conductor of phase coherence in the total 4D space/time of visible Cosmos. ***The human self-consciousness scans the history of visible Cosmos from start to end.*** ***This is the conclusion of this review that the self-consciousness entity is timeless.***		

Keywords: Visible Cosmos, Kosmos, Universe, Second low and reverse second low, Dark energy, Dark matter, Light, Order and coherence, Entropy and mathematical entropy, Acceleration of Habble expansion, Dark energy and brain cortex

INTRODUCTION

The first chapter of Torah and the Christian Bible alike is Genesis that depicts the initial state of Cosmos and the sequence of events that culminated in creation of Man. The Genesis is the eternal wisdom that is not scratched by unlearned interpretations. The unlearned interpretations have caused equally unlearned criticism and scorn of Genesis by most scientists since the French Revolution for reasons having to do with the oppressive religious beliefs rather than science. Isaac Newton, one of the greatest scientists and thinkers of all times was a deep believer in the divine origin of Cosmos that he saw literally as Kosmos. He extensively studied the Judaic writings and sought the words by which Creator said Kosmos into being.

One outstanding and for some disturbing attribute of Genesis not to be found in any other religious teachings of antiquity is the clear statement that the first act of coherent creation added to the initial timeless state of Cosmos is *light s*aid by Creator into being, liked by him and separated from dark. This could not escape attention of scientists as much as they wished to and is mentioned by many of them as a curiosity[1]. The creation of light is indeed in compliance with the widely accepted, although not by the proponents of inflation theories, understanding that Cosmos originated as the Big Bang of light.

However, the separation of light from dark has been interpreted by a legion of unlearned experts as the trivial separation of day and night on Earth. Clearly these experts have had low opinion of intellectual abilities of Hebrew sages passing the words of Genesis with not a single letter changed through millennia. In part this stubborn naiveté has been caused by difficulties of translation from Hebrew. This is indeed a hard task since many meanings in the text of Hebrew Torah is subtle. However, the naiveté walks hand in hand with a deliberate unwillingness by many to understand. We believe that the supercilious attitude is not warranted when dealing with the text of Torah, of which most contemporary cosmologists and physicists are unlearned about and many have not held in their hands, the text of unsurpassed complexity and coherence. In what follows we assert the entirely different scientific interpretation of the separation of light from dark. This interpretation is fairly obvious in view of the recent astronomical discovery of dark energy, a "mysterious" substance not interacting with light, photons of any wavelength.

The state of order, or the coherent state which is the same and the opposite state of chaos are semantically clearly perceived by our mind. However, as it often happens with the murky semantic meaning the rigorous mathematical definition of these states is complicated. Nevertheless, great minds of the 19th century physicists rigorously defined entropy, the measure of chaos in a system. The less is entropy of the system the more coherent it is and the other way around. Entropy is rather the measure of chaos and not of order is easier to define rigorously.

The tendency for the growth of coherence scale in matter is obvious. Quarks are forever glued into protons and other hadrons. Electrically charged protons and neutral neutrons make up the nuclei of atoms. They are held together in the nuclei by the nuclear forces the nature of which is pretty well understood. Neutrons are unstable when free. They decay into protons with emission of positron and a very light particle antineutrino. This is a very well understood process, but what is remarkable that when in nuclei neutrons are stable and thus the nuclei are stable and together with electrons they form atoms. Then atoms unite into molecules and molecules unite into all macroscopic matter in Cosmos. At each step the coherent structure formed is larger. Matter makes lumps of matter and the lumps unite into larger lumps until these lumps reach the scale of super clusters of clusters of galaxies and only at the very edge of observable Cosmos close to the event horizon lumps disappear. We remind that the farthest visible Cosmos at the event horizon is at the same time the earliest state of visible Cosmos that passed us long ago following the Hubble expansion of space. Therefore it is natural to conclude that the homogeneity of matter at the event horizon shows that at the very early stage visible Cosmos was homogeneous. This is in full agreement with the assertion that the Big Bang event is a perfectly coherent event, but also with inflation theories asserting that right after the birth Cosmos

[1] The author remembers well how the great physicist and cosmologist Yakov. B. Zeldovich many years ago was brooding over this curiosity. Later he opened up much more in expressing publicly his doubts of our ability to understand the origin of Cosmos scientifically. We will furnish references to his and other as distinguished scientists comments expressing their inner, often hidden beliefs on the origin of Cosmos.

expanded with great speed. However in the existing inflation theories require the birth of a hypothetical inflaton matter instead of the Big Bang of light. We will show that the inflation stage is equally inevitable in the regular vision of the Big Bang of light, but this light is not the equilibrium light but the ultimately coherent photons.

Coming back to the growing scale of phase coherence of visible matter and associated growing order of visible matter in Cosmos we again ask the same question. What is the primeval source for this order? The answer is unambiguous. The primeval source of order is the coherent momentum/energy flux from the DEC. For the microworld this is the only source of order, since the intermediate local sources of order are formed after the microworld matter is formed. If it was that equations of physics were really fundamental then the microworld, the protons and electrons in the first place would have been their exact solutions. Obviously they are not bas no coherent entity is the solution of the Hamiltonian physics equations.

We note that the frequent references to mysterious nature of say dark matter popular in contemporary cosmology are misleading. Miracles and mysteries do not exist and whatever is observed in visible Cosmos is rational and requires rational scientific explanation. It is that rational and miraculous is understood differently by proponents of different ideologies. Everything that is observed is natural whether we like it or not. However the interpretation of observed reality may be one or another. If one interpretation is predictive and others are not then the former interpretation is obviously the favorite unless it is inconsistent with even a single, firmly established experimental fact or observation. Even if this interpretation is not likeable and not in the mainstream of *a la mode* transient vision of Cosmos and us in it [2]. In particular dark matter is far from being mysterious. It is very natural chaos, boson chaos is the only chaos possible, that is generated by coherent visible matter to remain coherent as we described above. On galactic scales it must be so that lumps of matter are not torn apart by the acceleration of visible Cosmos expansion. But dark matter should also exist everywhere where there is any sort of coherent normal matter. The gluons holding protons ever stable play similar role. To make it clear we assert that all matter in visible Cosmos are different manifestations of dark energy, including dark matter in particular. There is nothing else in visible Cosmos except these manifestations.

Therefore our main task is trying to understand what dark energy is. This review is about the De locissanctis of Jerusalem, the Holy Chalice of all order in visible Cosmos. The primordial, primeval source that had given birth to visible Cosmos, has been furnishing and will have been furnishing the continuously growing order of visible Cosmos and self-conscious Man on Earth.

It all starts as a mathematical point, a seed that quickens within the DEC. When the point is ready it emits the light of the Big Bang that creates infinite force that pushes irresistibly the DEC to give way for the initial finite size 4D space/time. The quickening of the seed inside the DEC and the subsequent Big Bang cannot be scientifically explained as much as scientists wish to do it by natural laws. There is nothing natural in the Big Bang event. The cause of the Big Bang is beyond the scope of experimental science. And hence will forever remain the subject of beliefs. On the contrary the fact of the Big Bang is very near for the potential experimental capabilities of astronomers to establish

Also the mechanisms of evolution and life of visible Cosmos since the Big Bang are well within the scope of scientific exploration. Also the end of lifespan of visible matter in Cosmos and subsequently of visible Cosmos can be respectively predicted and calculated using only the available experimental and astronomical data and firmly established science, Although, it will take quite a while to witness the end.

The Big Bang event is the first material manifestation of the DEC. It starts as the coherent momentum/energy flux from a point source within the dark energy continuum. We reiterate that the cause of this source and its materialization are scientifically unfathomable and will be argued forever from ideological considerations. The Big Bang is not the beginning of time but the event "Before Adam". The source is a mathematical point and the density energy is infinite. There is nothing bad in infinite energy density singularity. We discuss the Big Bang event in the timeless continuum. Hence the infinite energy density is simply the mathematical infinity. It is a bit difficult to grasp since we are

[2] Conan Doyle attributed his famous private eye character Sherlock Holmes with elucidation of his success to the incredulous Dr. Watson. He would say: "Watson, when you ponder on a twisted case and all your versions prove to be wrong and there is only one left it is the right one; as hard to believe this may be".

addicted to the time concept and all our semantics is based on the ability to define the causal timeline of events. The ability to set the causal sequence is the comprehension of the unidirectional current of time. Our comprehension of the past events and their connection to the present is the realm of algorithmic thinking. Discussing events that had happened "Before Adam" when the time concept had not existed is outside this realm.

The time sequencing for the "Before Adam" events is rather viewed as a mathematical manipulation having no manifestation accessible to our perceptions except that we do. Nevertheless these events can be observed if they make imprints left on the structure of the material 4D space/time from the birth of time concept. These imprints would be then like the initial conditions for the material 4D space/time.

The Big Bang point endowed with the infinite energy density serves as the source of finite momentum/energy flux. The flux is determined by the two given material constant; the light speed **c** although there is no light yet and the Newton gravitational constant **G** , although there is no gravitation yet. This flux is as follows: $\mathbf{c^5 \cdot G^{-1}} \approx \mathbf{3 \cdot 10^{59}}$ erg/sec .Within a very short abstract time parameter $\mathbf{t_p} \approx \mathbf{3 \cdot 10^{-44}} sec$ this momentum/energy flux will generate $\approx \cdot 10^{16} erg$of energy within the infinitesimal, zero size point. The energy flux density therefore is infinite. But the energy flux divided by the speed of light constant that we already have at our disposal is the momentum flux generated within the point. The momentum flux is the force acting by the mathematical point on the surrounding dark energy continuum. Since the point is within the continuum this is like a point within the incompressible fluid. The continuity of rigidly incompressible media cannot be broken by any force. The force in incompressible media is the pressure gradient and this pressure gradient exerting infinite pressure on the surrounding DEC media. In mundane terms the point wants to expand but cannot because the media is incompressible. It is absolutely clear that the Big Bang event occurred and hence the DEC media had given in to the infinite pressure gradient and allowed the point to expand and reach a finite size. This cannot be explained by any "natural" law and is clearly the deliberate action of the DEC to grow visible Cosmos subdomain within its infinite and timeless continuum. The goal can be achieved by introducing the quantum mechanical principles and the fundamental quantum mechanical Planck constant. This is apparently what the DEC had done.

When we look in retrospect into the "Before Adam" history we conclude that the quantum mechanics allows the local compressibility of the DEC. This local compressibility allows the singular point to reach a finite size to become what is known now the hypothetical Planck particle. At this point we define it as the virtual Planck particle. Together with the gravitational and the speed of light constants, both the gravitation and light phenomena yet to be it is now possible to calculate uniquely the size, the life span and the mass/energy of the virtual Planck particle. Since it is the virtual one it pops out from the DEC and pops back in within the $3\mathbf{t_p} \approx 10^{-43} sec$time unit. However it pops out again and pops back into the DEC and again and again. In otherwords it is a flickering Planck particle witha very high frequency: $\mathbf{\Omega_p} \approx (\mathbf{1.3})\mathbf{t_p^{-1}} \approx \mathbf{10^{43}}\ hz$:. Over a time period it looks as if it is always present in a certain space volume of visible Cosmos yet to be.

The flickering Planck particle is now endowed with the 4D Planck domain that will remain the smallest possible domain in the future irreversible time visible Cosmos. It is senseless to have smaller domains in visible Cosmos since if there is one it belongs to the DEC. Therefore we assert that the future visible Cosmos is the 4D discreet, corpuscular 4D space/time subdomain embedded into the DEC.

The future visible Cosmos is finite or infinite, but we believe that there is no reason for visible Cosmos to be finite, since if it is this would introduce an unnecessary scale unit. However, by being discrete it remains the unccountably smaller subdomain relative to the dark energy timeless continuum.

The virtual Planck particle flickering within the DEC is the birth of a finite size black body. Exactly at the mathematical time $\mathbf{t_p} \approx 3 \cdot 10^{-44} sec$ this black body is endowed with all the necessary constants to radiate photons in accordance with the classical Stephan-Boltzmann. This is the light of the Big Bang.

The Stephan-Boltzmann flux explicitly depends on the quantum mechanical Planck constant. However, for the flickering Planck particle domain the Planck constant cancels out. With this cancelation of the Planck constant the radiation energy flux of the Planck size black body into the

DEC is exactly equal to the flux that this subdomain receives from the DEC above. This subdomain is not the part of the continuum at the instant it is formed since at this instant light is separated from the dark energy continuum. Indeed, with the introduction of quantum mechanics the Big Bang flux of photons separates from the DEC energy flux. This is the first creation.

This is fairly remarkable by exactly delineating the start of Cosmos as a singular point, a deliberate break of continuity of the dark energy continuum, from the exact instant of mathematical Planck time when the quantum mechanical visible Cosmos is born. From now on Cosmos is quantum mechanical and will remain always during its lifespan. Getting ahead we mention that the end of visible Cosmos will look again classical with the laws of quantum mechanics left from visible Cosmos back into the DEC.

However, although the momentum/energy flux from the DEC into the Planck size subdomain and the equal reverse radiation momentum/energy flux back into the DEC are independent of the Planck constant this does not mean that the Big Bang event and the end of visible Cosmos are the classical ones. The Big Bang would have not happened at all if it was not for the quantum mechanics. This duality is typical for extremely coherent phenomena. Such phenomena can be exactly and rigorously treated either as classical or quantum mechanically. On the other hand their existence is possible only quantum mechanically. Therefore the Big Bang can be treated as if it was a classical effect, but on the other hand the Big Bang event would have not at all occurred classically.

From now on the Planck domain becomes the nonequilibrium subdomain within the DEC domain. It receives the coherent momentum/energy flux from the DEC and returns back the same energy flux into the DEC. But for any time $\mathbf{t > t_p \approx 3 \cdot 10^{-44}}$*sec* the momentum/energy flux from the visible Cosmos subdomain will be more chaotic than the always perfectly coherent momentum/energy flux from the DEC into the visible subdomain.

The "Before Adam" Big Bang is indeed the most important nonequilibrium and obviously nonalgorithmic event that only the self-conscious mind of Man can comprehend[3].

Let us analyze what happens after the Big Bag. We remember that there is no real sensual time yet. For the material time concept to have meaning it is necessary to have means to measure time. To do it in a meaningful manner it is necessary to have at least a pair of clocks showing the same time. For this the clocks should be synchronized. To synchronize them with the maximal possible precision it is necessary for light to shuttle between them. It can be only light since the speed of light relative to the clocks does not depend on the motion of the clocks. It remains constant relative to any object in visible Cosmos having nonzero rest mass and hence not being able to reach the speed of light. This is one of the most fundamental laws in visible Cosmos that we learned from the Einstein special relativity theory, the ESR.

In order to build the pair of clocks there should be visible matter and this can be only matter with the nonzero rest mass/energy. Light that consisting of zero rest mass/energy photons is not visible by itself. It makes other matter having nonzero rest mass/energy visible interacting with it, by reflection of absorption. There is a more stringent condition for the existence of the time concept. This one is the existence of self-conscious observer comprehending the time concept and causal sequence of events

[3] The nonalgorithmic mathematical and semantic statements are such that cannot be falsified as true or not by an arbitrary large, but finite number of digital operations. The famous mathematical example is the Alan Turing machine that poses a problem that in principle cannot be solved by an arbitrary large number of digital operations and subsequently by a computer as large as this may be. This example is fairly obvious proof that human mind while possessing fairly mediocre algorithmic intellect compared with computers is gifted with the nonalgorithmic one. The only ones who do not grasp it are certain militantly materialistic computer scientists and philosophers. Some of them are sincere in their convictions, like the fanatical fighters against emission of carbon dioxide. We suspect that some on the other hand have such profound vested interest in their refusal to recognize the obvious that arguing with them is the lost case from the start and may be almost as dangerous as it was entering into argument with medieval Inquisition.We also use the terminology of "nonequilibrium phenomena" that are usually meant as certain material processes There are no processes at all "Before Adam". However there are mathematical informational processes that are uniquely intertwined with the material processes. This amazing correlation between the two sheds light and validates our reasoning of the "Before Adam" events as informational events. The all-important and unique connection between material order and chaos and informational order and chaos is at the core of the reasoning in this work and we believe at the core of all and every event in visible Cosmos.

in a global manner from their beginning and in to the future. Such comprehension of time that is not based on a particular experience that animate life in general is endowed with on instinctive computers can be taught with. The comprehension of time as the comprehension of semantics are complicated and controversial subjects that have been discussed and argued about for thousands of years and are not near resolution. We believe that both have explicit connection to the gift of self-consciousness that Man is the only species in visible Cosmos gifted with. We will discuss the issue below. In the meantime we accept the regular approach of ESR starting the forward running time count when the first stable nonzero rest mass/energy matter is born. But what from this matter is borne? We will answer this question shortly.

We note that the Big Bang event is the emission of a perfectly coherent light having one frequency and wavelength. It is like the ultimately coherent point laser. Unfortunately the only such laser possible is the Big Bang event. The birth of visible Cosmos is the separation of light from the DEC as the radiation emitted by the Planck size domain black body. The Planck domain is the only possible in that it emits the equilibrium Planck radiation which at the same time is the ultimately coherent laser. At the first glance it seems contradictory.

Indeed, we are used to the black body equilibrium Planck radiation spectrum as the wide spectrum having all frequencies and with the peak determined by the temperature of the black body. On the other hand the ideal laser radiation is a monochromatic one frequency beam of light. There seems to be only one case when wide Planck distribution transforms into the monochromatic radiation spectrum and this is for the zero temperature. If the temperature is zero then all photons are in the quantum ground which in this case is the state of zero energy and zero frequency. For all bosons and photons are bosons it is possible to be in one quantum state as a result of the fundamental quantum mechanical rule established by Wolfgang Pauli.

The phenomenon of multiple bosons occupying the same quantum momentum/energy ground state is called the Bose-Einstein condensation. When these bosons are photons the phenomenon is called the Bose condensation of photons. Such state of photons is also the equilibrium state of the second kind that is possible only in the quantum mechanical world. This is the state of maximum possible. ultimate order in contrast to the classical physics statistical equilibrium of the first kind that is the state of maximum possible, ultimate chaos. Therefore the Big Bang event is the emission of photonic Bose condensate.

However, clearly the Big Bang does not emit zero momentum/energy photons. Also if we see the Planck maximum domain as the black body it does not radiate. The resolution is simple. The ground state of the Planck domain is not the zero energy and not the zero frequency. The only frequency that exists in the preborn visible Cosmos is the one indicated above : $\boldsymbol{\Omega_p \approx (1.3)t_p^{-1} \approx 10^{43}}$ *hz*:and it is extremely high. In other words the Big Bang event is the emission of the photonic Bose condensate from the ground state that in this case is not the zero but the extremely high energy state $\mathbf{E_{Big\ Bang}^{photons}}$=$10^{16}$*erg.* On the other hand the Big Bang can be seen as the Planck radiation with the highest temperature that can be achieved in visible Cosmos$\mathbf{T^{Big\ Bang}}$ = 10^{32}K. However since this is the only temperature that exists the Planck distribution compresses into the
$\mathbf{E_{Big\ Bang}^{photons} = 10^{16}}$*erg* $\cdot \boldsymbol{\delta (\Omega - \Omega_p)}$ where: $\boldsymbol{\Omega_p \approx (1.3)t_p^{-1} \approx 10^{43}}$ hz^4 . The two are not a contradiction for the Planck domain.

The reason beyond the cancelation of the Planck constant is the absence of time. When there is no time there is no distinction between chaos and order. There is only ultimate order of the DEC, Formulating it in the conventional terms the light of the Big Bang is the flux of Bose-Einstein condensate of photons all occupying the only possible ground state in the wavenumber/frequency space. The photonic Bose condensate is a quantum effect. It is the statistical equilibrium of ultimate order possible only in quantum mechanical Cosmos. This is the equilibrium state of the second kind in contrast with the classical equilibrium of the first kind that is ultimate chaos. The exact Bose condensation of photons is possible if there is not a single electrically charges fermion in visible

[4] $\boldsymbol{\delta (x)}$ is a special function with the property $\boldsymbol{\delta (x \neq 0) = 0}$ and $\boldsymbol{\delta (0) = 1}$

Cosmos. This is the Big Bang event before the electron/positron pairs are born and again at the end of visible Cosmos lifespan when all fermions will have been melted in the DEC.

The coherence of the Big Bang event is forcefully emphasized by Sir. Roger Penrose (e.g., Penrose R. , 2010). However bearing in mind our discussion of the role the quantum mechanics plays in the Big Bang we remind that the event coincides with the birth of quantum mechanics and would have not been possible with no quantum mechanics. The two are inseparable from each other. The separation of light from the DEC is in fact the birth of independent light and equivalent photons not interacting with the invisible DEC and hence delineating the future visible Cosmos subdomain.

The coherent light of the Big Bang gives birth to the whole variety of virtual electron/positron pairs that are electron particles and positron antiparticles followed by almost immediate annihilation. Nevertheless the Big Bang photons interact with the virtual electron/positron pairs and lose coherence. The latter means that the photons decorrelate and lose the phase coherence. Losing coherence means that photons with new frequencies and wavelengths around the leading coherent frequency of the Big Bang are born. However they cannot be born as stable particles because there is no space enough for them in the Planck domain. We did not mention that neither there is room for the electron/positron pairs to stay since their classical pseudo-size is greatly larger than the Planck domain.

In other words the interaction between the coherent wavelength photons of the Big Bang with the virtual electron/positron pairs must generate photons that are too big for their boots and cannot squeeze within the Planck size domain. This creates absolutely huge internal pressure in the Planck domain. The pressure gradient between the Planck domain and the surrounding DEC, although not infinite any more: since the Planck domain has the finite size and is not a mathematical point, is still enormously large. The Planck space/time domain must expand. The DEC gives to the inside pressure since the quantum mechanics makes the DEC slightly compressible and allows the Planck subdomain to expand. This is the quantum mechanical phenomenon. If a media is compressible it is also necessarily viscous. Therefore the quantum mechanics makes the DEC slightly compressible and subsequently slightly viscous or the other way around. However, the DEC outside the visible subdomain is perfectly coherent.

Since the subdomains smaller than the Planck subdomain do not exist the initial Planck subdomain should be able to multiply in quantum steps like the cells of a live body multiply. In this the visible subdomain must be necessarily compressible since the multiplication of the Planck domains break the continuity of the DEC. The easiest for implementing it is if the 4Dspace/time of visible subdomain itself is quantum 4D grid with the Planck units of the equidistant space/time steps. If it is the case the dark energy manifestation in visible subdomain cannot be compressed beyond the Planck size corpuscles and in this sense having the rigorous limit of compressibility and be viscous at the same time as the usual fluids are. The virtual flickering Planck particles are naturally interpreted now as the corpuscles of the 4D space/time visible Cosmos subdomain. We note that conveniently such quantum grid model of space/time in the visible Cosmos subdomain defines the maximum possible speed that we will identify with the speed of light.

We will show that the Planck domain grows extremely fast in the abstract mathematical time and this period can be called inflation, although the existing inflation theories have very different mechanism and cause than the ones suggested here. We see no need for yet another unknown matter except light. The inflation ends when the space size is reached and the temperature of visible Cosmos is low enough for the birth of stable fermion matter from which the pair of clocks to measure time can be made and synchronized by light. This is when the time as we feel it is born.

The first born fermion matter is protons. The birth of protons is the further most important creation. It signifies the birth of material time. This is also when the 4D space/time is born. The deceleration of inflation starts from the birth of time. We will argue below that this is when the self-consciousness of Man is born that is not yet ported in the material body.

Why the slowing down of visible Cosmos space/time acceleration starts with the birth of time? This deceleration results from the explosive growth of coherent visible matter density and associated chaotic dark matter density starting from the birth of time. Together the two put brakes on the superfast visible Cosmos expansion, but it takes billions of years to bring the acceleration of expansion to the current stable value.

From the birth of time the evolution of visible Cosmos is the subject to the *RSL*. From the evolution of inanimate matter in far space to life on Earth the *second law and RSL* are the prime laws defining all the events and processes in and of the visible Cosmos subdomain since the birth till the end of lifespan

As soon as the second law and RSL are born in conjunction with the birth of time, exactly in resonance with this creation the coherent visible matter, protons are born. As soon as the coherent visible matter is born the chaotic dark matter is born. Together the two start deceleration of space expansion. But what from the visible matter is born and why it is being born explosively fast since the birth of time? We will answer these questions one by one.

The coherent normal visible matter is born from dark energy and we will calculate below how fast it happens. The coherent visible matter to stay coherent will create a protective cloud of virtual bosons. These absolutely natural protective cloud of virtual bosons is the whole mystery of dark matter. Dark matter is equivalent to additional 4D space/time curvature that added to the normal curvature of visible matter resists the global acceleration of the 4D space/time expansion. Subsequently the lumps of visible matter and dark matter that is disposed by visible matter exist and form larger and larger lumps, galaxies, clusters, superclusters and up the scale in quasi-fractal hierarchical manner becoming homogeneous near the event horizon.

Now we will discuss the origin of visible matter starting from the elemental electrons and composite protons, the main constituent units of all visible matter.

The indivisible constituent elements forming visible matter in Cosmos are *virtual* Planck particles fluctuating from the DEC into the visible Cosmos subdomain and prevented from returning back to the DEC during the lifespan of visible matter, inanimate matter and the animate matter on Earth alike. This temporal enslavement of virtual Planck mass particles in visible Cosmos is the result of a remarkable intrinsic mechanism similar to the Casimir effect. The latter is well known and observed experimentally via pressure of virtual photons trapped between the fast oscillating metallic plates. The enslavement of virtual Planck particles is the intrinsic property of fermion matter created by the virtual Planck particle in this manner. The temporal enslavement of the virtual Planck particles is self -imposed. Hence the delay of their returning back into the DEC is rigorously justified and does not require artificial experimental contraptions.

We emphasize the *quasi-steady* state of matter in visible Cosmos. Matter is never static and never steady state in visible Cosmos. It is in constant nonequilibrium exchange and interaction with the DEC. Within a finite time calculated in this work all entrapped Planck particles will return back into the DEC or as most would prefer calling it the quantum vacuum. This will be the end of visible matter lifespan and the end of visible Cosmos. In this sense visible Cosmos is the virtual creation of the DEC. However, there is an important distinction in that during the lifespan of visible matter the self-conscious Man and only Man creates information over the one received from the DEC. This additional information is brought by dissolution of visible matter into the DEC. As if the debt of life that visible Cosmos owes to the DEC is returned with the "add on" . With no "add on" over the information received from the DEC there is no meaning to visible Cosmos and it would have not existed[5].

As we have pointed out the motivation for the new approach develop in this work is the obvious inability of contemporary cosmology and physics to furnish quantitative explanation of the wealth of recent revolutionary astronomical observations. This crisis in modern theoretical physical and cosmological studies is in stark contrast with continuous revelations brought by astronomical observations and theoretical astrophysics. The recent spectacular observations have brought specific facts translated by astrophysicists into precise numbers. Not a single of them was either predicted, or follows from experimentally verified physical theories. Neither a single number follows from other contemporary physical theories not yet experimentally verified[6].

[5] The quasi-steady concept of visible matter should not be confused with the steady-state Cosmos hypothesis of Fred Hoyle. The distinction is basic and will become quantitatively clear in what follows.

[6] The inflation theory is a refreshing counterexample. One can argue whether the specific inflation theory is correct or not but all of them predict fundamental events "Before Adam" that imply major imprint on the structure of space/time that may be observed via the Cosmos microwave background radiation, the CMB.

Even more upsetting is that scientists have not gotten a vaguest idea why the organized structures of visible matter exist at all. The existence of elemental quarks and electrons, composite protons, atoms and molecules, simple or complicated with their sizes and masses are imposed by no fundamental equation of physics. How scientists can seriously talk about the theory of everything when they have not gotten a trace of comprehension why the mundane Gulfstream like a huge river of salty water flows through the slightly less salty ocean water without mixing for millions of years and will continue flowing for many more millions of years. But the Gulfstream can be hidden under the rug as a strange peculiarity that fundamental physics does not care about. Similarly the usual tropical hurricanes and tornadoes such as they are and why they hit with remarkable consistency about the same places on the globe can be declared too small problems not worth attention of physicists pondering on the origin of Cosmos. Most also have no idea why it takes one time to fly from Europe to the US and another time to fly in the opposite direction except vaguely referring to the atmospheric jets. These jets are rivers of air that flow like Gulfstream but in the thin air at about 10 km from the ground in the upper atmosphere. But no one knows why these rivers like jets flow around the globe as eternal coherent structures instead of mixing with the surrounding air. It is surprising how little is known about these mundane phenomena to physicists working on the theory of everything. We will show below how extraordinary these phenomena are tracing their origin to the very birth of visible Cosmos and how pertinent they are to the existence of life on Earth. There will no theory of anything unless the nature of order and chaos in visible Cosmos is understood.

When it comes to animate matter scientists even do not try to understand what makes bees and ants forming hives and hills and what convinces wolfs and deers to organize into packs and birds into flocks and humans into tribes and states and Empires. Or why all the above structures and organizations, inanimate and animate arise, evolve and decompose. All these peculiar effects are referred to Darwin which is very convenient because great Darwin cannot be asked of his opinion and to social scientists that can see the events only in retrospect and have zero ability of predicting anything.

But few suspect what is the real cause for animate matter evolution on Earth, although it is pretty obvious and was qualitatively understood by Erwin Schrodinger back in 1944. Few are quantitatively aware that the probability of life on Earth is so close to zero that the usual reference to some natural laws as the cause is not even a funny joke like claiming that Earth is flat. And it has not been our luck to meet a scientist who would not laugh if he was told that the self-conscious mind of Man had existed as long as the time concept and will go on evolving and creating in one way or another on Earth and/or in the galaxy for uncountable millions of years or even as long as visible Cosmos lives, although clearly not in the "carbonated" water flesh. Even the boldest science fiction writers do not dare imagine it since it is against the natural laws established by scientists, rather than science. In a way it is easier to work on a "natural" theory of everything than on the theory of Gulfstream since nothing can be verified concerning the former whereas much can be tested as regards the latter.

If we try to look around with eyes wide open and think on the scope of our scientific knowledge the first question we would ask is why the animate matter, fauna and flora on Earth exist. We will not find the answer searching on Google We can decide asking a geneticist at the nearby laboratory a simpler question so that not to make him/her angry at our ignorance. Assume that they exist. But what holds their leaves and trunks and flesh together? What forces the cells of animate matter to stick together in the by far the most complex live organization in all Cosmos? And why these forces if they exist fade when live entity dies? And what is death? And then we may recall that there are no forces in physics, or the forces are not really forces, but something else. For instance the gravitational force is fictitious and reality is the curvature of the 4D space/time that we perceive as if it was a force. Likewise there are no electromagnetic and strong forces. It is just the language to describe something totally different. No doubt that what holds the cells of flesh together is something deeper than normal and anomalous osmotic forces. The geneticist will not answer the question explaining that he/she is specializing in different branch of genetics and send us to someone else. But we may ask for eternity all geneticists in the world just to be sure that we are completely dumb Because the answer we will be getting is that this is obvious, is it not? The reality is that they have no idea why the cells of animate matter hold together and most have never asked themselves beyond the mechanism of osmosis why it is like this.

The reality that some thinkers whom we quote in this work understand well is that by comparison with the complexity and mystery of a flower in the garden the complexity of far Cosmos galaxies and clusters and black holes is a joke. However the real complexity is in the self-conscious mind of Man who peers into the deepest past of Cosmos hoping to find reasons for his own complexity and for how it had been created and what purpose and by what, or by whom. The reference to natural laws and the theory of everything as the answer to these eternal questions is more pathetic than referring to the host of pagan gods of antiquity. The eternal questions above are asked only by Man and this is what self-consciousness is all about. The gap between our self-conscious mind and very similar from the medical viewpoint animal mind cannot be bridged, despite the similarity of DNA of cockroaches and humans. There is no evolutionary process that would explain self-consciousness since there is no evolutionary benefit in self-consciousness. The latter has nothing to do with intellectual abilities that are indeed useful for survival of the fittest. The attribute of self-conciseness most probably must be seen together with the comprehension of irreversible time concept on one hand and the concept of timelessness of ultimate order on the other.

Returning from the star roving back on Earth we would like to reiterate that no existing quantitative science theory imposes the existence of coherent organization in Cosmos and on Earth. The existence of all coherent entities in Cosmos and on Earth is postulated and then cosmologists and physicists, chemists and biologists are searching for the mechanisms hidden in what is considered the fundamental equations of nature compatible with the existence of the postulated elemental coherent units and correctly predicting how they can form the composite structures. Furthermore the latter is being done only for the simplest coherent entities..

We would like now to furnish readers with an example close to our everyday life that will define to path of our logic in much more farther from the daily life problems. The life of visible Cosmos and phenomena in it are built on very similar general principles and we should not be frightened by mysterious far Cosmos. Visible to us Cosmos is not at all mysterious but complex. And the most complex phenomena of visible Cosmos are Earth and we on Earth. It is here on Earth where the very thin line is drawn between complex and unknowledgeable. We consider below a very mundane science of aeronautics in a manner different of the usual practical exposition of this subject.

Let us consider an airfoil, say the extremely thin aircraft wing moving relative to air that we treat as the zero viscosity ideal fluid. The moving wing is the obvious tangential discontinuity with the break of the normal to the wing air velocity component. From the Euler equations it then follows unambiguously that a vortex must develop around the wing. This is the famous Zhukovsky and Kutta theorem and their conformal transformations that enabled calculating the wing profile was the birth of the aeronautics as we know it now. The theorem states unambiguously that the vortex creates the lifting force and this is why aeronautics exists[7].

[7] A few years later during and after WW1 Einstein apparently independently invented and patented a profile of an airfoil that minimizes the drag and maximizes the lift. Similarly to Zhukovsky and Kutta he believed it is possible neglecting the air viscosity, although all of them knew of course of the turbulence phenomenon. Turbulence had been among the foremost interests of Leonardo da Vinci who coined the word *Turbolenza* for the phenomenon. The genius had also apparently understood the mechanism of fracturing of initial externally generated vortices into the multitude of progressively smaller ones since he depicted this process in his paintings. This is the mechanism by which coherent energy of large scale motion is converted into the chaotic energy of the small ones and disposed into heat. Thus ever increasing order in turbulent flows is born and in actuality imposed by the *second law* in conjunction with the *RSL*.Only four hundred years later in the end of 19th century Navier and Stokes added the phenomenological viscous term to the Hamiltonian Euler equations. In the 20th century largely for the military purposes of bombing from the air the aeronautics started to develop. The whole of aeronautics and meteorology of modern world is based on the semi empirical theories of turbulent flows pioneered by the above mentioned authors and dramatically developed by the*Pléiade* of remarkable mathematicians and engineers, among themChaplygin, Prandtl, von Karman and Reynolds. Taylor, Townsend, Yaglom and the crowning Kolmogorov. The works of the above and others following in their steps and enormous accumulative experience resolved most of the practical needs of aeronautics. However, they hardly elucidated the fundamental nature of turbulence.The problem is that the NSE cannot be solved analytically for turbulent flows. It does not have sense. Huge prizes by philanthropists were recently established for the lucky one solving the NSE for turbulent flows. In our view it is an example of a totally misguided attitude to the problem of turbulence as a mathematical puzzle. As large as supercomputers and prizes may be they will not resolve what Richard Feynman called the most important unresolved problem of classical physics.

But there is a problem. The wing acted upon by the lifting force will start rising up. Since the fluid is ideal and there is no viscosity and resistance for the wing rising up it rise with some constant acceleration. This means that the momentum of the wing will grow but also its kinetic energy. However the lifting force is a fictitious force. It is the result of nonuniform acceleration at the different space/time points of fluid perturbed by the obstruction of the wing. The fictitious forces cannot generate energy out of nothing. For each point of the fluid there is a local reference frame where the acceleration is zero. The whole point is that there is no global reference frame such that the acceleration at each space/time point of the ideal fluid is zero. This is the source of the Euler fictitious force. However, we reiterate that the fictitious force cannot be the source of energy and this why it is called fictitious. Hence there is no energy flux from the fluid to the wing. The two just do not interact and the wing cannot accelerate and actually there is no lifting force and no aeronautics. We have arrived at a brutally disappointing paradox contradicting the obvious facts that birds fly and fish swim and humans also do.

The resolution of the paradox is in the *second lawand RSL*. In reality all fluids are viscous as the result of their molecular structure. The tangential discontinuities do not exist. In their place is taken by the locations of most intensive concentrations of vorticity in turbulent flow, turbulence inevitably arising around the moving airfoil. The complicated pattern of vorticity concentrations in turbulent flow not necessarily locally but is associated with the locations of most intensive chaotic energy dissipation. The Euler fictitious force role now is to convert the coherent energy flux into the chaotic one so that the viscous mechanism can dispose this chaotic energy out. If the chaotic energy is disposed of it means that there is the real, not fictitious momentum/energy flux to the wing and the wing can rise up with acceleration. This accelerating lift must prevail over the real friction force of viscous air and hence the increasing order of the wing is compensated by the increasing chaos of viscous air.

But again there is a problem. Indeed if there is the chaotic energy dissipation there must be the coherent energy injection into the lift of the wing. Where does it come from? This is the energy spent by the flapping wings of the birds, wavy motion of the fish body and burned fuel energy of the aircrafts. These are the external sources of coherent energy that furnish the coherent momentum/ energy to the airfoils both the lift force up and horizontal motion forward. The horizontal thrust of say reactive engines of the aircraft is not the same as the flapping of the birds and insects wings. The former does not need air or any media and gives the thrust in any direction in the vacuum as well in compliance with the Newton laws. In contrast the flapping of the wings or fish body movement can do work only if they fly or swim in the viscous media. It is the work done against the friction force that propels them forward. The motion through the viscous media, even the flight of insects through the air causes turbulence in the media. We note that the wing or any airfoil does not lift with acceleration after a limit since the fictitious lift force decreases with the decreasing of the air density as they move up and eventually balanced by the opposite direction gravitational pull of Earth. We remind that the gravitational force is as fictitious as the lift force so that the two fictitious forces cancel each other. Also the real friction force between the airfoil surface and the air balance each other in such a way that the coherent energy furnished by the external source, say the burnt fuel is compensated by the chaotic energy dissipation by friction with the viscous air and corresponding viscous mechanism. We also note that the friction flow in difference to most forces is velocity dependent. The faster is the horizontal flight the bigger is the friction force. Hence the real thrusting force of the source is balanced by the real velocity dependent friction force, or the coherent momentum flux of the thrust is balanced by the opposite direction coherent momentum flux caused by the friction force. However while the balance between two real coherent forces is not reached the order of the airfoil grows with acceleration since its coherent momentum and coherent kinetic energy grow.

Now we can sort out where the *second law and RSL* enter into the aeronautics. First of all the phenomenon of flight is a clearly nonequilibrium phenomenon. The gist of the straight *second law* is that chaos should not diminish and order cannot grow in the rigorously isolated systems. The airfoil is not an isolated system, but together with the media it is submerged into it is almost precisely the isolated system. The airfoil is a subdomain of the isolated system and order in a non-isolated subdomain of an isolated system can grow but only if there is the third subdomain in this system that is the source of order. In our case it is the flapping wings or the thrusting engine of the airfoil. In

conjunction with the coherent momentum/energy flow from the third subdomain the airfoil order can grow.

But it can grow as we saw only if the airfoil is submerged into the subdomain of viscous media with which the airfoil interacts via real friction force caused by the viscosity of the media subdomain. If not for the viscosity of the media there would be no lift force and no flight. That the lift force can be derived from the Hamiltonian Euler equations for the ideal zero viscosity fluids is the illusion. This is the case of non-analytical dependence on viscosity. The lifting force does not depend on viscosity, but it would have not existed if it was not for viscosity. It is just that viscosity cancels out in the final calculations. It is a bit difficult to get used to but such is the remarkable properties of turbulent flows in viscous fluids and this property is the concomitant of the scale invariance of the proper NSE in contrast with the Hamiltonian Euler equations that do not have it. We will see the wonderful and benign power of scale invariance property in what follows for a variety of the most prominent phenomena in visible Cosmos and agree that there is nothing strange in this property.

The transfer of order to a nonequilibrium subdomain by a source of order within the multi-domain closed system is the reverse second law, the RSL. The RSL cannot function unless the straight second law is not nearby. Indeed chaos of the media subdomain increases in conjunction with the order increase of the airfoil subdomain and hence neither the total order of the closed system grows nor the total chaos decreases. The RSL is just the proper interpretation of the second law in nonequilibrium phenomena. It is very important to know that if the source of order subdomain in a closed system does not exhaust injecting order into the airfoil the latter will continue disposing chaos into the media subdomain and the media subdomain will be increasing chaos till it reaches the maximum possible. This latter state is the state of statistical equilibrium in classical physics. On the other hand the airfoil will achieve the state of maximum possible order. This latter is the state of statistical equilibrium possible only in quantum systems by the name of Bose-Einstein condensation mentioned above. This is the state of maximum possible order because all bosons are collected at one quantum state of energy and naturally there is no room for chaos. If to consider this process in time we will see collecting of bosons to this single state passes through incredibly complex of intermediate states similar to turbulence in fluids and birth and death of infinite diversity of locally coherent structures till all of them coalesce into one infinitely large coherent structure. But again there is a problem because only Bose particles can achieve this state of total order equilibrium and it has to do with the fact that bosons have integer spins. The fermions like the fundamental protons and electrons have half-integer spins and cannot reach the state of total order. However no first principle of physics forbids the presence of inexhaustible source of coherent energy in a closed system. If we manage to identify such genuinely closed system and genuinely inexhaustible source of order in the third subdomain of the closed system the above reasoning would mean that the *second law and RSL* in conjunction would force fermions to vanish.

We have built a paradox showing that the zero viscosity fluid cannot exist. The ideal fluid cannot exist because it would violate the *second law of thermodynamics*. The zero friction causes the violation of the *second law* resulting in tragic consequences for visible Cosmos. We are fortunate that visible Cosmos in contrast with the fundamental equations of physics rigorously complies with the *second law.*

We note that the Euler equations for incompressible ideal fluid has been suspected for a very long time to develop an incurable singularity in the global space/time for the general type of initial conditions although they are endowed with the uncountable infinity of stationary time independent solutions of highly complex topological nature. This general type singularity has never been proved; although we believe it is inevitable.

This why the NSE equations mandate the existence of order in turbulent flows and other equations do not. The NSE was formulated by wise scientists. They learned from Leonardo da Vinci and Newton that friction is the dominant attribute and the most powerful mechanism determining all aspects of visible Cosmos functioning. The friction forces are the concomitant of the time irreversibility. The irreversibility of time is the one and only cause of the *second law of thermodynamics.* Hence the viscous dissipation term was introduced phenomenologically into the time reversible Hamiltonian Euler equations of fluid motion. Order and intermittent concentrations of intensely vortical structures are universally observed in turbulence on Earth and in Cosmos. The uncountable infinity of coherent concentrations of vorticity are metamorphosed by viscosity the above

mentioned uncountable infinity of the time independent solutions of the Euler equations for the zero viscosity fluids.

Hence due to friction order is not only found in the NSE, but the NSE impose the intermittent coherent structures of uncountable diversity in turbulent flows. All other equations of physics not taking account of friction and subsequently not respecting the *second law cannot and do not impose order*. Hence the Schrodinger equation does not have in it frogs, composers and ethics and the attempts to find these attributes in the existing or any other equations contradicting the *second law* are futile. Neither the *second law* can be derived from the time reversible Hamiltonian equations of physics. The *second law* is the most general law in visible Cosmos and all equations of physics are just the mechanisms subservient and implementing the aims of the imperial *second law*.

We would like to make the following important observation. There is no analytical transition from the zero friction ideal fluid flows and the nonzero internal friction fluid flows. Even if the internal viscosity and subsequently the friction tend to zero this is not the same as if viscosity is zero. The results for the former case and the latter one have nothing in common. In the case of zero viscosity the flows of ideal fluid cannot be turbulent. The flow dynamics is caused by fictitious Euler forces caused by difference in local accelerations in space/time dependent on the choice of non-inertial reference frame. In the case of arbitrary small viscosity the flow becomes unstable and turbulent for certain values of the single dimensionless parameter entering the NSE. Turbulence reveals extraordinary diversity of nonequilibrium coherent structures each embedded in the self-generated chaotic cloud protecting the structures from early destruction by each other and hence extending their lifespan.

What we learn from the above observation is that there is no way that the *second law* can be approximately accounted for. Either the *second law* is seen as the imperative cause behind all order existing in and of visible Cosmos or there is no order at all in visible Cosmos and no visible Cosmos. This is a fundamental statement and there is no doubt the correct one. There are only two sets of equations of physics that respect the *second law* and hence imposes coherence in Cosmos. The first one is the NSE phenomenologically endowed with the dissipation mechanism. The second one is the Einstein gravitation equations, the EGE with positive value of cosmological constant, but only in conjunction with quantum mechanics. Without quantum mechanics the EGE has the incurable black hole type singularity in the global 4D space/time. In difference to the Euler equations where such singularity although certainly exist but has not been proved to the singularity in the EGE was proved to exist in the seminal paper of Roger Penrose published in 1964.

In simple words the EGE is not valid in the whole of 4D space/time. Somewhere in the whole 4D space/time there is the 4D space/time singularity similar to that of a black hole. The only way to cure the black hole type singularity is the quantum mechanical uncertainty principle. The uncertainty principle smothers the singularity over the finite Planck domain. This smothering is equivalent to a nonzero friction force. The nonzero friction force can be interpreted as the non-zero viscosity of the cosmological constant mater, or dark energy that we identify with the cosmological constant and subsequent compliance with the *second law*.

The introduction of nonzero friction and viscosity associated with dark energy has tremendous consequences. As introduction of even arbitrary small viscosity dramatically alters the flows of fluids resulting in turbulence phenomenon , one of the most fundamental for visible Cosmos and life on Earth and the subsequent uncountable diversity of coherent organization in turbulence similarly the arbitrary small viscosity dramatically changes all our vision of visible Cosmos past, present and future. This may be hard to reconcile with for some disattached from *the second law problem* in their vision of Cosmos. Nevertheless, cosmology will have to make the final break from the Hamiltonian equations of physics. The latter is not an approximation to the non-Hamiltonian reality of visible Cosmos. There is no smooth transition between the two at all. The time reversible equations of physics are only good for the description of near to equilibrium phenomena and near to equilibrium systems. Even for such phenomena and systems the Hamiltonian physics is at a loss when matter or a field is near to the second order phase transitions and has to invent the phenomenology of spontaneous symmetry breaks. In reality there are no sudden symmetry breaks if the second laws and RSL are accounted for. If the second order phase transition is properly considered in time and the dynamical equations contain the effective viscosity terms the transition from one phase to another is smooth in the sense that it takes a well-defined finite time for the phase transition to occur. If this is

the phase transition from the classical state of equilibrium which is the state of ultimate chaos to the coherent state of say Helium 2 superfluidity, or Einstein-Bose condensation of atoms then for such to occur there should be an outside source of order, for instance quenching the temperature of the system below the critical one .

The interplay between the fictitious gravitational force and the real dissipative force is behind the coherent structures of visible matter in Cosmos. There is deep analogy between the intermittent structures of visible matter in Cosmos and intermittent structures of vortices in turbulent flows. The reason behind this similarity is the subservience of all extremely nonequilibrium phenomena in systems driven by external sources of order to the *second law* and its alter ego the *reverse second law*, briefly the *RSL*.

Respecting the *second law* is not enough. Indeed, the straightforward **second law** states that chaos in all closed systems grows with time and order diminishes. Therefore why do we see all us on Earth and in Cosmos so much order? Why we are rightly convinced that animate life on Earth has been evolving and becoming more coherent with the passage of time? Moreover it is absolutely clear from the astronomical observations since 1998 that the global order of visible Cosmos as the whole system is growing and most likely visible Cosmos has started approaching the ultimate order to be reached in ten quadrillion of quadrillion of years from now[8]

The reason for all order in Cosmos is in the existence of the primeval source of order at the very birth of Cosmos and before the time concept was born. Since the birth of visible Cosmos and till the time of its death, or transfiguration indicated above this primeval source has and will have been furnishing our Cosmos with order. This primeval source acts as the pump in the above example of turbulence in viscous fluid flows.There are myriads of local in space/time sources of order stretching as a cascade of steps from the birth of Cosmos to our Sun and from our Sun all the way to the animate order of life on Earth. When the sources of order exist and only when they exist the *second law* metamorphoses into its alter ego that we will call the *reverse second law*or briefly RSL The *second law* and RSL work hand in hand. While *RSL* imposes mechanisms for sucking and absorbing coherent energy from the donor source by a system the straight *second law* imposes mechanisms for the chaos disposal by the system. By disposing chaos inevitably accumulating with age by virtue of the second law the same second laws furnishes mechanisms for it disposal. By disposing chaos the system extends its lifespan of coherence. The mechanisms for extracting and absorbing order and disposing chaos always exist. If they do not the system is not fit to survive as a coherent entity.

The crux of the matter is that for hundreds of years turbulence is seen as chaotic, or random, or at least ultimately irregular phenomenon. It is defined as such in all textbooks written from the days of WW2. The idea of chaos is engraved in stone in scientist's minds, while the engineers do not really care and build the planes. In a way like the architects of the past built their magnificent castles and temples with no knowledge of the Newtons classical mechanics guided by genius rather than theoretical knowledge.

[8] We will see this time exactly calculated below

Chapter 1

ORDER AND CHAOS IN COSMOS AND ON EARTH

Many believe that order and chaos of things inanimate is something that follows from the "natural laws", the equations of physics that science has determined or will soon. When it comes to human affairs on Earth we do not connect the phenomena in inanimate matter of far Cosmos with our mundane phenomena on Earth. Those who still do are frowned upon as superstitious backwards not coping with inexorable progress of science and technology.

We often associate order with good and chaos with bad or the other way around dependent on whether order or chaos serves us well. Most of us believe that the people's will power installs suitable for some of them order or wage suitable for some of them chaos. It is only the hard core ethno-political, or ethno-religious ideologists believe that the laws of historical evolution are objective and they know exactly what these laws are and subsequently are the tools implementing these laws. Surprisingly among the conclusions of this review it follows that these laws are objective and the successful ideologists are indeed the tools for implementation of these laws. This conclusion is intensely unpleasant for some and hurts human ego.

The grandeur of order of constellations of stars, nebulas, galaxies, clusters of galaxies awes astronomers when they look in the sky and thrills science section editors of the New York Times and other mass media. Probably not to many does it occur that this grandeur of cosmic order would have not existed if not for the violent chaos of destruction of myriads of stars devoured by the monstrous black holes, the MBH,s lurking in the center of all large coherent formations of stars. However for most of us the far Cosmos is not a concern except for a few curios scientists, the fans of waning science fiction sagas and Hollywood producers making profits on mediocre imagination of contemporary fantasy movies directors. The inanimate order is not associated in our psyche with order of animate life and inanimate violence does not connect with the brutal war for domination among animate species on Earth, flora, fauna and human species alike. Only astrologers and politicians furtively communicating with them connect grand events in the far 4D space/time of Cosmos with the mundane affairs on Earth.

However, order is invariably intertwined with chaos in visible Cosmos, whether in far visible Cosmos or on Earth. They are like Dr. Jekyll and Mr. Hide, the two faces of one grand spectacle of visible Cosmos. Would it be inanimate matter of galaxies uniting billions of stars and the phantasm of violent chaos of burning stars inexorably swallowed by black holes always present in the center of these galaxies, the orderly global weather patterns on Earth interrupted by chaos of destruction wrought by tropical hurricanes and tornadoes, huge coherent solar flares of plasma, flocks of birds forming and dissolving, the hives of ants and bees built and destroyed by competing subspecies, family life, social interactions, political and tribal structures, emergence and clash of conflicting ideas, chaos of violent wars exploding order of cold wars, extermination of biological species in the war for survival of the fittest, arising and dissolving states and empires, we always witness that order emerges, expands, struggles for domination, declines and falls into chaos only to be followed by emergence of more coherent entities and species. Wondrously over a period of time chaos does not prevail and the global order grows.

The microworld inanimate matter is essentially similar in the above sense. The elemental quarks irresistibly attracted to each other unite into composite protons and neutrons that together form nuclei and nuclei unite with elemental electrons to form atoms and atoms unite to form molecules and molecules unite into the composite matter, inanimate matter and animate matter life. Obviously in the sequence of matter formation the amount of order grows and the amount of chaos declines. However while over a period of time order grows this growth is intermittent with the violent events of decomposition and chaos weeding out the units of matter not fit to survive and be part of global order of visible Cosmos, would it be the inanimate matter, or biological species. One of the outstanding achievements of contemporary science was the recent astronomical discovery convincingly demonstrating the growth of global order of visible Cosmos itself.

Both inanimate structures and animate species exist and live the time span allotted to them and then respectively disintegrate and die in chaos of decomposition and transfiguration. The typical time span of inanimate coherent existence and animate lifespan are vastly different. Unless burning in the

thermonuclear reactions in the stars, or manmade nuclear explosions the inanimate matter is much more stable. The inanimate matter has been formed in billions of years of visible Cosmos evolution in the course of pretty well understood nuclear and chemical reactions in conjunction with the formation of stars, planets, comets. When not a fuel burning in the stars the inanimate matter interacts weakly and is near to indifference to the surrounding cosmic environment.

The animate matter live species are much more complex and have been evolving longer and will continue evolving far into the future. This never ending evolution of animate matter on Earth is the fundamental attribute of visible Cosmos. It is the life of Cosmos. Life of animate matter, is the ultimately nonequilibrium state *Vis a Vis* the surrounding cosmic environment. Earth is a special place in visible Cosmos. Earth as a whole is in a highly nonequilibrium quasi-steady state of unique coherence with the global cosmic environment. *This global environment is furnishing Earth with huge amounts of coherent, organized energy, while Earth is returning back into space the same amount of chaotic energy.*

Order is all sucked out from the flux of coherent energy and stays on Earth. It stays and accumulates for millions and probably billions of years and it is this ever growing order that causes and imposes evolution on Earth. Order received from the solar radiation is used for maintaining the coherent and conjunctive organization of the atmosphere and oceans on Earth. No one knows however how the oceans appeared on Earth and scientists are busy trying to search for oceans in the space/time of visible Cosmos. Such find would make oceans on Earth not out of the ordinary and indicate that there is nothing unusual in the huge expanses of Cosmos. Whether the search for oceans now or in the past will be successful or not remains to be seen, although the author is highly skeptical of success. The point is that if not for the oceans no order of life would be possible.Thecoherent atmosphere and oceans on Earth in conjunction with many other extraordinary "coincidences" make possible extracting coherent component of solar radiation and absorb it, while emitting back the same amount of chaotic energy. This is the mechanism of all order on Earth culminating in extraordinary complex order of life. The mechanisms that allow Earth to do the trick of extracting the coherent component of the equilibrium solar radiation are so amazing that it is likely that Earth is the most complex organization in visible Cosmos. That is except the self-conscious Man who is by far more complex and coherent entity than even Earth and life on Earth per se.

The ability to absorb coherent energy from an external donor source in conjunction with the metabolizing mechanism transforming this energy into the chaotic one and further disposing chaos is the key mechanism of emergence of order of all organized entities in visible Cosmos, inanimate order and animate life on Earth alike. We once again emphasize strongly that the self-conscious Man is not just life per se but a creation that stands alone.

In each case when organized entity is observed, inanimate or animate, the first question ought to be asked where the external to this entity source of coherent organization is, where the external source of order is. If it is identified then this external source is the donor of the *coherent energy flux* flowing into the receiving entity like a blood transfused from a donor to the patient. From the conservation of energy law, or the *first law of thermodynamics*, the same amount of energy should escape from the receiving patient over a span of time. If energy does not escape out the patient would explode like the overblown balloon. Energy does escape and it does because the rejuvenating patient starts energy costing activities, like metabolizing food, physical exertions and the incoherent dreams during long sleep. Incidentally brain needs a lot of coherent sugar molecules for coherent functioning when awake. When asleep the brain disposes the digested and regurgitated order as chaotic dreams.

The spent energy escapes from the patient as sweat, refuse of metabolism, brain disposing mental refuse by dreaming, etc. Compared to the coherent energy of the donor source it is relatively disorganized, chaotic in composition having no aim or purpose and should be washed off and slept over. However, the refuse still has enough order to be the fertilizer in agriculture and for writing scientific papers on the mystery of dreams and the need for sleep by all animate species.

Order from the donor's energy stays with the patient. Indeed the donor weakens as the source of coherent energy, his/her vitality and cognitive skills wane, while the vitality of the recipient grows. The recipient becomes more coherent, more assertive and the keen at his bed are happy. The usual mistake they do and we all do is assigning the vitality to the increase of energy per se. In fact it is not just the increase of energy, but it is the increase of coherent energy. Energy has quality to it.

It can be orderly and purposeful like the energy of a laser beam hitting the target or energy can be chaotic like the diffuse heat of a hot oven. If we measure the accumulative energy of a big hot oven it is huge, it is more than of a powerful laser. But it cannot hit a target; it is diffused over time and not focused in space. Lasers concentrate all their energy in a short pulse of space focused beam. Therefore the density energy in the beam can be huge, enough to hit and incapacitate a ballistic missile in the near future. It is this kind of energy that the source of order donates to the receiving entity. The receiving entity organizes itself by absorbing this focused, purposeful energy and simultaneously ejecting the low quality, disorganized energy.

While staying in a steady, stationary state as far as energy is concerned, as much energy goes in that much energy goes out, the receiving entity is in the non-stationary state as far as order is concerned. The receiving party order is accumulating as long as the external donor source of coherent energy goes on transfusing it into the receiving entity, pushing chaos out of it as spent fuel and replacing it with the coherent one.

The inanimate, dumb matter in visible Cosmos has only one sensible reason to be; supporting the long cascade of descending steps, each step being a particular donor of intermediate in 4Dspace/time local order decaying into the intermediate in space/time states of chaos embedded between the steps of order all the way down to the bottom. The last step of order, the immediate donor for Earth is Sun. Sun furnishes order to Earth via coherent component of solar radiation. Earth weeds out from the solar radiation this coherent energy component, digests it and ejects back into cosmic space the same amount of regurgitated, chaotic energy. During the time interval between the coherent energy injection and chaotic energy ejection the difference between the two orders expressed quantitatively via the difference in entropy, the measure of chaos, is used to build and evolve all and every coherent entity on Earth and life itself. It happens through myriads of processes and transfigurations of unimaginable complexity and eventually all order extracted from the solar radiation settles in the animate matter of life.

However at the top of the prime cascade of order in visible Cosmos, the pinnacle from which all order from the birth of Cosmos flows down all the way to Earth, the primordial, primeval source of order, the Holy Chalice is waiting to be discovered, rather perceived for what it is by the resisting self-conscious Man.

Everything at the bottom is due to this ultimately coherent at the top. Could it be that no memory of the primeval order is left at the bottom of the cascade and only the last several steps of order before the bottom matter? Order can break at the bottom into total chaos, like water at the bottom of waterfall. But it may be that there is a turbine at the bottom waiting for the fall of order. It will seed out, recover and absorb the primeval order from the top despite all the intermediate chaos between the steps. The primeval order will not be lost despite any number of intermediate steps and metamorphoses. Eventually the primeval order is recovered by the coherent turbine and passed over to the coherent electrical grid and passed over to the coherent engineers operating it and into the myriads of other things. But extraordinary it eventually returns back to the timeless primeval source, the timeless donor of coherent energy ever waiting at the top of the cascade to absorb everything it had given before, but greatly evolved by the creations of Man. Material order and mathematical order considered as one cannot literally die in a closed system, although the former may metamorphose into the latter and back. This process is timeless indicative of the timeless nature of the primeval donor source of order flowing into and permeating visible Cosmos.

The above assertions may sound metaphysical. They are not at all. Each step of the above cascade can be well defined and delineated, or will be in the framework of contemporary and future science. We must identify the primeval source of order in visible Cosmos and if and when this is done the assertions will look familiar[ii].

It is known to everyone in our enlightened age that all energy on Earth is furnished by the solar radiation. Life on Earth and everything else flourishes on this energy. The same solar radiation is available on other planets and actually everywhere. However life flourishes only on Earth. Earth is a unique planet. It had been created for life. We will expand on the uniqueness of Earth in a systematic manner and via quantitative analysis. Briefly Earth was created in a way that allows absorbing coherent energy from solar radiation while exactly the same amount of energy is returned back into space as the chaotic one.

The average temperature on Earth is about the same, although slightly different in different epochs. The local temperature on the surface of Earth is almost everywhere compatible with the existence of animate matter. Over shorter time periods, but still extensive ones the temperature remains nearly the same. Hence the average energy on Earth is naturally conserved, i.e., as much energy is absorbed from the solar radiation that much is radiated out into space over a period of time. But the quantitatively well-defined amount of order is sucked out from the solar radiation, remains on Earth and step by step, mechanism by mechanism, each of amazingly elegant complexity is passed over into all coherent entities on Earth and eventually into order of animate life. Moreover this order is growing inexorably with time and chaos is declining with time. The growth of order is intermittent with periods of chaos, but over a large enough time spans this growth is absolutely inescapable despite the intermittent chaotic events. This assertion is as confident as the most fundamental mathematical theorems.

While being the sole source of energy for Earth it is also the donor transfusing coherent order of life on Earth. This is a grandiose observation made by one of the giants of pre-WW2 science, one of the creators of quantum wave mechanics Erwin Schrodinger. He published his observations in the context of life evolution and Darwinism in the book "What is Life" (Erwin Schrodinger, 1944). Indeed, the implications that are drawn from his observations are extraordinary. In qualitative terms, shown in rigorously quantitative terms in this review, it follows that the global order on Earth averaged over a time period has been growing and will continue growing indefinitely into the future. Over large enough time spans it does not depend on whatever we humans do on Earth. The growth of order and waning chaos, probably, although unlikely, can be influenced slightly by human activity for short time spans, but not essentially. It is rather that the human activity is directed by the needs of constantly growing order. This is of course true unless Sun is destroyed, or oceans disappear which is improbable, Even if we continue emitting carbon dioxide, or try destroying life by nuclear bombs over a period of time some new order exceeding the previous one will emerge.

Most probably the entities willing and capable of causing too much chaos will be properly dealt with by the law of growing order. Such seeming negation of free will may be against the ego of some and difficult to accept by others, but such are the laws by which Cosmos lives. This conclusion although sounding strange will be rigorously justified below in just a few lines of transparent scientific calculations and in retrospect look fairly obvious.

The natural question would be about the source of coherent energy of Sun. Where does it come from? Sun as all stars formed from interstellar gas and the theory of stars organization is extremely well developed and supported by astronomical observations and almost unimpeachable physics[3] However it is clear that if not for the gravitational force stars would have not formed. The solar radiation is the result of thermonuclear reactions in primarily hydrogen in most of stars bulk and in heavier elements closer to their core. This is not the subject of this work. However a remarkable phenomenon should be reminded to no-professionals. The Sun and stars hold coherence in the course of their evolution. This is how they do it.

With passing of time stars accumulate chaos as we do, as all matter does with aging. This chaos should be disposed of as animals and humans do by various cleansing means and sleeping. One of the clear mechanisms of chaos disposal is solar radiation. In physical terms Sun is the so-called black body having the surface temperature $\mathbf{T_{sol}= 6.000}$K. The terminology of black body is just the anachronism and Sun is very bright. The energy flux, that is the amount of energy per second radiated in all directions from the surface of Sun as a black body is given by the 150 years old, well-known formula of Stephan-Boltzmann. It is:

$$\mathbf{J_{solar} = 4\pi \cdot R_s^2 \cdot X \cdot} \boldsymbol{T_{sol}^4} erg \cdot sec^{-1} \qquad (1.1)$$

where $\mathbf{4\pi \cdot R_s^2}$ is the area of the radiating surface area of Sun and **X** is the Stephan-Boltzmann constant composed of fundamental constants of Cosmos: the Boltzmann constant

$$\mathbf{k_B} \approx 10^{-16} cm^2 \cdot g \cdot sec^{-2} \cdot K^{-1} = 110^{-16} erg \cdot K^{-1}$$

where **K** is the temperature in Kelvin units,the Planck constant of quantum mechanics $\hbar = 10^{-27} erg \cdot sec$ and the speed of light $c = 3 \cdot 10^{10} cm \cdot sec^{-1}$:

$$X = \pi^2 \cdot k_B^4 / 60 \cdot \hbar^3 \cdot c^2 \quad (1.2)$$

The important fact is that the black body radiation is the equilibrium Planck radiation, like the radiation from a hot oven. It is perfectly well known that the equilibrium radiation is the 1st kind of equilibrium state of maximum possible chaos. It is the exact opposite of the laser radiation. Therefore where is the order of solar radiation that we tried to persuade readers is the source of all order on Earth? This question shows how profound was the observation of Erwin Schrodinger who nevertheless identified this order of solar radiation relative to Earth.

Now it is clear that Sun and other stars dispose chaos by radiating chaos. This is not enough however. There are different paths of stars evolution. The most peculiar is for the stars having mass over about two solar masses. Under certain situations nothing dramatic happens with these stars, they do not explode as nova and super nova massive stars. They just cool down. While they cool down they compress under the pull of their self-gravitation. The Einstein general relativity formalized in the Einstein Gravitation Equations, the EGE go much farther and predict with no shadow of doubt that these stars continue to compress and nothing can stop this compression if they reach certain size and kept their mass in certain relation with this size. If this happens their density becomes so huge within such a small volume that their gravitational pull at a certain distance from their physical center is so tremendous that even light if reached the surface located at a certain fatal surface around the star will not be able to escape the inward pull. These fatal surfaces were named the trapping surfaces by Sir. Roger Penrose who rigorously defined the properties of the trapping surfaces in the ground breaking theorem published in (Penrose R., 1964). The star inside the trapping surface it is the famous black hole.

Chapter 2

BLACK HOLES AND MASSIVE BLACK HOLES AS VACUUM CLEANERS OF VISIBLE COSMOS.TWO MECHANISMS OF MELTING OF VISIBLE COSMOS AT THE TOP OF ORDER CASCADE

The black holes are fascinating and significant objects. Since light itself cannot escape their pull they should have been invisible. However they are visible via radiation of accreted matter. This is the matter that is caught by their pull and is inexorably falling onto the trapping surface with ever increasing acceleration burns. It burns like a meteor falling into the atmosphere of Earth. This extremely hard radiation reaches us.

The Einstein gravitation equations, the EGE predicting the black holes existence in the first place also predict that the time dilates indefinitely at the approach to the trapping surface. For the outside observer the time span for the falling matter to cross the trapping surface tends to infinity. But if the he/she observer is too close to the black hole and is reckless to touch the trapping surface he/she will reach the center of the black hole in their finite time, but very dead for our visible Cosmos. All matter crossing the trapping surface inevitably meets the singularity of space/time at which the energy and associated mass density become infinite and the classical EGE likely lose their validity. It is widely believed that only the quantum mechanical intervention may cure the classical EGE from the malicious black hole type singularities, but no one knows how to do unite the two rigorously. On the other hand qualitatively it does not seem such an unsolvable problem as will be shown below.

The significance of black holes in particular is in that they are the vacuum cleaners of Cosmos. They absorb chaos from the rest of visible Cosmos hence maintaining visible matter order anywhere in the 4D space/ time of visible Cosmos, it is emphasized at any point of space and at any time since the birth of Cosmos in the Big Bang during the lifespan of visible Cosmos is compensated by the growth of chaos of black holes and invisible dark matter. In the meantime the stars keep their coherence by disposing chaos in the present, but also into the past and future time, or what is the same borrowing order from the past[1].The chaos disposal is primarily increasing the number of gravitational degrees of freedom are all chaotic, so that organization of visible matter is compensated by chaos of gravitation. However the gravitational degrees of freedom and gravitational chaos, except for the black holes have not been defined and is an issue of confusion. The further confusion is that it is against our intuition that whispers to us that the force of gravitation is behind order of planets, solar system, galaxies, etc. This is true but not in the sense we usually perceive it.

The black holes are the largest storage of chaos in visible Cosmos. This is why the large lumps of matter, like galaxies and larger visible matter concentrations could have not existed as coherent structures if not for the MBH's always present at their center. The lumps of matter dispose their chaos of aging into the MBH's and relieved of chaos stay coherent. That the black holes are indeed the storage of chaos in visible Cosmos was rigorously proved by the Israeli scientist Jacob Bekenstein.

---

[1] Such borrowing of order back in time is a bit strange and would not be possible if not for the quantum mechanics. It is well known that mass/energy can be borrowed from quantum vacuum of negative energies. This vacuum is inevitable consequence of Einstein special relativity, ESR in conjunction with quantum mechanics first understood by Paul Dirac back in 1932. Order and chaos are just the qualities of energy and can be likewise borrowed from the past. The point is that both the amount of energy and associated coherence can be borrowed only for some finite time. This time is determined by the Heisenberg uncertainty principle. We will show quantitatively how order can be borrowed from the past to the very birth of Cosmos. In fact all our visible Cosmos order may be borrowed from the past. The concept difficult to accept by our minds tied to the perception of time reality is that order in visible Cosmos can be equally easy borrowed from the future. We comment that this is the phase coherence order and it can materialize into order accessible to our amplitude connected perceptions only for a finite timespan. However this timespan can be as big as the lifespan of visible Cosmos. In this sense the birth and the end of visible Cosmos are diffeomorphic to each other separated by no more than our perceptions. In mathematical terms this implies that the birth and the end of visible Cosmos should be scale invariant and this scale invariance must be defined exclusively by a certain necessarily single dimensionless *number*. This *dimensionless number* should be and is available from the astronomical observations.

His breakthrough works (Jacob Bekenstein, 1972 and 1974) gave rise to the whole new discipline in physics, the thermodynamics of black holes and contributed to the development of string theories.

The very basic conclusions of these works will be discussed in what follows and used in the context of this review. Nevertheless we emphasize again that MBH's will be the largest and only chaos content near the end of visible Cosmos lifespan, while in the meantime the largest chaotic contribution in visible Cosmos is furnished by the dark matter permeating throughout visible Cosmos, but especially clearly observed in association with galaxies and other large lumps of visible Cosmos[iii]. Until then the largest chaos of visible Cosmos is in the dark matter present everywhere in visible Cosmos. Visible matter cannot exist without dark matter around and permeating it as order in general cannot exist without chaos. The forecast that we would like to make and unlikely ever tested is that near to the end of visible Cosmos lifespan all dark matter will coalesce and will become the trapping surfaces of the monstrous black holes, or massive black holes, the MHB's devouring all visible matter and eventually vanishing themselves into the primeval source of order that long time ago had given birth to visible Cosmos and everything in it.

The problem of chaos disposal is universal. It is like the problem of manmade chaos on Earth. If we did not create chaos all around us we would have not existed. Chaos disposal is the law of visible Cosmos upon which its very existence hinges. There are no arguments possible with this law. On Earth rich in remaining order chaos, the coherence left in organic and inorganic trash should be reprocessed this remaining traces of order and utilize it by disposing the lower grade chaos. Whether we want the problem of chaos disposal on Earth solved, or not has zero relevance. We will see in this review that the global order on Earth is inexorably growing for reasons totally independent and outside of our control having nothing to do with our technologies and screaming of environmentalists. This growth of order on Earth is the law of visible Cosmos and Earth had been chosen and formed by the forces beyond visible Cosmos for the purpose of growing order on it and as the residence of self-conscious Man. The more mundane subsequent forces still beyond our influence will force us to deal with the manmade chaos. The law of growing order does not care about our wishes. This is the law of Cosmos. The very fact that the screaming environmentalists were born and the justification for their existence is this law, although the environmentalists would laugh from such a proposition, at least by the day light.

However let us go back to the black holes. With the black holes it is much less complicated since they themselves are simple by comparison with Earth and animate life on it, although the gist is the same. Black holes are continuously collecting chaos from the 4D space/time visible Cosmos and. In particular they absorb chaos from the lumps of visible matter into which they are embedded. However, as a result of the quantum coherence entanglement a black hole may perfectly well absorb chaos from the past and from the future of visible Cosmos and from anywhere in the 4D space/time. Also, the black hole exists contemporary if it is within the event horizon relative to Earth, as a compact domain in 4D space/time and in this sense is also a coherent entity. It can stay a coherent entity only by the mechanism described above.

The black hole must *absorb coherent energy and dispose chaotic energy*. It is perceived by some scientists that the black holes only absorb chaos from all around. In general the black holes are portrayed very negatively in popular science culture except by some talented science fiction writers creating of Cosmic Operas. In reality the black holes and especially the MBH's are supremely benevolent entities that weed out weak matter and stars to die with dignity without being the burden for the healthy visible matter destined to live longer. When weak visible matter touches the trapping surface of MBH's it dies and all information contained in this matter is absorbed by the MBH's[2].

The gravitational pull of MBH's makes matter to accrete on their trapping surfaces. While approaching these surfaces matter accelerates without limit, since roughly speaking at the trapping surfaces the acceleration is infinite. Hence accreted matter burns. The hard electromagnetic radiation

[2] There are fierce arguments among a few leading cosmologists, while the rest keep mum, on the fate of this lost information. The issue is that in accordance with quantum mechanical principles information cannot disappear at all. This is the conclusion of the time reversible equations of motion that disregard and in fact contradict the most fundamental law of visible Cosmos, the second law of thermodynamics. In fact as we have mentioned above information is certainly does not disappear but most definitely it disappears forever in our visible Cosmos and no scientific authority can seriously contest it.

of this burning that escapes the trapping surfaces reaches us and this is why we know that the dark holes do exist and can study them. However entropy/chaos of this burning matter is not at all the reason for the growth of chaos of MBH's. On the contrary and despite the fact that the accreted matter all burns while falling onto the trapping surface the latter still manage to suck out the remaining order from the part of radiation that touched the trapping surfaces. It is like we on Earth extract some remaining order from the reprocessed trash.

This is why the accreting matter is not the source of chaos for the black holes, but the donor source of order. We will calculate a bit later how much order is in the black hole. Moreover the amount of this order will only grow with time and all order of a galaxy into which the MBH at the center is embedded will convert into order of MBH. This is not a paradox. The chaos of the black holes grows as the area of the trapping surface, while the coherent component of the black hole grows linearly with their size and subsequently much slower over a period of time. In the meanwhile it helps its residence galaxy to extend its coherence and live longer. But in the end this galaxy and all huge order accumulated by its matter is devoured by the MBH. It's the payment for the debt of life that the MBH assisted the galaxies and other larger lumps of visible matter to extend.

We would like to emphasize that the MBH is born by the mechanism of gravitational pull of stars, the constituent units within big concentrations of visible matter, e.g., the galaxies and clusters of galaxies, etc. The weak stars organize into the MBH, this shows us that also weak can be employed, and help the galaxies and other lumps of matter to extend their lifespan by absorbing the chaos disposed by all these large lumps of matter. MBH's are the subdomains in 4D space/time accumulating chaos in visible Cosmos. They are the vacuum cleaners in visible Cosmos. However, when the MBH's are formed they themselves become the coherent entities. In this state they devour their parent galaxies and other lumps of matter. But for what purpose do they do it? They do it so that after a long period of time no matter is left in visible Cosmos exceptthe MBH's. And what happens with the MBH's? They metamorphose; melt in the primeval donor source of order, the infinite timeless dark energy continuum from which all visible Cosmos and visible matter in it had been born. The MBH.s is the intermediate order/chaos stage and the escape route mechanism that enables the life of visible Cosmos. In the end with all the accumulated order and chaos, all the information created by self-conscious Man in the total 4D space/time of visible Cosmos the MBH's return back to the prime progenitor, to the primeval source that had parented visible Cosmos.

There are two mechanisms implementing the above drama. The classical, well known mechanism is the MBH's evaporation. Within a very long time period the small, stellar black holes and almost all matter will be swallowed by the MHB's. The semi- quantum mechanical results of Bekenstein-Hawking show that the MBH's should eventually evaporate into the incredibly low temperature equilibrium thermal radiation. This radiation storing huge amounts of chaos will be released into the remainder of visible Cosmos. For the largest, final MBH's it will take 10^{112}years to evaporate as was estimated by Roger Penrose in his latest book (Cycles of Time, 2010). For a black hole having a few solar masses it will take 10^{67} years to evaporate. Also there are doubts that MBH's can evaporate at all in the expanding Cosmos because while evaporating they may become colder than the surrounding visible Cosmos environment. In this case they stop evaporating.

However, this is not so important. There is another quantum mechanical mechanism suggested in (Levich E. 2013) that furnishes dramatically shorter lifespan of visible matter and subsequently of visible Cosmos. This lifespan is $\mathbf{t_c = 10^{31}}$years. This one is also not easy to comprehend. However we will justify this visible Cosmos lifespan by fairly clear and simple calculations. Moreover we will establish correlation between human individuals' puny lifespan and the grandiose lifespan of visible Cosmos. This may sound ridiculous but in fact is quite sensible given the deeper understanding of the prime source of order in visible Cosmos. It will be argued that at the time $\mathbf{t_c = 10^{31}}$protons and electrons and subsequently all other fermion visible matter will have been dissolved within the primeval donor source of order, the Holy Chalice waiting at the top of the order/chaos cascade. The boson matter except for photons has no meaning without fermions left and hence will disappear together with fermions. The MHB's will not be spared and the trapping surfaces will not protect their demise. The quantum mechanical uncertainty principle smothers the singularity inside the bounded trapping surface and since the latter is just the attribute of the former the trapping surface is also smothered and become penetrable, i.e., smoothly connected with the rest of 4D space/time. Since MBH's are made of the same matter as everything else in visible Cosmos, essentially protons and

electrons and their gravitational field, they will dissolve in the primeval source at the top of the cascade exactly at the same time as all the remaining visible matter.

Chapter 3

THE TIME CONCEPT AND SELF-CONSCIOUS MAN

The Einstein special relativity, the ESR explains something fundamental about the time concept. Indeed, time should be measured. For this it is necessary to have two pieces of matter with nonzero rest mass to emulate two clocks and synchronize them by means of light passing from one to another and back. Light is the carrier of information, communicating between the two clocks to let them know of each other. To serve as clocks any matter is good, inanimate or animate alike. However this cannot be matter with zero rest mass, such as light. Light is dual, being both waves and corpuscles dependent on the circumstances. This is the phenomenon of quantum duality, the prime attribute of matter in visible Cosmos and surely of the 4D space/time itself. All matter in visible Cosmos is always quantum mechanical and dual. It is only the extent to which the corpuscular and wave attributes manifest that matter differ one from another. The corpuscles of light, photons have zero rest mass. This is why photons propagate with the speed of light in vacuum, or light propagates with the speed of photons in vacuum. This is the maximal speed possible in visible Cosmos. Matter having nonzero rest mass cannot reach the speed of light and for this matter time exists and this is why this matter can serve as clocks. For photons there is no time. If photons were self-conscious all visible Cosmos space would be one point to them. From their perspective they would be at every point of space in Cosmos at the same time. This is the same as if they existed everywhere and all space is compactified into a point. Photons are not self-conscious. Photons are the universal messengers furnishing communication, or equivalently the intermediaries of interaction between the two clocks so that one of them knows that there is the other. With no exchange of information the concept of time does not have sense. Photons that we perceive as visible light, or any other electromagnetic radiation, low energy photons as the long wavelength/low frequency radio waves, higher frequency but still invisible to naked eye thermal infrared radiation , higher frequency/shorter wavelength energetic green light, hard short wavelength penetrating **x**-rays and still much harder dangerous **γ**-rays, etc., is the ultimately quantum mechanical matter. Photons are exceptional and primeval in visible Cosmos; they are affine with our elemental perception of visible matter; by eye, or via telescope and other devices. Hence light and equivalently photons are the senior citizen of visible Cosmos. Not accidentally the first creation of visible Cosmos had been light of the Big Bang.

However there is a delicate logical catch associated with the time concept that is outside the realm of special relativity and the traditional scientific view of physics per se. Indeed, what sense there is for time to exist if there is no observer that can perceive it and measure by the pair of clocks communicating by exchange of photons? Neither inanimate nor animate matter can perceive the existence of communication between the two clocks since neither matter is endowed with the awareness of being. Inanimate matter and animate biological species have no awareness of being. Dogs for instance exist and we perceive them as smart and they are smart and loving, but they do not know that they are dogs[1].Animals know only what is good and bad for their survival and procreation, the most basic information encoded in their genetic storage. Only the self-conscious human mind can appreciate the time concept and associate the irreversible passage of time with casual material processes backward into the past all the way to the beginning of time. The self-conscious mind of Man is intrinsically tied up with the time concept[2].

[1] Many years ago a small Israeli boy by the name Alon with his mother visited me in New York. The adults around the table talked about dogs and whether they are like we are in their attachments to their masters. Suddenly Alon entered into our pretty shallow conversation with this observation about dogs. He said: "Poor dogs, they even do not know that they are dogs". I doubt that the adults at the table paid attention to what a small kid said. Only much latter I recalled it and appreciated the depth of comprehension by a small kid of the unbridgeable chasm between animals and humans. Only humans are given the incredible gift of self-consciousness, the awareness of being.

[2] This intrinsic connection was for the first time indicated to the author by outstanding cosmologist and physicist Isaak Khalathikov. He attributed it to the firm conviction on the time concept by his teacher, the late famous physicist Lev Landau who had shared it with him.

This is what decisively distinguishes Man from animate matter of biological species at large. It will be strongly asserted in this work that human brain communicates with the global Cosmos on incomparably higher level of coherence and subsequently on incomparably smaller spatial and time scales, the smallest ones in causally connected 4D space/time visible Cosmos. These scales are the well-known and ever debated Planck space/time scales. This assertion will be furnished with quantitative estimates of the human brain mass.

It is asserted that the emergence of self-conscious Mind of Man on Earth had been predetermined and is the contemporary and corollary of the very birth of the irreversible time concept at the early childhood of visible Cosmos born in the Big Bang. This is not in contradiction with the emergence of "soulless" animate species on Earth since our bodies are surely the bodies of animals. On the contrary the biological life on Earth is inevitable and had been as predetermined as the self-conscious Man. However, the animate life does not have more sense than the inanimate matter, unless both serve as residence, the vessel for storing the self-conscious mind.

And where is the Holy Chalice of Jerusalem, the external primordial source of all order in visible Cosmos including the animate species and ultimately the self-conscious Man on Earth? The external primordial source is the timeless, infinite dark energy continuum manifested in visible Cosmos as positive Einstein cosmological constant. The cosmological constant is indirectly, but confidently observed via the acceleration of Hubble expansion.

Chapter 4

BACKGROUND FOR THE REVIEW

Assertions made on the nature of Cosmos and life is often impossible to decisively falsify by direct observations. When possible it is always the great achievement of astronomers and astrophysicists self-conscious mind. The arguments and bets made on fates of Cosmos within a group of contemporary leading cosmologists should not make one forget that often they have no remotest chance of being verified experimentally and are therefore beliefs.

It makes them very different from the ESR, EGE, quantum mechanics and unified quantum field theories. All the latter were either based on early experimental evidence, or were almost immediately experimentally verified with as in the case of quantum electrodynamics with astonishing accuracy. This is not the case with many cosmological hypotheses not supported by anything tangible except mathematical elegance. Surely this does not make even esoteric cosmological conjectures useless. On the contrary they are the products of the imperative embedded into our self-conscious mind and eventually will bear fruits. Nevertheless, at least some of these products are beliefs and should be understood as such.

Fortunately the generality of scientific concepts relied upon in this review allows their application to certain physical phenomena that have been notoriously hard for fundamental quantitative understanding and nevertheless mundane and falsifiable. These are order and the evolution of life on Earth and at the first glance not associated problem of turbulence in fluids. Surprisingly it will be shown that if not for the extraordinary complexity of order intrinsically arising in turbulent atmosphere and oceans Earth would not be such a unique place in visible Cosmos and subsequently life would have not existed on Earth. It is truly wonderful how all and every phenomenon in Cosmos has the appropriate role to play and place to fill in the ultimately coherent organization of visible Cosmos, the pyramid of life with the deep roots in the ground and the self-conscious Man at the pinnacle.

The key words in this review are order, coherence and organization that semantically carry roughly the same meaning for our perception and the opposite to them chaos, incoherence and disorganization. It was argued that order and chaos are intermittent and one would have not existed without the other. It is necessary to go beyond the semantic meaning and formulate in quantitative terms what order, coherence and organization on one hand and the opposite notions of chaos, incoherence and disorganization are on the other. This means brief familiarization with the most basic ideas of thermodynamics and statistical mechanics of Maxwell, Boltzmann, Gibbs, Clausius and other titans of 19^{th} century physics. It is also necessary to familiarize readers with a few basic concepts of Einstein special and general relativity or Einstein gravitation equations, respectively ESR and EGE and quantum mechanics. The brief recourse of some basic physics for non-professionals but is superficial and may seem not satisfactory for professionals to whom I extend apology. However such recourse instead of frequent references also helps the author to stay the course of coherent exposition.

The reasoning and conclusions made in this review are the outcome of a careful rethinking of recent astronomical observations and their novel interpretation, but strictly in the frame of Einstein special relativity and Einstein gravitation equations of general relativity, the respectively ESR, and EGE, quantum mechanics and thermodynamics. No outlandish fantasies are invoked in this work, but this is the author's opinion inevitably subjective. Nevertheless, it is rather that the well known facts are looked upon from a different angle and the subsequent interpretation follows fairly smoothly.

The assertions made in this review are reinforced by calculations and qualitative estimates based only on the well verified constants of Cosmos:

- the Newton gravitational constant $\mathbf{G = 6.7\cdot 10^{-8}} cm^3\cdot g^{-1}\cdot sec^{-2}$the introduced above
- speed of light $\mathbf{c = 3\cdot 10^{10}} cm\cdot sec^{-1}$,
- the quantum Planck constant, $\mathbf{\hbar = 10^{-27}}\ erg\cdot sec^{-1}$,
- the basic thermodynamics Boltzmann constant $\mathbf{k_B = 10^{-16}} cm^2\cdot g\cdot sec^2\cdot K^{-1} = 10^{-16} erg\cdot K^{-1}$
- the dimensionless fine structure constant of quantum electrodynamics $\mathbf{\alpha = (e^2 / \hbar\cdot c) = 1/137}$
- the square of the electrical charge of electron $\mathbf{e^2 \approx 5\cdot 10^{-20}} erg\cdot cm$

However the critical one is the new dimensionless constant of visible Cosmos, the dimensionless number:

$$\mathbf{Re_c = (\hbar \cdot G/c^3)^{-1/2}\ [(\hbar \cdot c\ /G)^{1/2}\ /\ \Lambda]^{1/3} = 10^{41}} \qquad (4.1)$$

In (4.1) $\mathbf{\Lambda \approx 10^{-29}} g/cm^3$ is the dark energy matter density, or the Einstein cosmological constant with the value accepted by cosmologists and astronomers as most compatible with the observed acceleration of Hubble expansion and the basic premises of the ESR and EGE. The new dimensionless constant $\mathbf{Re_c}$ was identified previously in (E. Levich, 2013). The cube of this constant is known as the dark energy density in Planck units, but as such it does not serve any purpose[1]. I suggest that prior to the cited paper the meaning of $\mathbf{Re_c}$ and its potential significance as the only *dimensionless scale constant* in physics, except the fine structure constant $\boldsymbol{\alpha}$ had escaped attention. Attention should be paid to the quantity:

$$\mathbf{L_c = [(\hbar \cdot G \cdot c^{-3})\ \Lambda]^{1/3} = 10^{8}} cm \qquad (4.2)$$

It is a very meaningful length scale. The only one that can be constructed from the four fundamental constants **G, c, ħ** and **Λ** in conjunction with each other. There is yet another length scale, the well-known Planck scale constructed as follows:

$$\mathbf{l_p = (\hbar \cdot G \cdot c^{-3})^{3/2} = 10^{-33}} cm \qquad (4.3)$$

Some and the author among them believes that it is the smallest possible scale in visible Cosmos and the corresponding Planck time scale is the smallest possible time in visible Cosmos:

$$\mathbf{t_p \approx l_p \cdot c^{-1} = 3 \cdot 10^{44}} sec \qquad (4.4)$$

However only with the Einstein cosmological constant in conjunction with the other three constants it is possible to construct the dimensionless constant (4.1). We also note that:

$$\mathbf{Re_c = L_c / l_p = 10^{41}} \qquad (4.5)$$

The dimensionless constant (4.5)is central for our further observations. It will be asserted that the infinite, timeless continuum of dark energy is the primeval donor source of all order in visible Cosmos. The donor source supports the growth of global order in visible Cosmos by the coherent energy flux at the typical scale $\mathbf{L_c = 10^{-8}} cm$ while visible Cosmos is disposing the same value of the chaotic energy flux at the Planck scale $\mathbf{l_p = 10^{-33}} cm$. Since the energy flux from the dark energy continuum into visible Cosmos is equal to the inverse energy flux from visible Cosmos into the dark energy continuum the number of harmonics, or the degrees of freedom in the inverse flux in 3D slice of the 4D space/time is $\mathbf{Re_c^3 = 10^{123}}$ times bigger than in the direct energy flux from the dark energy continuum into visible Cosmos. This means that the direct energy flux is hugely more organized, coherent than the inverse energy flux that is subsequently drastically more chaotic and incoherent. This is the mechanism of the ever growing order of and in visible Cosmos.

The above mechanism is the same as with the solar energy and Earth described above, the flux of coherent energy IN and the equal flux of chaotic energy OUT. However the dark energy continuum is the primeval donor source at the top of the cascade, the Holy Chalice of Jerusalem. The coherent energy flux from the Holy Chalice is the donor source of all matter and its transfigurations, from inanimate into animate and ever growing order in visible Cosmos and of visible Cosmos. The flux form the dark energy continuum supports the constant energy density of dark energy in visible Cosmos via its manifestation as the Einstein cosmological constant. The two are indistinguishable as far as our experimental abilities are concerned.

It is asserted that our visible Cosmos is embedded into the dark energy continuum. Moreover the dark energy continuum via the cosmological constant builds both the discrete 4D space/time geometry

[1] It is as if the electrical charge square would be seen as having the value of 1/137 in the units $\mathbf{\hbar = c} = 1$. In fact this is the dimensionless coupling constant of quantum electrodynamics and the foundation of this great theory.

of visible Cosmos and all visible matter. The invisible matter, both dark energy and dark matter are the manifestations of the dark energy continuum in visible Cosmos. The 4D space/time of visible matter and by implication matter itself are asserted to be quantum and subsequently discrete.

It is suggested that the self-conscious mind of Man is unique among all the animate matter in that it is in coherent interaction with the dark energy continuum. The intermediate cascade to life on Earth is needed only to provide conditions for animate matter and animal life existence and evolution to prepare an appropriate vessel to support the self-conscious mind in it. As if the whole huge construction of visible Cosmos is just a subdomain in infinity of timeless continuum, the tiny VIP lounge in a huge airport for the comfort of Man destined for a long travel in space and time[2].

The above marvelous phenomena are all imposed by the *second law of thermodynamics* generalized for the nonequilibrium systems. Both these are well known to scientists and engineers for the last 150 years. We will start discussing in the following section. The ultimate power and generality of the *second law* strongly indicates, whether one likes it or abhors, it does not play any role, that visible Cosmos is just a vessel, a womb of the infinite and timeless dark energy continuum that through myriads of steps, mechanisms and processes grows within it the self-conscious mind of Man to comprehend.

[2] This belief should not be equated with the anthropic principle. The latter states that it just happened that we exist in a Cosmos such that allows our existence, because if it did not allow we would have not existed. It seems that there is no value to the anthropic principle as it does not explain anything and just supports the vision of our existence as serving no purpose, like the inanimate and animal existence serves no purpose.

Chapter 5

THE MAX PLANCK WORLD

Max Planck was one of the first pioneers of quantum mechanics. The fundamental and universal constant of quantum mechanics **ħ** is named after him. It has been known for a long time that the three fundamental constants: **ħ,** the gravitational constant **G** and the speed of light **c** can be uniquely arranged to define the unit of Planck length introduced above, the units of Planck time and of Planck mass:

$$\mathbf{l_p} = \sqrt{\hbar \cdot \mathbf{G} \cdot \mathbf{c^{-3}}} = \mathbf{10^{-33}} cm \tag{5.1}$$

$$\mathbf{t_p} = \mathbf{l_p} \cdot \mathbf{c^{-1}} = \sqrt{\hbar \cdot \mathbf{G} \cdot \mathbf{c^{-5}}} = \mathbf{3 \cdot 110^{-44}} sec \tag{5.2}$$

$$\mathbf{m_p} = \sqrt{\hbar \cdot \boldsymbol{G^{-1} \cdot c}} = \mathbf{10^{-8}} g \tag{5.3}$$

The Planck units are the subject of continuous debate and uncertainty. The ever asked question is whether to treat them as physical quantities, or as a system of units having no particular meaning. The latter seems a misconception. These quantities first gain significance in the pioneering thinking of John Archibald Wheeler and in the works of Jacob Bekenstein and Stephen Hawking as definitive for the black hole entropy and radiation. They obviously connect EGE, ESR and quantum mechanics. Indeed, the contemporary string and brane theories and other theories attempting to connect the EGE and quantum field theories into one quantum gravitation theory treat the Planck constants, not just as units, but as fundamental physical quantities.

In accord with the above vision of 4D space/time geometry of visible Cosmos it is postulated in this review that the Planck length $\mathbf{l_p=10^{-33}}cm$ and the Planck time $\mathbf{t_p = l_p \cdot c^{-1}}$ as the minimal existing length and the minimal existing time in the discrete 4D space/time of visible Cosmos. The subsequent corollary is the speed of light as the maximal possible speed in visible Cosmos. It is also suggested that the fluctuating Planck mass $\mathbf{m_p=10^{-5}}g$ is the elementary, indivisible constituent part of matter and subsequently the 4D space/time of visible Cosmos.

The above are not bizarre suggestions. We have pointed out that they have been pursued for some time, quite extensively from the mathematical standpoint. In the real world physics the Planck length plays the principal role in the classical works of Jacob Bekenstein and Stephen Hawking that discovered black hole entropy and thermal radiation. The Planck constants are central for the string theories, etc. In any case there is no trace of evidence that would point towards visible Cosmos continuity except the huge baggage of traditional thinking.

Neither there is any reason to believe that the Planck mass $\mathbf{m_p \approx 10^{-5}}\ g$ would not be born as a virtual particle from the dark energy continuum, or as some would rather from the quantum vacuum, It will exist in visible Cosmos fleetingly for the Planck time $\mathbf{t_p \approx 10^{-44}}sec$ occupying, assuming the isotropy, the 4D Planck space/time domain:

$$\mathbf{D_p = l_p^3 \cdot t_p = 3 \cdot 10^3} cm^3 \cdot sec \tag{5.4}$$

We would like to point out that despite the non"revolutionary" nature of the above assertions the reasoning adopted in this review is entirely original leading naturally to certain fairly unusual conclusions and striking agreement with the newest available experimental data. Also the concepts laid down below are predictive and at least some of them can be experimentally verified and falsified. We strongly believe that if scientific theories are not predictive, not verifiable by experiment and field observations within a reasonably short period of time they are likely shallow.

When the extremely short lifespan expires the Planck particle returns back home into the dark energy continuum or the quantum vacuum. It is unlikely observable directly for the reasons that will be explained in what follows. There is no drama in this. For instance quarks and gluons also cannot be directly observed. However they are obviously the real ones since they are explaining and most importantly predictive concepts.

It should be noted that the Planck particles automatically follow the Heisenberg uncertainty principle of which(5.1), (5.2), and (5.3) are simply the corollary. On the other hand since we will argue that all matter consists of the flickering Planck particles the uncertainty principle must hold for visible matter. We will remind the gist of the uncertainty principle below. Another important comment is that nothing forbids the Planck particle to continuously reappear from the dark energy continuum, i.e. to flicker as we have just mentioned with the frequency:

$$\mathbf{\Omega_p = t_p^{-1} / 3 \approx 3 \cdot 10^{43} } sec^{-1} \mathbf{= 3 \cdot 10^{43}} hz \tag{5.5}$$

From the quantum view point and from the classical ESR relation between the rest energy and the rest mass this means the flickering of the rest energy with the frequency(5.5) as follows:

$$\mathbf{E^{virtual} = m_p \cdot c^2 = \hbar \cdot \Omega_p = 10^{16}} erg \tag{5.6}$$

Chapter 6

SECOND LAW OF THERMODYNAMICS

The *second law of thermodynamics* is perfectly well known since the second half of 19th century. It is widely used In physics, chemistry and engineering since the insights of Carnot, Boltzmann, Gibbs, Maxwell, Clausius and other titans of the 19th century science, the creators of thermodynamics, statistical physics and physical chemistry. All scientists and engineers for over 150 years believe in the sanctity of the second law, although some shy away from the puzzling impact that its rigorous application leads to the origin and future of Cosmos, the mundane events on Earth and life on Earth. The analogue of the second law exists in information theory, an applied field of mathematics. While all the engineering energy consuming and generating contraptions are subservient to the material second law and the Electrical Engineering, Internet and the global world of information are subservient to the mathematical information second law.

In a loose formulation the *second law* states that in a closed system rigorously isolated from and not influenced by any exterior factor, the amount of chaos defined by its mathematical measure entropy cannot get less. Conversely order in an isolated system cannot grow. The mathematical measure of chaos in everything material is entropy **S** rigorously defined by Boltzmann and Gibbs back in the second half of 19th century. Where $\mathbf{k_B}$ is the famous Boltzmann constant that was introduced above in (1.1) when we discussed the radiation of Sun as the black body. In the simple ideal gas $\mathbf{k_B}$ connects the statistical average energy of molecules $\mathbf{E_{statistical}}$ in *erg* units with thermodynamic macroscopic temperature of an object consisting of these molecules:

$$\mathbf{E_{statistical}} = \frac{3}{2}\,\mathbf{N}\cdot\mathbf{k_B}\cdot\mathbf{T} \tag{6.1}$$

The entropy of one particle of an ideal gas is simply $\frac{3}{2}\mathbf{k_B}$. If there are **N** molecules of ideal gas entropy is:

$$\mathbf{S} = \mathbf{E_{statistical}}\cdot\mathbf{T^{-1}} = \frac{3}{2}\,\mathbf{N}\cdot\mathbf{k_B} \tag{6.2}$$

The temperature is easy to measure by comparing with the chosen standard.

The remarkable thing is that the above relation between the statistical energy and its entropy remains the same for any system ingeneral and not only for ideal gas. It was proved by the above titans of the second half of the 19th century, the time of industrial revolution. The measure of chaos is generally:

$$\mathbf{S} \leq \mathbf{E_{statistical}} > \mathbf{T^{-1}} \tag{6.3}$$

The concept of informational chaos and mathematical information entropy $\mathbf{S_{inf}}$ was introduced by the famous Claude Shannon one hundred years later (e.g., Claude Shannon, 1948).The two entropies are remarkably connected by the same Boltzmann proportionality constant $\mathbf{k_B}$:

$$\mathbf{S} = \mathbf{k_B}\cdot\mathbf{S_{inf}} \tag{6.4}$$

It is quite amazing that the Boltzmann constant singlehandedly unites respectively the abstract world of coherent digital information with the material order and informational chaos with material chaos. In mundane social and societal affairs the informational ignorance cannot fail to be the cause of the corresponding material chaos The Biblical awful ailment "confusion of the mind" has profound material implications for the afflicted. In rigorous mathematical terms the *second law* is as follows:

$$\frac{\partial S}{\partial t} = \frac{\partial}{\partial t}(E_{statistical}\cdot\mathbf{T^{-1}}) \geq \mathbf{0} \tag{6.5}$$

The *second law* states that entropy/chaos in a closed system cannot get less and hence order cannot grow.

The *second law* is axiomatic. It cannot be derived from the fundamental equations of physics. In fact none of them respect the *second law*. There are only two exceptions. The first exception is the Navier-Stokes equations of fluids, gases and liquids, flows, the NSE briefly. But the NSE is not fundamental in the sense that it cannot be derived from the Newton laws or any other time reversible equation of science. The NSE is the time irreversible equations that automatically respect the *second law*. The other exception is the Einstein gravitation equations, the EGE with the Einstein cosmological constant. However, for the EGE to respect the second law the cosmological constant must have necessarily the quantum mechanical nature.

Nevertheless, all phenomena with no exception in visible Cosmos and the visible Cosmos respect the *second law.*

The reasons behind the exceptional compliance with the *second law* by the NSE and EGE will be addressed at a proper place below. They are formally different, but the gist is the same and fairly extraordinary. Nevertheless, all other believed to be the fundamental equations of physics, the time reversible Hamiltonian equations are incompatible with the time irreversible second law. This is absolutely unambiguous fact at which, with few notable exceptions, physicists look with eyes wide shut for over a century prior to the recent developments in cosmology. The fundamental equations of physics conserve energy and its relativistic generalization and hence in compliance with *the first law of thermodynamics.* However they blatantly contradict the even more basic *second law*. It is argued confidently in this review that the Hamiltonian equations of physics do not and cannot contain in them neither the coherent nature of visible matter, nor the elemental constituent elements of matter in visible Cosmos and of visible Cosmos 4D space/time structure[1].

As soon as the concepts of order and chaos were given the appropriate mathematical formulation of the *second law* (0.1) it was noticed that it may be applied to Cosmos as a whole, since it has been believed that visible Cosmos is the all-inclusive, strictly closed system. If this is done then the immediate conclusion is that entropy as the measure of chaos grows with time, Then far in the future visible Cosmos will reach the statistical equilibrium, the state of total chaos, the maximum possible entropy, the final death of all material processes. This sad end was given the name "Heat Death of Universe". Although the heat death is not expected in the near future it is still unsettling. The heat death of Cosmos gives ammunition to the view point that there is no meaning to the existence of self-conscious life and actually this life is an accident that happened in our Cosmos or in one of many Cosmoses and it is time to stop dreaming about mysteries of Cosmos and focus on environmental issues on Earth and global warming from the emission of carbon dioxide into the atmosphere.

[1] This is not an entirely new claim. In the field of quantum chemistry such claim has been confidently made in (Gribov and Magarshak, Bogomolov and Magarshak and subsequent works of these authors. Qualitatively the similar claim was done by R. Feynman in his famous lectures. We will return to this most important subject in what follows.

Chapter 7

SECOND LAW OF THERMODYNAMICS. (CONTINUATION)

To better understand the *second law* let us consider ideal gas. Ideal gas is the simplest statistical system that nevertheless contains the gist of the second law and almost all of statistical physics and thermodynamics. Ideal gas is composed of molecules, or atoms, or just small particles. Suppose that a stream of **N** molecules of the same mass m each having its own velocity $\mathbf{v_i(x,y,z,t) = v_i(r,t).}$The average energy is injected into an arbitrary bounded volume:

$$(\mathbf{m} < \mathbf{v^2} >)/\mathbf{2} = (\mathbf{m} \cdot \mathbf{N^{-1}}/\mathbf{2}) \sum_{\mathbf{1}}^{\mathbf{N}} \mathbf{v_i^2} \tag{7.1}$$

The brackets < > mean the averaging over the initial velocity distribution function of injected molecules: $\mathbf{W_{initial}(v_i)}$. This averaging is equivalent to summation of energies of all the molecules normalized by their number **N** The molecules wander about in this volume; collide with the volume boundaries, but only elastically with no energy exchange. As a result of non-elastic collisions with each other and exchange of both the momentum and energy the molecules will eventually arrive at the equilibrium state. The average energy will remain the same of course due to the energy conservation in closed systems, but the distribution of velocities will be independent of the initial velocity distribution. The final velocity distribution will be the Maxwell distribution corresponding to the maximum of randomness, of chaos in their motion. Not surprisingly this distribution is the Gaussian function defining random processes. This equilibrium distribution has the maximum possible entropy **S.** The average energy of ideal gas is easily calculated from the Maxwell distribution getting:

$$\mathbf{<E_{ideal}> = N \cdot m <v^2> = 3N \cdot k_B \cdot T/2} \tag{7.2}$$

The temperature **T** in (7.2) is the basic macroscopic phenomenological parameter of the macroscopic state of matter in thermodynamics. Since temperature defines macroscopic system and does care about individual molecules it is easy to measure, say by thermometer. Expressed via temperature it can be interpreted as if each molecule has the kinetic energy $\mathbf{(3/2)\ k_B \cdot T}$, although certainly only the macroscopic statistical ensemble of molecules has thermodynamic temperature **T**. Then by definition the entropy is:

$$\mathbf{S_{ideai} = <E_{ideal}> T^{-1} = (3/2) N \cdot k_B} \tag{7.3}$$

This is a very important relation. It was emphasized in the previous section that the relation between the thermodynamic energy and entropy was long ago rigorously proved in classical thermodynamics to be exactly the same as it is in the relation (6.3).

In the ideal gas each molecule moves independently of each other by definition of ideal gas. There are no correlations in their individual motion. Hence they can move in all three directions in the 3D space **X,Y,Z** Hence each molecule has three degrees of freedom in the simplest case of no rotation. Therefore each degree of freedom can be assigned entropy$\mathbf{S_0 = k_B/2}$ .The above may seem trivial facts, but they lead to very general conclusions. It took the genius of Maxwell to understand how beautiful and complex even the simplest possible ideal gas system is. Thus the maximum possible entropy of N molecules of ideal gas is:

$$\mathbf{S_{max} = (3/2) N \cdot k_B} \tag{7.4}$$

For any other than the Maxwell equilibrium distribution of velocities of N molecules of ideal gas entropy is rigorously less:

$$\mathbf{S_{arbitrary} \leq S_{max} = (3/2) N \cdot k_B} \tag{7.5}$$

The (7.5) can be interpreted as if entropy $\mathbf{S_{max}}$ is equal to the total number of independent degrees of freedom of **N** independent, uncorrelated molecules, or any other uncorrelated objects.

But assume that suddenly $\sqrt[3]{\mathbf{N}}$ of molecules are strongly correlated in an arbitrary way; say forming one or many tightly linked chains, or strings, or loops. Then the number of independent degrees of freedom is only $(\sqrt[3]{\mathbf{N}})^2 \equiv \mathbf{N}^{2/3}$ and the "reduced" maximum possible entropy is:

$$\mathbf{S_{max}^{"reduced"}=S_{max}/N^{1/3}} \tag{7.6}$$

If **N>>1** then the "reduced" maximum possible entropy is much smaller $\mathbf{S_{max}^{"reduced"}} \ll \mathbf{S_{max}}$. The conclusion is that the correlations resulting from interaction of any kind between the constituent elements reduce their freedom and subsequently reduce the number of independent degrees of freedom and their total entropy. Simply the proper mechanisms of interactions between the individual units composing an arbitrary system reduce chaos and increase order. This is true for all interaction mechanisms except such that are designed to create chaos, like generators of random numbers for computer modelling.

In every day routine for instance if negotiations between political parties start from irreconcilable material contradictions they are bound to fail, creating more entropy/chaos. However the global increase of chaos in the system may be conveniently accompanied by the growth of order for one party at the expense of creating more chaos for other parties. This is often hailed as smart negotiations by such a winning party in business and politics. But it cannot be that all parties will win in the amount of order. One or several parties will always dominate over a period of time in the amount of order over the others. This time period may be significant, but the result is preordained and inevitable. Cosmos does not care about local space/time fairness, neither in grand events, nor in mundane life of biological species. The fittest necessarily win. And the next fittest will win later.

It is easy to grasp the qualitative connection between the material and informational entropies/chaos, although the quantitative theories of both are complicated and deep. Assume that we want to build a coherent object. We allow certain amount of random inaccuracies in its organized structure. The allowed random inaccuracies are defined by the entropy measure $\mathbf{S_{allowed}}$.To build an object we need layouts, numerical calculations, computer design, etc. Engineers spend their knowledge and thinking and technical work to have the full design ready and eventually ported on their computers. This is the order of their brains invested into building the object. The executive software and specific orderly numbers are calculated subject to random inaccuracies and mistakes creeping into the calculations. The random inaccuracies are inevitable in a complicated design. They are amplified by intrinsic noise of computations. Everything that the engineers ported into the computer is now digital data. The computer then computes the executive data and controls the work of the machines feeding them with the design digital data and the machines manufacture the object. Via these steps the brain order investment in conjunction with the computer as a tool and building materials is now implemented into a coherent object. Now we look if this object complies with the predefined specs. The total random mistakes in the computer generated digital data, resulting primarily from the inaccuracies of the design, are defined by the mathematical entropy measure $\mathbf{S_{inf}}$. Neglecting the noise from manufacturing itself this mathematical entropy will be in correspondence with the total material entropy measure of the manufactured object as follows: $\mathbf{S_{manufactured} = k_B \cdot S_{inf}}$ .If we are lucky the manufactured object will be as accurate as was planned in the specs. This would mean that the random mistakes in the digital design are within the allowed limit of random chaos of inaccuracies of the manufactured material object $\mathbf{S_{inf} \equiv S_{allowed}}$. If this is the case the two entropies are commensurate, the design is a good one and the engineers will be remunerated for their brain order invested into the design. The remuneration hopefully will facilitate the rejuvenation of their brain order.

In light of the above it is not overly surprising that the most pertinent problems of cosmology on one hand and conscious life and creations on Earth on the other are tightly intertwined with the *second law*, entropy/chaos and remarkable global growth of order in conjunction with the *second law*. I emphasize the growth of order, rather than the growth of chaos is paradoxically the consequence of the *second law*. There is no contradiction in this as will be explained below.

How it is possible to argue that the growth of order in visible Cosmos is the consequence of the *second law?* It is only possible if the growth occurs in a subdomain of 4D space/time of Cosmos. Nevertheless the growth of Order does happen in the whole of 4D Cosmos space/time. It is only

possible if 4D Cosmos space/time is not the rigorously closed system. To be precise this is only possible if what we consider and observe as our Cosmos is not rigorously closed system. What is meant is not the limitation imposed by the light event horizon and our inability to see the light outside of this expanding light event horizon. The more fundamental, unrelated attribute makes the visible Cosmos only a small part of the total closed system. This attribute is *dark energy* and *dark matter;* the two invisible substances are endowed with mass/energy that makes up about 95% of all matter in visible Cosmos. Dark energy permeates every point of 4D space/time of Cosmos as well as the voids between the visible matter structures and the smallest possible voids between the constituent elements of the visible matter as small as the voids may be.

Any system physical, biological, astronomical, cosmological, information system is not dead only if it is out of equilibrium with something exterior to this system. Then objects in the system can do work on other less vigorous objects. For instance teachers do, hopefully some useful work on students. They spend energy, but they also invest into students an amount of brain order. Students gain order from their teachers, at least in theory. If teachers are in equilibrium with their students there would be no gain of orderly intelligence by the students. Teachers must have more knowledge, more ordered information in their brains. This excess of orderly information compared with the students, the teachers share with students. Here we see an obvious example that order is inked with information. However we know that any information can be represented in digital form that is the amount of digital bits and bytes. Therefore the amount of organization, order in any system is diffeomorphic to the total knowledge contained in this system. Therefore order as information, or knowledge can be in principle expressed by the number of digital bits and bytes. The Boltzmann constant then allows connecting the coherent sequence of bits and bytes with the material manifestation.

The quality of information may be different. If the mind of a teacher is confused and disordered the teacher would share mumble-jumble chaos with the brains of students that the students dependent on the amount of order of their minds can absorb or repulse. However teachers may deliberately share some orderly packaged, but false information with the students. The same ploy may be employed by attorneys, politicians, businessmen, intelligence and security personnel and other people, or even animals, pursuing their own goals of survival. This is orderly disinformation; deliberate brainwashing and the subjects of this brainwashing must have high enough amount of their own mind order to resist the absorption of disinformation. Their opponents may emit noise, the disinformation of chaos to replace order in the minds of the subjects. In semantic terms it is deliberate confusion of the subjects so that their orderly version of events or phenomena loses coherence.

I am trying to share my awe in front of generality and inevitability of the *second law*, its relevance and dominance over all aspects of our lives that are usually disconnected from what is called the exact sciences.

The *second law* seems to deny our free will and freedom of choice. To a very large extent it does, but not completely. The *second law* is the bridge from our material, biological existence to the life of global Cosmos. It is difficult to accept emotionally that order in our individual and collective life has the prime source dominating it not within our environment, not even on Earth, but outside of what we perceive as Cosmos. Nevertheless, it is the same prime source that furnishes global order of visible Cosmos itself. Of course the prime order imperatives pass through myriads of generations of order/chaos cycles enabled by myriads of servile mechanisms to be implemented into our small by size, but infinitely complex brain organization. However human brain is uniquely coherent. The coherence of human brain is maximal possible relative to our individual lifespan that is the same as coherence of the dark energy continuum. Therefore even dark energy continuum cannot totally erase human free will[1].

[1] In Hebrew philosophy it is emphasized that the choice between good and evil is not and even cannot be controlled by Divine intervention and is totally our individual responsibility. There is great wisdom in this since it does not allow evil committed by humans to be justified by inexplicable will of the Creator.

Chapter 8

ORDER IN COSMOS AND REVERSE SECOND LAW

Notwithstanding the *second law* everywhere we see the emerging and growing order. One should not be a rocket engineer, in fact it may be counterproductive[1], to notice that when the interstellar gas molecules chaotically wandering in space condense, due to the gravitational attraction, into coherent star systems the molecules become constituent cells of whole organized entities in which their individual freedom, their chaos are subdued in favor of the wholeness. The scientific measure of chaos, entropy becomes smaller. Conversely order or "negative" entropy increases[2]. When stars unite with planets into star systems and then again due to the gravitational pull unite between themselves to form galaxies these are more orderly than a collection of randomly wandering stars. And when galaxies unite into clusters of galaxies these are more organized than independently wandering galaxies and so forth. The scale of coherent organization grows from the size of one proton and one electron to atom, to molecule and so forth up to the size of galactic clusters and end of greatness" as it is called at the very edge of visible Cosmos. The mechanisms responsible for the sequence of formation of these large coherent structures are primarily due to the properties of gravitational field, but what about the *second law***,** why entropy/chaos does not increase and instead order grows?

Similarly in the micro world the protons and neutrons unite into nuclei their individual freedom is lost suppressed by the residual strong interactions between the two. When three quarks unite into protons due to the original strong interaction between themselves via exchange of the boson gluons their freedom is lost. Quarks are intrinsic slaves. They cannot exist free at all and their only irresistible drive is to couple with other quarks. In all micro-world unification events entropy/chaos decreases and order grows. Protons and electrons unite into atoms, then molecules then macroscopic matter, coherent planetary atmospheres, stars, galaxies and so forth.

And on Earth we witness and are participants of the ever evolving life. Ants and bees building hives, Birds flock together to fly to warm lands and back, wolves hunting together in packs. Humans had united into tribes, tribes into states, states into Empires. In all this unification the freedom of individuals and constituent parts is sacrificed for common coherent cause, order of survival and dominance.

Similarly the manmade social laws, criminal and all laws to which the societies, states, groups, families and individuals are forced to submit, all the mechanisms that should have served the autocracy of the *second law* instead serve exactly the opposite growth of order. From time to time as we described before the coherence of cause is lost between constituent parts and individuals of structures and interregnum of chaos settles. But then again new order, new structures emerge and struggle for survival and dominance.

The ground breaking astronomical observations by the two groups of indefatigable astronomers published in 1998 and decisively affirmed in all subsequent observations showed that the global order of visible Cosmos as a whole entity is growing and entropy/chaos of Cosmos is decreasing in what appears to be a global violation of the *second law*. Visible Cosmos is not to be executed by the heat death. Neither will it end in the death of cold loneliness. On the contrary visible Cosmos is running with acceleration to Global perfect Order, the GPO of Kosmos. Is it possible that despite our firm belief in the sanctity of the *second law* it is nevertheless wrong?

The latter suspicion is naïve and the *second law* is unimpeachable. The growth of order and waning of chaos in visible Cosmos is forced by the *second law* if it is interpreted correctly,

This is how it happens. The *second law* predicts that order cannot grow in rigorously closed systems. With total confidence if in a system in 4D space/time domain order is observed growing this system is not a closed system. Somewhere in the 4D space/time there is a donor source of order furnishing the system the coherent energy while the system disposes the same amount of chaotic, at least larger entropy lesser quality energy. Therefore in accordance with the *second law* somewhere in 4D space/time where this donor/source of low entropy energy is located, or in any other space/time

[1] No offense meant to marvelous rocket engineers. Just an expression!

[2] Entropy staying constant is not the option here. This would mean no changes taking place which is obviously wrong in visible Cosmos.

space domain entropy/chaos should grow. The latter can take place very far away in space and time from the system, but inevitably will or has taken place.

The phenomena in nonequilibrium systems described above are much more interesting than that in equilibrium systems**.** *Almost everything in visible Cosmos is nonequilibrium. The visible Cosmos itself is highly nonequilibrium. In a wide class, almost in all nonequilibrium systems of interest the reverse second law, RSL in what follows, is dominant*.

We reiterate that in this kind of closed systems some subdomains serve as the external source of order for other subdomains of this closed system. It happens only in a manner well defined by the laws of thermodynamics and always in the same manner.

The flux of organized, coherent energy flows from the donor source subdomain into the receiver subdomain of a closed system while exactly the same flux of chaotic energy flows back from the receiver subdomain into the source of order subdomain or anywhere else inside the closed system in a case there are more than two subdomains in this system. Therefore energy is naturally conserved as it should in the closed system but the amount of order in the source subdomain decreases while the amount of order increases in the receiving subdomain. If the source of order, the donor possesses plenty of coherent energy the transfusion of order the process of redistribution of order over the whole closed system can go on till the genuine statistical equilibrium, the equipartion is achieved, both for energy and order.

This is again awful. Because this state will mean again total chaos, since order will be equally partitioned among, generally the infinite amount of degrees of freedom.

However if the donor source of order subdomain is an infinite manifold the equilibration time may be infinite. The primeval source of order, the pinnacle of the order/chaos cascade must be the infinite storage of order. But since visible Cosmos is also likely the infinite 4D space/time manifold the donor source must also have the infinite capacity to absorb chaos flowing into it. This indicates that the total number of degrees of freedom of the donor should be infinitely bigger than that of visible Cosmos. This may be achieved easily by assuming that the 4D space/time of visible Cosmos 4D space/time is quantum and hence discrete manifold.

The equilibrium state can be of two kinds. The equilibrium state of the 1st kind is simple. If and when the surplus order of the donor source subdomain is exhausted the whole closed system reaches eventually the state of statistical equilibrium of maximum possible chaos. This is the case in classical physics systems. However where will all order disappear if the system is closed? It will not disappear. Some tiny fraction of order will always remain. This is a quantum mechanical effect subsequent to the ground breaking results of Jacob Bekenstein several times referred to above. The fraction of this die hard order is fairly easy to estimate. However fundamentally it is amazing example that EGE and quantum mechanics, rather than classical physics are always at the root of everything in visible Cosmos and both EGE and quantum mechanics should respect the second law, which they per se do not.

In quantum systems there is also the 2nd kind of coherent statistical equilibrium. This 2nd kind of statistical equilibrium is on the contrary the maximum possible order. For instance the well-known state of quantum matter in equilibrium is superfluid helium and superconducting metals. These are states of the maximum possible order and this state is achieved only by the boson quantum matter, such as photons, Helium4 atoms, the pairs of fermion electrons in metals at low temperatures coupled together into bosons by weak long range interaction peculiar primarily, but not only for metals and strangely electron spins in ferromagnetic[3].

[3] The latter is possible only because the spins in metals can be represented through the infinite but exact expansion in powers of boson occupation number operators.

At the same time all visible matter is made not of bosons, but of fermions, although the fermion matter is seen only via interaction with photons, the particles of light which are bosons[4]. Interaction with photons and gravitational field is universal for all visible matter in visible Cosmos. This is in contrast with the weak and strong interactions that are more selective.

There are obvious, mundane examples of the *second law.* For instance a sick he/she lives alone in a strictly isolated room. If help does not come to tidy up the room it will soon be mess, chaos in the room. From time to time he/she would restore order in the room at the expense of his/her orderly energy. But then again order will soon lose to chaos and he/she will have no internal orderly energy left to restore order in the room again. Eventually he/she dies of depravation sunk in the self-generated chaos of decomposition and it will be total mess. Thus in the isolated room the space/time entropy/chaos mess will eventually reign.

It was grim illustration. But this is how Cosmos functions. The mechanisms that serve the supremacy of the *second law* may be entirely different for different systems described by different physical equations if such are known. The equations are simply the mathematical format of these mechanisms. They may be different or only one physical equation of everything from which all other equations and subsequent mechanisms follow. However all the equations and what is called natural laws are merely the mechanisms implementing the *second law.*

Similarly the social laws to which the societies, states, groups, families and individuals are forced to submit are the mechanisms implementing compliance with the *second law.* However the *second law* does not allow order to grow, although it allows order to stay constant in the status quo static situation with no processes or change. Subsequently this is how our material visible Cosmos should have functioned were it the ultimately isolated, all inclusive system, a dwelling where we and all the matter reside. It is the depressing vision of Heat Death originated in the 19th century in the wake of all rational vision of Cosmos and life that has been one way, or another adapted by, pessimistic contemporary science.

Let us consider another example recalling what we know about the Neolithic times when Neanderthals and Cro-Magnons creatures were roaming Earth. Each of them was independent and free. Let us assign to each of them a label that we call a degree of freedom. Each of the creatures is one degree of freedom. Altogether there are **N** creatures and **N** degrees of freedom. Each creature is independent and does not correlate with any other creature. As a system they live miserable life of high entropy $\mathbf{S=k_B \cdot N}$ where we remember that $\mathbf{k_B}$ is the Boltzmann constant. This is the simplest definition of entropy as the number of independent degrees of freedom, or independent harmonics in the momentum space, or independent modes**.** However, we know that Neanderthals together with*Cro-Magnons*started to form groups and later tribes, as ants and bees do. In the groups they are not independent any more. The degrees of freedom, or harmonics now correlate and their number now is the number of subgroups of the creatures locked up together by common egoistic interests that prevail over common interest of individuals. Entropy of all **N** creatures is now $\mathbf{S=S=k_B \cdot N_{groups} << N}$ where $\mathbf{N_{groups}}$ is the number of groups with the total number of creatures **N,** $\mathbf{N_{groups} << N}$. Eventually the group grows into a tribe, state and autocratic Empire with the interests of all individual creatures subservient to one Emperor. This is total coherence of **N i**ndividuals or entities that either by their own will, or out of fear, or usually both submit their independence to the will of Emperor. There is only one degree of freedom left that locks up into the coherent grip all **N** previous degrees of freedom.

[4] All quantum particles in nature are of two kinds, bosons and fermions. Large ensembles of these particles submit either to Bose –Einstein statistics, or Fermi statistics. Both are different from the classical Maxwell statistics ensembles. The difference is due to the specific quantum properties of bosons and fermions, primarily their spin. Bosons have integer values of spin. Fermions are always half integer spin particles. For instance photons are bosons with spin l and helicity ∓ 1 . Bosons attract each other in the space of momenta and fermions. This is the famous Pauli principle with great implications. If fermions were repulsive in the momentum space they would have not been attractive in the usual conjugate space/time and there would be no lumps of matter. Bosons are not attractive in space/time. They are carriers of all types of interaction between the fermions. By themselves except photons, or bosons made by coupling of fermions at very low temperatures, the elemental bosons do not exist. Photons are infinitely more significant as the carriers of the information, the most basic type of interaction between fermions. However, photons generate the electron/positron pairs converting back into photons and in this sense are also intrinsically involved with fermions.

The entropy now is merely $\mathbf{S = k_B/2}$. This is how the total coherence of purpose is achieved. When this ultimately coherent entity acts with energy, say against another Empire it does it like a coherent laser beam, a dream of commanders in chief.

However, this seems to be against the *second law* that forbids the growth of order in a closed system. However the group of **N** creatures is not a closed system. They are influenced from outside and subjects to many external influences. For instance not once in recorded human history there was a static situation when a single Empire ruled the whole globe. Had it been it would have been an almost closed system. Such global Empire would be the subject to the *second law*, its coherence diminishing and entropy/chaos growing and it would decompose after a time period[5].

However the prime cause of order on Earth, the prime cause of ant's hives, the arising of human tribes and Empires and technological progress and wars and almost everything else including the animate life, *although not the self-conscious mind of Man***,** is not romantic. As we have discussed above this cause is the inanimate, soulless solar radiation. The solar radiation is the external source of order on Earth and instead of the proper *second law* its alter ego *RSL* rules over nearly everything that is happening on Earth. The end result of this solar radiation rule is extraordinary. When considered over a period of time it is the ever growing of order on Earth. The continuing growth of order and falling entropy on Earth will go on almost indefinitely into the future. It is strongly emphasized once again that the self-conscious mind of Man is the tremendous exception in that the human brain is in coherent entanglement with the dark energy continuum, the DEC.

The recent astronomical data is convincing. Instead of striving to the equilibrium chaos of Heat Death the global visible Cosmos is striving to the timeless state of GPO, the continuum of dark energy. This is not at all in contradiction with the *second law*. The tendency to GPO is the result of the *reverse second law*, the *RSL* in conjunction with the servile mechanisms of EGE and quantum mechanics. The growing order of visible Cosmos simply shows that visible Cosmos is not at all the closed, all inclusive system. We have always been taught and thought that Cosmos is closed, all inclusive system. But we had no idea that there is invisible dark energy and dark matter that totally dominate visible Cosmos. Neither visible nor observable Cosmos are all inclusive systems. It is the infinite, timeless dark energy continuum Kosmos that is unaccountably larger than visible Cosmos that is all inclusive, closed entity. The time evolution of visible Cosmos is totally dominated by the invisible substances, dark energy and dark matter. However even with all this invisible matter the observable Cosmos, a much larger place than visible Cosmos that includes all invisible dark energy and dark matter is still not a closed, all inclusive system. The observable Cosmos is not the system in equilibrium.

The constant flux of coherent energy flows from the continuum of dark energy into visible and observable Cosmos alike, passes through every point of the 4D space/time, maintains the average dark energy density in visible and observable Cosmos at a certain constant level and flows back into the continuum of dark energy. In other words visible Cosmos is in the steady state as far as energy is concerned meaning that the energy flux from the continuum of dark energy is exactly equal to the reverse energy flux from visible Cosmos into dark energy continuum:

$$\boldsymbol{F}_{darkE}^{from} \cdot \mathbf{E}_{\mathbf{statistical}} = \boldsymbol{F}_{darkE}^{Info} \cdot \mathbf{E}_{\mathbf{statistical}} = \mathbf{const.} \qquad (8.1)$$

Therefore the average energy density of the dark energy continuum, DEC manifestation in visible Cosmos remains constant:

$$<\boldsymbol{E}_{DEC}^{visible\ Cosmos}> erg/cm^3 = \mathbf{const.} \qquad (8.2)$$

However, the inverse flux of energy $\boldsymbol{F}_{darkE}^{Info}$ from visible Cosmos into the dark energy continuum has hugely bigger number, by the factor $\mathbf{Re_c^4 = 10^{164}}$ of independent degrees of freedom in 4D space/time and hence hugely larger entropy/chaos. Visible Cosmos is in the steady, stationary state as

[5] This is what ought to be the fate of any coherent entity that for some reason wins global domination and controls the globe, or artificially isolates itself from the surrounding parts of the globe. Unless there is competition between at least two entities over control of other entities it is the path to stagnation and decomposition. Such is the second law and its implications. Expectations of world harmony are futile, unless humanity is confronted with challenges from far space, which is unlikely.

far as the density energy density of dark energy manifestation in visible Cosmos is concerned; the Einstein cosmological constant remains the same by definition. However order is sucked out from the coherent energy flux $\boldsymbol{F}_{darkE}^{from}$, remains and is accumulating in visible Cosmos. In other words the dark energy continuum, of which the cosmological constant is the manifestation in visible Cosmos, is the donor of order for visible Cosmos. Hence entropy/chaos of visible Cosmos is steadily diminishing, i.e., the cosmological constant is the manifestation of the flux of negative entropy/chaos into visible Cosmos and visible matter:

$$\boldsymbol{F}_{S}^{from\ DEC} = \frac{\partial S_C^{visible}}{\partial t} < 0 \qquad (8.3)$$

Hence order of visible Cosmos is steadily and ever growing till the end of time. This growth of order is observed unimpeachably via acceleration of Hubble expansion of visible Cosmos. The RSL is unimpeachable.

We repeat that this does not contradict the *second law*. It simply means that visible Cosmos is not the thermodynamically closed system. This is rather obvious and instead the *RSL m*ust be complied with instead of the straight *second law*. The dark energy continuum is the donor source of global order flow into visible Cosmos, like the solar radiation is the donor source for the growing order on Earth.

The dark energy flux $\boldsymbol{F}_{DEC}^{from}$ has the typical coherence scale $\mathbf{L_c = 10^8}$ *cm* defined above in (4.2). This is the scale at which energy is injected into visible Cosmos. However the scale at which energy is ejected by visible Cosmos back into dark energy is the Planck scale $\mathbf{l_p = 10^{-33}}$ *cm* defined by(5.2). Their ratio is the large number $\mathbf{R_c = 10^{41}}$ and the fourth power of this number is equal to the ratio of the number of degrees of freedom of injected energy flux into the 4D visible Cosmos and ejected energy back into the DEC.

It should be emphasized that the EGE with positive cosmological constant and with no explicit reference to the *second law* per se indicates the growth of order directly. The EGE with cosmological constant are near to respecting the second law. But the genuine compliance can be achieved only paying respect to the quantum mechanical structure of cosmological constant $\mathbf{\Lambda = 10^{-29}} g{\cdot}cm^3$.

It seems that conversely entropy/chaos of the DEC should be also growing. However it does not happen. The DEC into which our visible Cosmos is embedded is *infinite continuum* of perfect order and its capacity to absorb chaos is unbounded No countable or finite amount of chaotic degrees of freedom can harm the ultimate coherence of this continuum. Likewise all information of order accumulated in visible matter from the birth of visible Cosmos does not disappear in the MBH's. It is rather the MBH's with all their accumulated chaos and intrinsic coherence dissolve within the DEC. All information accumulated during the lifespan of visible Cosmos evolution is placed back into the dark energy timeless continuum.

Chapter 9

EXCURSION INTO ESR AND EGE

It is instructive to familiarize non-professional readers with a few basic facts and implications of the Einstein Special and General Relativity or equivalently Einstein Gravitation Equations, the ESR and EGE respectively. For those who prefer to skip this section mat do so and it should not impair the understanding of the main conclusions of this review. However, they would have to believe certain classical results that are perfectly well known and are incontrovertible, verified and falsified facts of science that will be used for the original results of this review.

In both ESR and EGE the 4D space/time means 3 space dimensions **r(x,y,z)** and imaginary time dimension ***i*ct** where the imaginary unit is $\boldsymbol{i} = \sqrt{-1}$ and as always $\mathbf{c} = 3 \cdot 10^{10} cm \cdot sec^{-1}$ is the speed of light. The speed of light is the maximal speed of matter existing in visible Cosmos and this is the first postulate of ESR that has been validated in hundreds of experiments and is beyond arguments. It is the fact implicitly, but not directly first indicated by American experimentalists Albert Abraham Michelson in 1881 and Edward Williams Morley together with Michelson in 1887 in some of the most valuable experiments in the history of physics. Physicists have continued these and other experiments since then and achieved incredible precision. What it means in particular among many other things is that there can be no motion of matter relative to light. Indeed if such existed than it would have been possible to exceed the speed of light by matter moving in the same direction as light with additional velocity. Hence whatever are the matter velocity light moves relative to this matter with the same speed of light, not more and not less. But then there is no reference frame that is at rest with light! It is not possible to be in rest relative to light by any observer that is not light. But light cannot be an observer. Light is the means to communicate between an observer and matter.

It is not surely known if Einstein was aware of the experiments of Michelson and Morley when he published his theory of special relativity in 1905. But it is not relevant. The two great experimentalists aimed at measuring the speed of light relative to mythical ether and did not find one, a hugely important result at that time, but they did not explicitly aim at measuring the light speed relative to matter.

If there is no motion relative to light and subsequently no reference frame at rest with light there is no time concept for light. Let us consider two points fixed on Earth and ride on a train between these two. It will take less time for us sitting on the faster train. Let us sit on a train that moves at a speed that tends to the speed of light, but still never reaching exactly the speed of light since except for light nothing can move with the speed of light. The time of travel for us would be tending to the minimal possible as the speed of the train tends to the maximal possible speed of light. The minimal time is exactly zero, but this can be only if the speed of train is infinite. But the speed cannot exceed the speed of light. The only possibility is to have the travel time tending to that that it takes for light to reach the destination. Suppose that despite the fact that it is not possible we would be naïve to assume that we can ride with the light to the point of destination. In this imagined situation the time of travel would be exactly zero. And this is another way of saying that an observer cannot ride with the light. As close as the observer would be close to the speed of light nevertheless light will move relative to the observer with the same speed of light. The speed of light is absolutely invariant, fundamental constant of visible Cosmos.

The above mental exercise nevertheless supports the previously made suggestion that for light there is no time concept. If we could ride with the light the time to reach any destination in visible Cosmos would be exactly zero even if the destination was infinitely far from us. In other words all space of visible Cosmos contracts for light, better to say from the perspective of light if such existed, into a point. In zero time we could have travelled and learned everything about visible Cosmos. Although it is suspected that no big thrills would have been discovered.

We have established above that the distance and length are not absolute quantities in Einstein special relativity and indeed in visible Cosmos. They are reference frame dependent, or as we say not invariant under the group of transformations between the inertial reference frames.

While space contracts in the fast moving relative to the observation point reference frames the time on the contrary dilates. If we could ride the light dragon we would have lived forever from the view point of observers on Earth. Of course while riding the light dragon we would live our own

biological life span, but we would be able to traverse all visible Cosmos infinite number of times because for us it would be just one infinitely small point. We would be this point infusing it with life.

The real processes transpiring in different inertial reference frames moving with constant velocities relative to each other should be independent of the choice of reference frame. Constant velocities are not associated with forces affecting events or processes. It is just that for an observer moving relative to the domain in which the processes take place or the other way around the size of this domain and the time duration of the processes is different dependent on the relative speed of the observer and the domain.

The size of the domain in the direction of relative velocity contracts for the observer as follows:

$$\mathbf{l = l_{restframe} \cdot \gamma = l_{restframe}\sqrt{\frac{1-v^2}{c^2}}} \tag{9.1}$$

where $\mathbf{l_{restframe}}$ is the proper domain size in the direction of relative velocity**v** in the reference frame at rest relative to the domain. The time of the process on the contrary dilates as follows:

$$\mathbf{t = t_{restframe} \cdot \gamma = t_{restframe}\left(\sqrt{\frac{1-v^2}{c^2}}\right)^{-1}} \tag{9.2}$$

where $\mathbf{t_{restframe}}$ is the proper time of the process, say the life time measured in the reference frame at rest with the domain. We can see that when the value of relative velocity approaches the speed of light the domain size in the direction of relative velocity $\mathbf{l \to 0}$ and if the light speed could have been reached the domain size would be truly zero. The whole space would contract into 2D plane. But then we could have ridden the light dragon into two directions on the plane as well in zero time, so that the whole space would be just a point. The time dilation would also be infinite and we together with the light dragon timeless. There is nothing really strange in this because if the time of processes becomes infinite it means that there are no changes and hence the time concept has no sense. We note that the product the proper 4D volume of the domain remains invariant under the Lorentz transformations.

Of course this is fantasy and we cannot make the transition from moving in space with the speed tending to the speed of light and actually having the speed of life. Therefore to traverse space will take always a bit more than the distance divided by the speed of light. However due to the time dilation the time span passed on Earth while we are travelling in the starship will be tending to infinity while the time measured by the clocks on starship will be tending from above to the time equal the travel distance divided by the speed of light, but never reaching it.

The above transformations of length and time are called the Lorentz transformation. Prior to the publication of ESR in 2005 Hendrik Lorentz found the group of transformations preserving the invariance of Maxwell equations of classical electrodynamics. Einstein on the other hand understood that all processes in matter and space/time, not just the electrodynamical processes, and the equations describing all processes must be invariant under transformations of the Lorentz group. This invariance is not the particular attribute of electrodynamics. It is all physics and other material equations describing real phenomena in Cosmos must be Lorentz, or relativisticaly invariant. The relativistic invariance for high speed moving objects substitutes the Galileo Galilei group invariance for slow speed moving objects of Newtonian mechanics.

In the Newtonian classical mechanics the position of a point particle with mass **M** moving with a velocity as a function of time and three coordinates **v(**x,y,z,t**)** in flat 3D space is fully determined by the Newton laws. These laws furnish the time trajectory of the particle for all times **t>0 .**To solve them it is necessary to know the forces acting on the particle, initial conditions, the initial radius vector **r(**x,y,z,t=0**)** and the initial velocity **v(**x,y,z,t=0**)** for instance in rectilinear coordinates. With this data the solution of Newton equations will furnish the trajectory of the particle for all future time **t>0** that is the radius vector:

$$\mathbf{r}(x,y,z,t,\mathbf{r}(t=0),\mathbf{v}(t=0)) \tag{9.3}$$

This description goes back to Galileo Galilei and the Newtons laws that together with the initial conditions inside the brackets determine all the remaining quantities, i.e.,**v(**x,y,z,t**)** and the trajectory **r(**x,y,z,t**)** itself. This trajectory will be exactly the same in any other inertial reference frame moving

with constant relative velocity relative to the particle. For instance if we are in the reference frame moving with the constant velocity $\mathbf{V_0^z = const.}$ in **z** axis direction the trajectory of the particle will be obtained from the trajectory in the previous reference frame, say at rest with observer by the constant shift of the **z** component of velocity and translation of the **z** coordinate $\mathbf{z \rightarrow z' = z - V_0^z t}$ component. So that the trajectory becomes:

$$\mathbf{r}(x,y,z', t, \mathbf{r}(t=0), v_x(t=0), v_y(t=0), v_z(t=0) - v_0^z)) \quad (9.4)$$

However it is only approximately correct and only if the absolute value of the particle's velocity measured by observer in his rest reference frame is small compared with the speed of light: $\mathbf{V_0^z \ll c.}$ If the relative velocity is not small compared to the speed of light the transformation of the Cartesian or any other coordinate system is subject to Lorentz transformations instead of the Galilean one.

Let us stay for a while with small relative velocities. Let us consider two point particles in 3D space, say fixed on the surface of Earth separated by a small distance measured in the reference frame at rest with Earth and subsequently with the two points fixed on Earth. The squared distance between the two particles 1 and 2 positioned close to each other is called the interval. In the Cartesian space coordinates the interval value is given again by the 3D analogue of the Pythagoras theorem:

$$\boldsymbol{dr^2_{1\leftrightarrow 2} = dx^2_{1\leftrightarrow 2} + dy^2_{1\leftrightarrow 2} + dz^2_{1\leftrightarrow 2}} \quad (9.5)$$

Let us now choose another inertial reference frame that moves with a constant velocity relative to Earth and subsequently relative to the points that we fixed on Earth. For instance let us take a train moving away from the particles and measure the squared distance between the points, say by a beam of light. It seems at the first glance that the interval should be the same $\boldsymbol{dr^2_{1\leftrightarrow 2} = dx^2_{1\leftrightarrow 2} + dy^2_{1\leftrightarrow 2} + dz^2_{1\leftrightarrow 2}}$. It seems that the interval will remain the same if we choose another reference frame, for instance a faster train, or a plane and again measure the distance between the two particles by sending a light beam, say a laser beam for precise measurements. Mathematically we call it the interval invariance and it is approximately true for small relative velocities. That is:

$$\boldsymbol{dr^2_{1\leftrightarrow 2}} = dx^2_{1\leftrightarrow 2} + dy^2_{1\leftrightarrow 2} + dz^2_{1\leftrightarrow 2} \approx \mathbf{invar.} \quad (1.1)$$

In all inertial systems, such that are moving with arbitrary constant velocities relative to Earth and the points fixed on Earth would it be the fast train, or a car, or a fast aircraft. Interval is invariant under the Galilei group of transformations.

If we want to comply with ESR for large relative velocities this is fundamentally wrong. Because the Lorentz coordinates system transformations from one reference frame to another result in the value of space interval not at all invariant in different reference frames. This is because the space interval is the *relative velocity dependent:*

$$\boldsymbol{dr^2_{1\leftrightarrow 2}} = dx^2_{1\leftrightarrow 2} + dy^2_{1\leftrightarrow 2} + dz^2_{1\leftrightarrow 2} \neq \mathbf{invar.} \quad (9.7)$$

Is there a quantity instead of the space interval that is nevertheless invariant under Lorentz transformations? That such invariant quantity must exist we are sure because the real, say biological processes in the inertial reference frames, i.e., the reference frames that move with zero acceleration constant velocities relative to each other should be exactly the same. If there is no accelerations there are no Newtonian forces and hence nothing to affect the processes. It is just from the perspective of fast moving reference frames the space dimensions of domains with processes contract and the time of processes in these domains dilates. It is the perceptions of the processes in different inertial reference frames are relative, but the processes are the same. This is a tremendous illustration of how fragile our perception of space/time is.

Indeed, a modified relativisticaly invariant interval between two particles fixed in the reference frame at rest with them, say on Earth is the following quantity:

$$d\mathbf{S}^{\mathbf{2}}_{\mathbf{1}\leftrightarrow\mathbf{2}} = d\mathbf{r}^{\mathbf{2}}_{\mathbf{1}\leftrightarrow\mathbf{2}} + (ict)^2 = dx^2_{1\leftrightarrow 2} + dy^2_{1\leftrightarrow 2} + dz^2_{1\leftrightarrow 2} + (ict)^2 =$$
$$= d\mathbf{r}^{\mathbf{2}}_{\mathbf{1}\leftrightarrow\mathbf{2}} = dx^2_{1\leftrightarrow 2} + dy^2_{1\leftrightarrow 2} + dz^2_{1\leftrightarrow 2} - (c\cdot t)^2 = \mathbf{invar.} \qquad (9.8)$$

This is the space/time invariant of ESR and it is clear now why the time dimension can be formally considered imaginary, although of course the proper time by which we live and measure by the clocks at rest relative to us feels very real.

The imaginary time introduced by Minkowsky allowed deep and convenient manner of ESR interpretation in unified Minkowsky space/time. It became clear in this formulation of ESR that the dynamics of particles and bodies should be the trajectories in 4D space/time defined by the 4D vectors having 3 space components and the "imaginary" component in the time direction. Actually these trajectories are now the invariant domains in 4D space/time. The meaningful relativisticaly invariant 4vectors are such that their 4D length is invariant under the Lorentz group of transformations taking observer, or the object of observation alike from one inertial frame to another provided that the relative velocity between the inertial frame at rest with observer and the observed object is arbitrary, but still at least infinitesimally smaller than the speed of light.

In particular the interval vector is obviously the four component vector: d**S**[d**r**, d(*i*ct)] and its length is constant in all inertial reference frames by virtue of the interval invariance above. This 4vector is the relativisticaly invariant object trajectory in Minkowsky 4D space/time.

The geometry of Minkowsky 4D space/time is fairly remarkable. If one space dimension is compactified the resulting reduced 3D geometry is the hyperbolic Lobachevski geometry. The 4D Minkowsky space/time automatically complies with causality. It can be easily deduced that the only events that can occur are located within the event light cone. This ensures that only if light of one event reaches another these two events are causally connected and correlated. The light cone preservation of causality is however arguable in quantum mechanics. In quantum mechanics the speed of propagation of the wave function phase is infinite and hence, generally speaking the phases of all 4D space/time quantum particles are coherent. There are no reasons to believe that the quantum phase coherence breaks anywhere in 4D space/time of observable Cosmos and beyond observable Cosmos.

The classical Newtons mechanics is based on certain basic concepts. These are the absolute nature of space and time and subsequent existence of singled out absolute reference frame and as basic concepts of force and mass. The Newton second law conserves the moving objects momentum and energy.

Forces are always caused, better to say described by fields. Both are quite difficult concepts. Force is well understood semantically, although trying to explain quantitatively what force is, except by saying that it an act on matter is not easy. The Newton 2nd law equates the enigmatic vector force quantity applied to matter with even more mysterious mass of matter scalar quantity multiplied by matter acceleration. The acceleration can be of course easily measured. As for the mass of matter it has remained totally mysterious quantity from the times of Johannes Kepler and Isaak Newton till 1913 when Einstein published his EGE. Astronomers implicitly, but lacking understanding, equalized mass of a body with its weight that is measured on scales as one weight relative to another standard weight. The latter is not very helpful for understanding what it really means but empirically it serves well. It is only Albert Einstein formulated as one of the basic principles of general relativity that weight has no meaning by itself. It is just equal to the rest mass of matter.

In Newtonian mechanics the second law is equivalent to the conservation of momentum of moving objects interacting with each other elastically. When there are no external forces all three components of the momentum 3 vector and the total kinetic energy scalar are conserved. The momentum conservation for one object with forces acting on the object is as follows:

$$\frac{d}{dt}\mathbf{P}(x,y,z,t) = M\frac{d}{dt}\mathbf{v}(x,y,z,t) = M\frac{d^2}{dt^2}\mathbf{r}(x,y,z,t) = M\cdot\mathbf{a}(x,y,z,t) = (\textstyle\sum_i \mathbf{F_i})\cdot\mathbf{v} \qquad (9.9)$$

where $\sum_i \mathbf{F_i}$ is the sum of all forces acting on the object with mass **M** and subsequently forcing the object to move with acceleration:

$$\mathbf{a}(x,y,z,t) = \frac{d^2}{dt^2}\mathbf{r}(x,y,z,t) \qquad (9.10)$$

The sum of forces does work on the object by forcing its motion along the trajectory. The work done during the time interval $\mathbf{\Lambda t}$ is as follows:

$$\text{Work}(\mathbf{\Lambda t}) = \int_{\mathbf{t=0}}^{\mathbf{\Lambda t}} (\sum_{\mathbf{i}} \mathbf{F_i}) \cdot \mathrm{d}\mathbf{r_{0\rightarrow end}}(x, y, z, t), \mathrm{d}\mathbf{r}(x, y, z, t) \qquad (9.11)$$

The kinetic energy conservation yields as follows:

$$\frac{\mathbf{d}}{\mathbf{dt}}\mathbf{E_{kin}} = \mathbf{M}\frac{\mathbf{d}}{\mathbf{dt}}\mathbf{v^2}(x, y, z, t)/\,\mathbf{2} = \text{Work}(\mathbf{\Lambda t}) \qquad (1.2)$$

The work can be positive or negative, like the one done by the force of friction. Friction is fundamentally important for the compliance with the *second law* and the reality of visible Cosmos. Leonardo da Vinci defined the laws of friction two centuries before Newton formulated the second law. The "fundamental" equations of physics have nothing to account for friction and this is why they contradict the *second law*. Probably Leonardo da Vinci and Newton did not think about the *second law* in modern terminology but they understood the basic laws of friction.

The three conservation laws for the three momentum component and one conservation law for energy are correct always in all inertial reference frames. However the expressions for the momentum and energy are not independent of the choice of inertial system and hence not invariant under the Lorentz transformations. To find the invariant quantity it is necessary to construct the 4vector of momentum energy so that its length is invariant and does not depend on the choice of inertial reference frame. The 4-vector of momentum/energy is $P_i\{\mathbf{P}, ic\cdot P_4\}$ where $ic\cdot P_4$ is the fourth component of the momentum that stands for the object energy.

If the momentum/energy 4vector is relativisticaly invariant it means that is length is invariant in all inertial reference frames. This is very similar to the space interval and 3D trajectory that are not Lorenz invariant. Instead the two must be Lorentz invariant interval and trajectory in 4D Minkowsky space.

The specific expression for the relativisticaly invariant momentum/energy interval, i.e., the squared length of 4-vector momentum/energy is:

$$\mathbf{P^2 + (ic)^2 P_4^2 / c^2 = P^2 + (ic)^2 E^2 / c^2 = - (M\cdot c^2)^2 = invar} \qquad (9.13)$$

This is a very extraordinary relation rewritten in a way that makes it look as the invariant interval expression in Minkowsky space/time. The momentum/energy interval is exactly the same, as the interval in 4D Minkowsky space/time dimensions but in the conjugate 4D Minkowsky geometry of the momentum/energy space. Since the momentum energy 4vector is a function of space/time this can be seen as if the momentum/energy Minkowsky domain is mapped unto the Minkowsky space/time domain and the other way around. In other words the domains are conjugate. This is the conjugation that in quantum mechanics may lead, but had not originally, to the relativistic Heisenberg uncertainty principle for the momentum/energy versus position/time, or similarly to the non-commuting operators of momentum energy and space/time.

But not to be swept away by the line of reasoning the above expression is extraordinary in another respect. Indeed, if the relativistic momentum $\mathbf{P} = (M\cdot\gamma)\mathbf{v} = M\,((1-\mathbf{v}^2/c^2))^{-1/2}\mathbf{v} = 0$, , i.e., the object is at rest with the observer we obtain:

$$\mathbf{E_{rest} = M_{rest}\, c^2} \qquad (9.14)$$

This is perhaps the most famous Einstein formula that says that when any matter in visible Cosmos is at rest it still has the rest energy uniquely connected with the rest mass of this matter. Some interpret it as the potential energy of bound matter and formally it is correct. Matter contains coherent energy that bounds it together and this energy in principle can be released and in fact will be released at the end of times. Certain part of the rest mass is released as energy in the radioactive decay, but also can be converted into other matter in nuclear fission and thermonuclear fusion reactions on Earth artificially and on stars naturally.

The total mass/energy of matter is:

$$\mathbf{M_{total} = M_{rest} / (1-v^2 /c^2)^{1/2}} \quad (9.15)$$

The total mass is not invariant, From this formula of a genius it is seen that any type of matter that has nonzero rest mass $\mathbf{M_{rest}>0}$ cannot reach the speed of light since at this speed the total energy becomes infinite $\mathbf{M_{total}} = \infty$ that does not have sense in the sane visible Cosmos.

On the other hand light has the speed of light and in order not to have infinite energy we must conclude that light has exactly zero rest mass. At the same time we obtain the following relation between the light momentum and light energy that is valid for any mater that moves with the speed of light: Indeed, in this case the finite momentum and energy relate to each other as follows:

$$\mathbf{E= P\cdot c} \quad (9.16)$$

To reiterate the fundamental *rest energy and rest mass of matter*s the invariant intrinsic property of matter. If matter moves with the speed of light c this would be light itself, i.e., quantum mechanical photons, or virtual bosons like gluons, or some neutrinos with zero rest mass.

Not less important than the formula for the rest mass (9.14) is another Einstein formula obtained for the relativistic energy from(9.13). It is:

$$\mathbf{E} = \pm\sqrt{\mathbf{P^2} + (\mathbf{M}\cdot\mathbf{c^2})^2} \quad (9.17)$$

The expression (9.17) is the truly amazing one. The relativistic energy is not positively defined. For each positive value of energy of any object there is a negative alter ego with the same but negative energy value. If an object in our visible Cosmos increases its energy by some value the alter ego in the anti-visible Cosmos decrease its energy by the same value. This was realized by Paul Dirac who introduced the concept of antiparticles. Later it became the basic concept of quantum vacuum in quantum electrodynamics and generally in quantum field theories. The quantum vacuum of negative energies is present at each 4D space/time point of visible Cosmos.

It also easy to note that if entropy in visible Cosmos is increasing it means the declining entropy of the quantum vacuum and *vice versa*. It is asserted that the basic compliance with the RLS imposes the asymmetry of matter Vis a Vis antimatter in visible Cosmos. The time reversible Hamiltonian equations of physics violating the second law and RSL cannot pick up this phenomenon. It is asserted that this is the compliance with the *second law* imposes the asymmetry of matter *vis a vis* antimatter in visible Cosmos. The time reversible equations of physics by not paying respect to the *second law* cannot pick up this phenomenon unless postulating a spontaneous break of symmetry.

Any object can emerge in our visible Cosmos from the invisible Cosmos of negative energies, but only for a short time. This is the concept of quantum vacuum fluctuations. The rest mass/energy of such virtual objects and their lifespan are connected to each other by the Heisenberg uncertainty principle of quantum mechanics. That such should exist is absolutely clear from the energy conservation, the *first law* of thermodynamics.

All the above beautiful landscape of ESR breaks when we start considering the non-inertial reference frames, such that the object of observation moves with acceleration relative to the reference frame at rest with observer, or the other way around alike. It is noted in advance that the beautiful landscape of ESR is substituted by even much more beautiful one of the Einstein general relativity, or Einstein gravitation equations, the EGE.

Force acting on a mass of Newtonian mechanics, and ESR is vague concept. The force is easy to understand semantically, although if to think about it is not easy to explain what force is. The Newton 2nd law connects enigmatic force exerted on matter with even more mysterious mass of matter multiplied by matter acceleration. The acceleration is a very clear quantity and is easily measured. As for the mass it remained a mysterious quantity. In practice since the time of Johannes Kepler the astronomers implicitly, but lacking understanding, equalized weight measured on scales versus another weight chosen as standard as had been done for thousands of years.

It is only Albert Einstein formulated one of the basic principles of the EGE that weight has no meaning by itself. It is just the measure of the rest mass of matter.

The EGE postulate that matter defined by its macroscopic properties organizes the geometry of 4D space/time for itself in a way that is most suitable for residing in. It is like we design and build a house most comfortable for our life style. If we as builders are successful our residence and we in it become attached to each other as one entity. However if and when we change the dwelling we remain only slightly, if at all affected by this change. We can say that we are invariant under the transformations caused by changes of residence locations. The general relativity likewise postulates that the laws governing the dynamics and lifeline of matter are covariant under transformation of geometry into which it is embedded.

The energy, momentum, stress and tension are all unified in general relativity into the symmetric momentum energy tensor $\mathbf{T_{ik}}\{\mathbf{r}(x,y,z),i\}$ with indices **i,k** each taking values **i,k =1,2,3,4** corresponding to 3D **x,y,z** space plus 1D **t**- time. This tensor is the generalization of the 4-vector momentum/energy vector in Minkowsky space.

The $\mathbf{T_{ik}}\{\mathbf{r}(x,y,z),t\}$ tensor fully defines the macroscopic properties of matter embedded into the geometric structure of 4D Riemannian space/time defined by the Ricci curvature tensor $\mathbf{R_{ik}}[\mathbf{r}(x,y,z),it]$ and the metric tensor $\mathbf{g_{ik}}[\mathbf{r}(x,y,z),it]= \mathbf{g_{ik}}\{R_{ik}[\mathbf{r}(x,y,z),it]\}$.

The metric tensor $\mathbf{g_{ik}}(\mathbf{r},it)$ defines interval, the square of length for the 4 D Riemannian continuous manifolds:

$$\mathbf{ds^2_{Riemann}} = \mathbf{dx^i dx^k} \tag{9.18}$$

In (9.18) the time coordinate is the same as in the ESR $\mathbf{x_{i=4}} = \boldsymbol{ict}$. The interval (9.18) generalizes the Minkowsky 4D space/time interval for the general 4D Riemann space/time. While The Minkowsky space/time interval remains invariant under the Lorentz group transformations the Riemannian interval stays invariant under the group of all non-inertial reference frames transformations of Poincare group, i.e., transformations from an arbitrary accelerating reference frame to any other accelerating reference frame.

Since acceleration generally can be always interpreted and is in fact the curvature of 4D space/time and this curvature is defined by the Ricci curvature tensor $\mathbf{R_{ik}}[\mathbf{r}(x,y,z),it]$the elements of the group of non-inertial transformations are all tensor transformations of the metric tensor $\mathbf{Tr}^{ik}_{lm}(\mathbf{r},it)$ such that conserve the Riemann square interval:

$$\mathbf{ds^2_{Riemann}}= \mathbf{g_{ik}dx_i dx_k} = \mathbf{Tr^{ik}_{lm}}(\mathbf{r},it)\mathbf{g}_{ik}(\mathbf{r},it)dx_l dx_m = \mathbf{invar.} \tag{9.19}$$

However, if acceleration is just the 4D space/time curvature it means that the Newtonian gravitation forces are "fictitious" as they are sometimes called. They are just the way of expressing the action of the 4D space/time curvature on matter that created this cuΛrvature. The curvature of 4D space/time is defined in the most general manner possible in Riemann geometry by the Ricci tensor $\mathbf{R_{ik}}[\mathbf{r}(x,y,z),it]$ and we repeat is caused by the matter that is embedded in it. Mater is defined by the most general possible energy, momentum and stress/tension tensor $\mathbf{T_{ik}}\{\mathbf{r}(x,y,z),ict\}$. Therefore the two must be equalized. This is exactly what Einstein did by equalizing the two in the most general mathematically possible way as follows:

$$\mathbf{R_{ik}} - (1/2)\,\mathbf{g_{ik}R} = (8\pi G/c^{4}\mathbf{T_{ik}}) - \boldsymbol{\Lambda}\mathbf{g_{ik}} \tag{9.20}$$

where **R** is the scalar Ricci curvature that is the trace of the Ricci tensor $\mathbf{R=R_{ii}}$ and $\mathbf{R_{ik}}$ is uniquely connected with the metric tensor $\mathbf{g_{ik}}$, **Λ**is the Einstein cosmological constant. Therefore (9.20) is a closed equation for $\mathbf{g_{ik}}$, provided that the properties of matter are known via the tensor $\mathbf{T_{ik}}$. The EGE above satisfies, naturally the complementarity principle. For small velocities and curvature the EGE becomes the Newton law of gravitation, while by virtue of the mathematical identity of the Riemann geometry:

$$\partial^i(\mathbf{R_{ik}} - (1/2)\,\mathbf{g_{ik}R} + \boldsymbol{\Lambda}\mathbf{g_{ik}} = \mathbf{0} \tag{9.21}$$

We recover the matter dynamical equations for the macroscopic matter covariant under the Poincare group of transformations:

$$\partial^i \boldsymbol{T_{ik}}=0 \tag{9.22}$$

where ∂^i is the contravariant space/time derivative taken along the 4D curvature of 4D space/time.

Consider the expression:

$$\mathbf{R}_{ik} - (1/2)\,\mathbf{g}_{ik}\mathbf{R} + \Lambda\mathbf{g}_{ik} \qquad (9.23)$$

The expression (9.23) is called the Einstein tensor. It also can be seen as the momentum/energy tensor of the 4D space/time, if such existed. Therefore the EGE seems to be just equating of the two momentum/energy tensors. This is not correct. The fine point is that the (9.23) is not a proper tensor, but the pseudo-tensor with mathematical properties not identical with that of the proper tensors. The 4D space time does not have the proper momentum/energy tensor as matter does. The profound reason for this is only explained by the *second law*, as strange the connection may seem. The truth of the matter is that the gravitational degrees of freedom are chaotic, while visible matter is coherent. Visible matter creates curvature of the 4D space/time by disposing accumulating chaos and hence holding its coherence. In other words and fairly amazingly the curvature of 4D space/time is just waste for coherent matter trying to stay coherent, although at the same time the coherent matter uses, reprocesses this waste to stay coherent. This is done by the illusory, fictitious gravitational force holding matter together, although in reality it is just acceleration different for different space/time points within the compact body. If the curvature of this acceleration is very big it may tear apart the compact body. In other words while on one hand the curvature of 4D space/time holds the body coherent when this curvature tends to infinity it tears the body apart into indivisible constituent elements. This happens when the body self-compresses into the black hole. However when it happens it is only the dominant part of the indivisible constituent elements of the body becomes chaotic. Another part of these constituent elements form the coherent linear, string like component of the black hole. The chaotic and coherent components of the black hole are in precise ratio that we will establish below. This is a remarkable distinction between the tensor of coherent matter and pseudo-tensor of chaotic curvature of the 4D space/time. However it takes quantum mechanics to fully appreciate the significance of this distinction.

In the case of no visible matter in the space time $\mathbf{T}_{ik} = \mathbf{0}$ but $\Lambda > \mathbf{0}$, the EGE, or the reduced Friedman equations are easily solved and the metric tensor $\mathbf{g}_{ik}$ is determined. This is the puzzling de Sitter space/time. By means of a specific covariant transformation that leaves the Riemann interval conserved the time variable can be transformed out from the de Sitter metrics $\mathbf{g}_{ik}$ completely. However, the transformation itself is singular in the sense that it contains the event horizon. The de Sitter space can be considered as exponentially expanding with acceleration determined by the cosmological constant $\Lambda > 0$, but also timeless. The expansion is purely mathematical and illusory from the observational viewpoint. It cannot be otherwise since there is no fermion visible matter in the de Sitter Cosmos and subsequently no observers and no processes to observe. The de Sitter Cosmos is the state of global perfect order, the GPO of Kosmos. The same assertion can be approached slightly differently. Since $\mathbf{T}_{ik} = \mathbf{0}$ then there is also no dark matter and the only matter that remains is the dark energy cosmological constant in the de Sitter Cosmos. Moreover the curvature of the space/time is as illusionary as the space expansion in the de Sitter Cosmos.

Black hole is the most enigmatic object in visible Cosmos. Black holes are surrounded by the trapping surfaces as they were called by Roger Penrose in his ground breaking analysis of EGE published in Physical Review Letters back in 1964. In this wok Penrose showed that under very general conditions imposing no unwarranted limitations on $\mathbf{T}_{ik}$ the EGE must have at least one incurable black hole type singularity in the global 4D space/time. It proves that the EGE are not perfect. It is generally believed that this imperfectness can be cured only by the quantum mechanics. Apparently there are many such incurable singularities in 4D space/time since there are many black holes in visible Cosmos.

The trapping surfaces are not the singularities in 4D space/time but their manifestation. They are located at a certain well defined distance from the core of black holes. This distance is determined by the mass of a black hole $\mathbf{M}_{\mathbf{BH}}$ the Newton gravitational constant **G** and the speed of light **c**. Based on the classical EGE there is nothing else that can enter into the definition of this distance. Therefore for the simplest spherical geometry the distance from the core of black holes to the trapping surfaces are the spheres with the radius that can be easily found from dimensional considerations:

$$\mathbf{R_{BH} \propto GM / c^2} \tag{9.24}$$

The exact calculations with the EGE for a spherically symmetric mass source give the numerical factor ½in front of the r.h.s. of (9.24). This is the famous Schwarzschild radius of the historically first exact solution of the EGE for a point mass in empty space. It was obtained by Carl Schwarzschild in 1915 in the trenches of WW1one year before his death.

Calculating the potential gravitational energy of a spherical mass with the above radius using the Newtonian mechanics we obtain:

$$\mathbf{U_{pot} = -G \cdot M_{MB}^2 \cdot R_{BH}^{-1} = -G \cdot M_{MB}^2 \cdot (GM/c^2)^{-1} = M_{BH} \cdot c^2} \tag{9.25}$$

The negative potential energy of gravitational attraction is exactly equal to the positive rest energy of the black hole. To escape from the black star it is necessary to have the speed of light which matter except photons cannot acquire since their energy would be infinite. But light that touches the trapping surface also cannot escape since it just becomes the part of increased rest energy of the black hole. More precise treatment shows that for the outside observer at infinity the time for matter to reach the trapping surface tends to infinity. This is easy to understand from the view of ESR. Indeed since the matter to escape from the trapping surface needs to have the speed of light it means that the falling matter approaching the trapping surface is also approaching the speed of light. But then the time for the external observer stretches as in (9.2). It is easy to understand that the time stretches as:

$$\mathbf{t_{trap}^{external} = t_{proper}^{external} [1 - (\Delta - d_{trap} / d_{trap})]^{-1/2}} \cdot \frac{dy}{dx} \tag{9.26}$$

When the distance between light and the trapping surface tends to zero $(\mathbf{\Delta - d_{trap}}) \rightarrow \mathbf{0}$ the time (9.26) tends to infinity as it does in (9.2) of ESR when the speed of matter tends to the speed of light. For an observer outside and far enough from the trapping surface light freezes in vain attempt to reach the trapping surface of the black hole.

This is why the only way to observe a black hole and MBH is by the light of accreting matter captured by their gravitational pull and burning in the ever accelerating approach to the trapping surface.

In the framework of EGE the curvature of space/time becomes infinite at the trapping surface and anything that touches it naturally cannot get out. This picture of the world is radically altered when the basic principles of quantum mechanics are taken into consideration.

We make the following comment. If the values of (5.1) and (5.2) are seen as the smallest space and time scale, i.e., we assume that the 4D space/time of visible word is quantum then we receive for the invariant interval in Minkowsky space/time:

$$\mathrm{d}\mathbf{S}_{1\leftrightarrow 2}^2 \geq 2l_p^2 \tag{9.27}$$

Substituting the Planck mass (5.3) into (9.13) and forming the product:

$$\mathrm{d}\mathbf{S}_p^{\,2} \cdot \mathbf{P}^2 = \hbar \tag{9.28}$$

This is the Heisenberg uncertainty principle for the Planck particles and is natural.

Chapter 10

QUANTUM MECHANICAL WORLD VIEW

In quantum mechanics the photon energy is $\mathbf{E_{photon}} = \hbar \cdot \boldsymbol{\Omega}$ where $\boldsymbol{\Omega}$ the frequency of photons, the boson particles of which light and the electromagnetic radiation of all frequencies consists of. Any matter with zero rest mass is necessarily the ultimately quantum mechanical and hence subject to quantum duality. Individual photons behave both as waves; they interfere for instance, each photon with itself, and as particles since the number of photons, the occupation number of photons with certain momentum, or energy is an integer, the eigenvalues of the Hamiltonian operator made of photons annihilation/creation operators.

Moreover photons are bosons. In accordance with the Pauli principle, one of the most profound in quantum mechanics, the integer spin value bosons attract each other in the momentum/energy space, while the half integer spin fermions on the contrary repulse each other in the momentum space. In accordance with the Pauli principle only one fermion can occupy each energy/momentum level On the contrary theoretically it is possible to collect an arbitrary large number of photons at the state of zero momentum. This phenomenon is called Bose/Einstein condensation of photons. It is prominent in the astronomical observations of microwave relic radiation, the basic tool for studying the early Cosmos (Sunyaev, R A.and Khatri R.,2013).

The frequency of Bose/Einstein condensed photons is zero and the corresponding wavelength is infinite. The *photonic Bose/Einstein condensate* is ultimately coherent and is present at every space point not only in visible and observable Cosmos, but beyond. Since there is no reference frame and associated time for photons as was discussed above it means that *the photonic Bose/Einstein condensate* is present also in all the past and all the future of visible Cosmos and beyond all the way back to their progenitor the Big Bang and all the way forward in time to the end of visible Cosmos. Another nontrivial property of photonic Bose/Einstein condensate is that in their wave manifestation they are fully defined by a single, common phase. This is the ultimate coherence. It should be noted that a quantum mechanical operator associated with classical phase does not exists. This signifies that phase is not the subject to the uncertainty principle, although not formally and likely incorrectly it is sometimes invoked in conjunction with the occupation number operator.

However, the fine point is that it is assumed that the lowest energy/momentum level is zero value. In the Big Bang scenario promoted in this work the visible Cosmos birth the lowest possible momentum/energy state had been the Planck domain momentum/energy level. Due to the intrinsic compliance with the uncertainty principle there is only one frequency corresponding to the Planck momentum/energy domain:

$$\boldsymbol{\Omega^{BC}_{photons} = \Omega_p = t_p/3 = 10^{43}\, sec^{-1}} \tag{10.1}$$

Therefore the radiation of the primordial Planck mass particle domain is the perfectly coherent photonic Bose-Einstein condensate. At the end of lifespan of visible Cosmos at $\mathbf{t_c=3\cdot 10^{38}}sec$ all the remaining photons of relic radiation will be again totally coherent with the frequency:

$$\boldsymbol{\Omega^{BC}_{C} = \Omega_p \cdot R_p^{-2} = 10^{-39} sec^{-1}} \tag{10.2}$$

How this can be possible if the relic radiation that we observe now is the equilibrium Planck radiation having all frequencies? In reality the relic radiation that we observe does not come directly from the Big Bang. It comes from the rather adult Cosmos of about $300.000 = 3\cdot 10^5$ years old. Prior to this the initially entirely coherent radiation would thermalize as the result of induced and spontaneous Compton scattering primarily on electrons/positron pairs and Bremsstrahlung. The traces of Einstein-Bose condensation are observed in the relic radiation and are believed to be one of the two inevitable deviations of the MBC radiation spectrum from the isotropic equilibrium Planck spectrum

(Sunyaev R. and Khatri R., 2013). Most likely these are the traces of induced Compton scattering of equilibrium MBC radiation of the much later epochs[1].

Waves are emitted from the same primordial coherent source of radiation, the totally coherent 4D Planck domain. As particles photons are fully defined by the number of photons called the occupation number in the momentum/energy state. Hence the photonic Bose condensate in both waves and corpuscles manifestations are ultimately correlated in the whole of 4D space/time of primordial visible Cosmos and during the whole visible Cosmos lifespan. Moreover they are as coherent outside the visible and observable Cosmos and are the attribute of Kosmos. This is the reason why the reference frame associated with photons does not exist. If such would exist the whole visible and observable Cosmos in the view of photons would have been compactified into one 4D Planck domain.

There is nothing overly strange about it since photons in the state of Bose/Einstein condensate are ultimately quantum entangled. On the other hand photons are ultimately relativistic in their attitude to space/time. In the state of Bose/Einstein condensation at the zero momentum/energy level photons can be absolutely equivalently described quantum mechanically and classically. The result will be always independent of the quantum mechanical Planck constant. Although the Planck constant would appear in all intermediate calculations it necessarily cancels out in the final meaningful results. This is an important property of photonic Bose condensate and all other bosons with large occupation numbers.

The implication is that the primordial state of visible Cosmos can be perfectly well described by the classical EGE. However in this case the initial energy density at the Big Bang is infinite. Or it is equally possible to consider this primordial state as the quantum mechanical Planck domain and in this case the Planck constant will identically cancel from the meaningful physical quantities. As was explained It is the well-known duality phenomena e.g., the induced Compton scattering with large value of the photon occupation number and photonic Bose-Einstein condensation. This is why the energy flux from the primordial Planck 4D domain and the associated photon radiation flux are equal and independent of the Planck constant as will be shown below. The occupation numbers are too high and the classical laws hold sway. This is why the primordial visible Cosmos is most likely the classical one. The last assertion is important. It was made by Roger Penrose (Penrose, 2010) from entirely different EGE based considerations that converge with the above conclusion.[2].

It should be noted that in the corpuscular description the photonic Bose condensate may have infinite energy or zero energy density in the 4D momentum/energy conjugate space and these states are equivalent. In the former case the photonic Bose/Einstein condensate is ultimately localized at one point of 4D space/time and in the latter is ultimately smothered over the infinite timeless continuum. However when the photonic Bose/Einstein condensate is localized at one point of 4D space/time it means that the 4D space/time is just one point. However these two states of space/time and respectively the two photonic Bose/Einstein condensates are equivalent ultimately coherent, timeless global states so that one can be obtained from the other by simultaneous rescaling of the conjugate momentum/energy and space/time manifolds.

From the complementarity principle this indicates that the EGE must have a continuous, smooth solution connecting the primordial visible Cosmos with the final instant of visible Cosmos. Such solution was found by Roger Penrose and is the basis of his extraordinary concept of the "Cycles of Time" (R. Penrose, 2010).

.As we pointed out all matter in visible Cosmos is quantum mechanical. The particles dynamics is described by the wave function. For nonrelativistic velocities the wave function is the complex scalar subject to the Schrodinger equation.

---

[1] The photon Bose condensation dynamical effect was predicted in (Y. B. Zeldovich and E. Levich, 1970). The astrophysical and cosmological value of this effect has been investigated since then in the fundamental works of Rashid Sunyaev and his school. Only recently this important phenomenon has been observed in laboratory in the extremely elegant and smart experiments carried out at Lorentz center (Schmitt J., et.al., 2010). Since then a number of experiments confirmed their conclusions.

[2] Penrose used the property of conformal invariance of the EGE in space empty of fermion matter but with **L>0**. This allows identification of the infinite energy density of visible Cosmos birth and the zero energy density of photons in the last instant of visible Cosmos and hence obtaining a smooth solution of the EGE passing through the infinite energy density of the Big Bang the infinity of times and cycles. He called these cycles the eons of time (‘*ēən* in ancient Greek).

As a complex scalar the wave function is determined by the amplitude and phase. The most accepted although eternally argued interpretation is that the information for the location of the rest mass of the particle is carried by the wave function amplitude for which the speed of propagation cannot exceed the speed of light. However, since the wave function is also endowed with a phase it means that any matter is a wave as well as a localized object. The wave function square amplitude is usually interpreted as the probability of a point particle location in space/time. The interpretation closer to the author's heart and hopefully self-conscious mind is that a particle is rather endowed with the probabilities of having particular trajectories in the Euclidean space as the function of time. The probability weights of these trajectories are defined by a certain exponential generating functional in infinitely dimensional phase space where each point can be mapped into the trajectory in the usual Euclidean space and time. This probability generating functional holding as much data about the quantum particle as is in the dynamical Schrodinger equation was introduced by Richard Feynman. It should be noted that in the relativistic sense the trajectories are an illusion. It is rather that a particle or an object occupies certain subdomain in 4D Minkowsky space/time. Likewise in EGE the object occupies a certain subdomain in 4D Riemann space/time. In addition to the ESR in EGE matter objects builds the geometry of Riemann space/time as its residence. However not the other way around; the gravitational degrees of freedom are chaotic. They are the chaotic creation, the discharge by the coherent matter struggling to remain coherent and in this sense cannot exist without gravitational chaos that matter creates for itself.[3]

If a particle is the relativistic electron then the quantum dynamical equation of motion is the Lorentz invariant Dirac equation. The wave function is now the multicomponent spinor that has also the amplitude components and the phase components. The probability functional now will be different with each subluminal trajectory in the Euclidean space and time substituted by the relativistic trajectory or more precisely the subdomain in 4D Minkowsky space/time. Similar probability generating functionals can be formulated for the description of quantum fields. The above interpretation is much closer to the physical reality of visible Cosmos and clearly delineates the mythical dynamical nature of processes that is subject to our perceptions with the clear-cut statement that an object is a subdomain within the 4D Riemann space/time.

The quantum mechanics adds to the interpretation that the subdomain is not fixed within the Riemann space/time, it is smothered all over the space/time. It is as if here is the infinite, uncountable number of the subdomains densely filling the Riemann space/time. However, each of them has different probability and therefore different contribution into the measurable physical quantities for an observer outside of and not influencing this 4D object. The latter is not possible. The 4D subdomain cannot be a closed system. This is the root of the fundamental defect of the Hamiltonian equations of physics. In the above interpretation the summation over all the subdomains in the Riemann space/time respecting their probability weight neglects the openness of the subdomain. In other words all the interactions between this subdomain and the uncountable infinity of other subdomains embedded in the 4D space/time are forgotten. Since there is the infinity of such interactions, although each of them may be vanishingly small altogether they result in the inevitable and ultimately decisive *second law.*

In the regular interpretation and for subluminal velocities the location of matter in space/time depends on its momentum vector absolute value $\sqrt{\mathbf{P^2}} = \mathbf{M_{rest}}\sqrt{\mathbf{v^2}}$**.** This is the Heisenberg uncertainty principle stating:

$$\mathbf{\Delta}\sqrt{\mathbf{P^2}} \cdot \mathbf{\Delta}\sqrt{\mathbf{r^2}} \approx \hbar \qquad (10.3)$$

In the above relation $\mathbf{\Delta}\sqrt{\mathbf{P^2}}$ is the uncertainty in the momentum amplitude and $\mathbf{\Delta}\sqrt{\mathbf{r^2}}$ is the related uncertainty in the position in 3D space. If matter is a massive object with large mass of the size **l** then clearly the uncertainty in its position is very small, that is $\mathbf{\Delta}\sqrt{\mathbf{r^2}} \ll \mathbf{1}$ and therefore the dual wave nature of matter is not important in most practical applications. Let us consider an electron having the rest mass $\mathbf{m_{el}} = \mathbf{10^{27}}g$ and moving with the speed much smaller than the speed of light, for

[3] Human creations can also be seen as chaotic degrees of freedom. But it is unique for Man to create useless for his survival creations of art, ethics, abstract science and philosophy. However all these creations are useless for our animal bodies. They are imperative for the continuous evolution of Man. This is the eternal question for Man if indeed he is made in the image of Creator, or we are just smart animals as many believe.

instance $\sqrt{\mathbf{v}}$ = **c/10**. We chose subluminal speeds because for the ultra-relativistic matter the uncertainty principle is complicated. For the subluminal velocities the kinetic part of the electron mass is relatively small and can be neglected. Then we have from the above Heisenberg uncertainty principle:

$$\mathbf{\Delta\sqrt{r^2} \approx \hbar / m_e \cdot c \approx 3 \cdot 10^{-11}}\ cm \qquad (1.1)$$

This may seem an extremely small uncertainty in the position of the electron, but the problem is that the so-called classical diameter, the "size" of the electron is:
$\mathbf{l_e \approx 10^{-13}}cm << \mathbf{\Delta\sqrt{r^2} \approx \hbar/m_e \cdot c \approx 3 \cdot 10^{-11}}\ cm$. In other words the uncertainty in the position of the electron in space is about 30 times bigger than its size! It means in practice the total uncertainty in the electron's position if we try to fix its position in space experimentally. On the other hand if we experimentally determine with high precision the electron's position we will not be able to measure its momentum with any adequate accuracy.

Similar uncertainty principle holds for the energy of matter and time uncertainties. Indeed the Heisenberg uncertainty principle states in this case:

$$\mathbf{\Delta E_{rest} \cdot \Delta T_{uncertain}} \approx \hbar \qquad (10.5)$$

The general criterion to determine when the quantum effects become dominant is comparison with the Compton length defined as:

$$\mathbf{\lambda_{compton} = \hbar / M_{rest} \cdot c} \qquad (10.6)$$

If the size of an object is such that $\mathbf{l \leq \lambda_{compton}}$ the quantum effects become important and dominant for $\mathbf{l << \lambda_{compton}}$. However, in the fundamental sense the quantum nature of matter never disappears.

The uncertainty principle has nothing to do with the measurement deficiency. It is the intrinsic property of all matter in visible Cosmos testifying to the fact that matter is fundamentally and always quantum mechanical .The latter is correct even when it is expedient that certain phenomena of boson matter, for instance described above are treated classically and the results are independent of$\hbar$. It is a very delicate point because the independence on $\hbar$ does not mean that the quantum properties of matter are not important. Rather it is that the dependence on $\hbar$ as a parameter is not analytical. If we assume heretically that $\hbar$is zero neither the phenomena in visible Cosmos nor visible Cosmos would exist. However $\hbar$is small but not exactly aero. This makes the existence of visible Cosmos and the phenomena in it possible. But when it exists and the phenomena in it exist in certain ultimately coherent phenomena with bosons the dependence on $\hbar$ cancels. There is deep reason in this cancellation that rather emphasizes the universally quantum mechanical nature of matter and we believe of 4D space/time of visible Cosmos.

The quantum mechanical nature of matter shows best of all in the phenomenon of quantum mechanical entanglement, or quantum mechanical phase coherence. One particle or macroscopic matter wave function phase is ultimately coherent and correlates with all the phases of its past and its future at all and every space point of all visible Cosmos at all past and future times. The phase of a material object is coherent in the whole 4D space/time of visible Cosmos. This is unsettling and especially so is the correlation of the contemporary material objects wave functions phases with all its phases of the future and generally speaking all the future phases of all other material objects. For macroscopic matter, such as humans this quantum mechanical phase correlation may be claimed negligible and irrelevant. This claim may calm our ego but is wrong. The quantum phase coherence of photons separated by miles from each other was experimentally confirmed a number of years ago by Austrian physicists and recently the quantum phase coherence in time has been experimentally confirmed by the Israeli physicists at Hebrew University. In the same way, although we are not made to perceive it we are phase entangled with all our past till the birth of visible Cosmos and all our future till the end of visible Cosmos.

It seems pretty obvious that the space/time of visible Cosmos must be also quantum mechanical. As the wave matter is smothered all over 4D space/time and hence is totally phase coherent so the 4D space/time should be totally phase coherent. If matter is discrete and consists of indivisible, elemental

quanta so must be the 4D space/time. It is clear that the quanta of space/time are the quanta of which all matter consists and both are the Planck length and time units. The quanta of matter cannot be smaller than the minimal space/time domain. On the other hand if matter consists of minimal finite size domains what sense may be in the continuous space/time of visible Cosmos?

Chapter 11

UNCERTAINTY PRINCIPLE AND QUANTUM VACUUM

The greatest significance of uncertainty principle is in conjunction with the concept of vacuum states with negative energy. This was introduced by Paul Dirac. The idea is like this. The total energy of relativistic particle follows from the above Einstein Lorentz invariant formula (9.13) that we reiterate here:

$$\mathbf{E} = \pm\sqrt{\mathbf{P^2} + (\mathbf{Mc^2})^2} \tag{11.1}$$

Much follows from this extraordinary Einstein formula amplified by the genius of Paul Dirac. Indeed we see that energy of a particle is not necessarily a positively defined quantity. For each positive energy value electron, there exists the antiparticle with negative energy that in the case of electron is called positron. Equally there are antiprotons, antiquarks, etc. This is the infinite, timeless quantum vacuum of negative energy particles and matter in general that coexists and permeates all and every 4D point of discrete 4D space/time of visible Cosmos. However there is a fundamental asymmetry between visible Cosmos with visible matter and "anti- Cosmos" filled with antiparticles that is not in the scope of the contemporary time eversible physics equations.

In the meantime what happens with the energy conservation, the *first law* when matter possessing rest energy mass is born from the quantum vacuum? There is no problem with the *first law. The first law* is unimpeachable and preserved due to the above described quantum mechanical uncertainty principle. Indeed, if a particle appears from the quantum vacuum for a very short time and returns back into vacuum before it could be casually observed, caught and captured by a piece of equipment this particle is *virtual.* The relation between the energy of such born from the quantum vacuum virtual matter and the lifespan of this virtual matter before the return back into the quantum vacuum is the above relation:

$$\mathbf{\Delta E_{rest} \cdot \Delta T_{life} \approx \hbar} \tag{11.2}$$

For instance if one electron with the rest mass $\mathbf{m_{el} = 10^{27}}g$ and the rest energy $\mathbf{\Delta E_{el} = m_{el} \cdot c^2 \approx 10^{-27}}g \cdot \mathbf{10^{21}}cm^2 \cdot sec^2 = \mathbf{10^6}erg$ appears from the quantum vacuum in visible Cosmos its lifespan before returning back to the quantum vacuum is $\mathbf{\Delta T_{life} \approx 10^{-21}}sec$.

The appearance of a lone electron even for such a short time does not happen. There is a law of electrical charge conservation and with overwhelming probability a positron would also appear and they annihilate each other into photons that would return to vacuum. However it is possible to indirectly observe the birth of matter from the quantum vacuum in the so-called Casimir effect. Indeed, the quantum vacuum gives birth to virtual matter and the pressure of this matter was successfully measured and the experiments are developing. This Casimir effect is extremely beautiful and the author should have been greatly rewarded. The beauty is that a virtual photon with a certain wavelength is physically not allowed to return back into the quantum vacuum. It is arranged in such a way that virtual photons are born between the two extremely fast oscillating plates. The virtual photons are born, but cannot escape back because the frequency of oscillations is more than the frequency of virtual photons. Therefore the photons with frequencies lower than the frequency of oscillations are trapped between the plates. They want to go back and cannot. This creates pressure on the plates.

In similarity with the Casimir effect the Planck mass particles pop out from the quantum vacuum and get trapped in protons and electrons. However this is a complicated catch not easy to catch if a *calambur* is allowed.

Let us go back to the Neolithic times and assume that **N** Neanderthals, the free citizens, or **N** independent degrees of freedom, or harmonics in the momentum space are born at the same time from the quantum vacuum and so unlucky that the uncertainty principle (10.3) places them in the hands of a terrible Cro-Magnon autocrat. As soon as they are born he puts them in chains with a heavy lock. This is what happens in the Casimir effect experiment when the virtual photons are caught between the oscillating plates

In order to go back into the quantum vacuum as is prescribed by the *first law* the chains of autocracy must be broken. In the quantitative terms a force doing the work equal to the rest energy imposed by the negative potential energy of chains must be done on the chains. This latter is equal the minus of the rest mass corresponding to the potential bonding energy of the chains. When this work is done on the chains the potential bonding energy is released with a pop and the chains are broken. To cut it short the work done should be as follows:

$$\mathbf{A} = \mathbf{M_{chains}c^2} = -\mathbf{U^{pot}_{chaims}} \tag{11.3}$$

Dependent on the applied force to break the chains it can take a lot of time to reach the value of work (11.3) needed to return the Neanderthals back home into the quantum vacuum unchained. In fact this time can be even as large as the life time of visible Cosmos despite the seeming violation of the *first law*. What it shows is that it is not enough to return energy back into the vacuum. It is also necessary to return order of locked up in the chained, enslaved **N** degrees of freedom. The lifespan of order should be calculated paying respect to the *second law and RSL***.** Could it be that the uncertainty principle is wrong? Of course it is correct since it acts in conjunction with the conservation of energy *first law* of thermodynamics. The point is that the uncertainty principle is derived from the time reversible equations of quantum mechanics that do not respect the *second law,* although they respect the first law. Subsequently the uncertainty principle should be empirically modified in certain harshly nonequilibrium situations like the one with the chained Neanderthals above in such a way that it does respect the *second law and RSL* as well as the *first law.*

The gist of the reasoning is that in principle the time span of such dominance of the *second law* over the *first law* can be as long as the lifespan of visible Cosmos. Matter that is absolutely stable and has such lifespan can be seen as perfectly coherent virtual matter born from the quantum vacuum. All visible Cosmos can be seen like this**.** This is provided that the quantum vacuum is the infinite timeless continuum.

The quantum vacuum fluctuations should be treated in the context of nonequilibrium phenomena as the flux of coherent energy from the dark energy continuum and incoherent energy flux from visible Cosmos into the dark energy continuum. The Neanderthals will return back as free citizens with chains off. The work done by the forces of quantum vacuum "Homeland Security" is exactly that is needed to unchain them. However it can take as much time as the lifespan of visible Cosmos.

The next comment we would like t make concerns the property of the discrete 4D space/time with the minimal space/time scales defined as the Planck length and Planck time. We saw above that this leads to the minimal possible Lorentz invariant interval value determined by (9.27). Together with the uncertainty principle for the Planck particles (9.28) this means that the maximum mass that can be born from the quantum vacuum is the Planck particle! It strongly indicates that the composite proton and elemental electron in reality are the coherent strings of locked up Planck particles as we have suggested for the black holes and will further quantify below.

It is also noted that the interval in discrete Minkowsky space/time given by the square root of (9.27) is not positively defined any more similarly to the momentum/ energy interval (9.13) and the time itself is not positively defined any more similarly to the energy (11.1). This is strange observation as if there was the quantum vacuum in space/time in symmetry with the conjugate quantum momentum/energy vacuum. However if indeed the 4D space/time is quantum this would allow formulation of discrete relativistic/quantum mechanical dynamical equations. It should be noted that in computer simulations of turbulent flows we formulate the discretized NSE on a grid with minimal possible steps in space/time that are determined by the dissipation scale and the dimensionless parameter Reynolds number that we will introduce in the section 15 below. The gist of this reasoning is that the number of degrees of freedom in physical space/time should be the same as that in the conjugate momentum/energy space. This is the requirement of the *second law and RLS.* The Hamiltonian equations of physics do not respect these laws and in this sense are inadequate. As soon as these laws are incorporated in the dynamical equations the quantum nature of 4D space/time will become natural and inevitable.

Now we can discuss again the singularity of black holes. The quantum mechanics brings changes. The uncertainty principle states in this case that since any matter is also a wave its position in

space/time is fundamentally smothered by its wave structure. In particular a photon can be simultaneously behind the trapping surface and at a distance in front of it. It is just that there are different probabilities for a photon to be slightly behind the trapping surface and slightly in front of it. But in this case there is nonzero probability that the photon outside escapes crossing the trapping surface.

Even further a photon that is inside, but close to the trapping surface near has a finite probability to be outside the trapping surface anywhere and has a sportive chance to escape its clutches. This is a very profound intervention of quantum mechanics into the classical EGE. In accordance with the EGE the inside of the trapping surfaces is forever separated from the outside visible Cosmos. Quantum mechanics changes all this. The black holes start to communicate with the outside visible Cosmos apart from gravitational pull and become visible.

But if there is a nonzero probability for photons to escape the black holes it means for an outside observer that they emit photons, i.e. electromagnetic radiation. And what would the frequency spectrum of this radiation? Most certainly this should be the equilibrium black body radiation, because if it is not there should be a good reason for this and this reason would lead to the flux of coherent energy from the outside into the black holes. But we know that the only matter that flows into the black holes is the weak stars completely burning in incredible acceleration while falling onto the trapping surface. When they burn they emit out hard photons radiation. But what reaches the trapping surfaces is ultimately decomposed chaotic matter. It may seem strange for some but as we have pointed out above the ultimately chaotic matter is the state of equilibrium of the 1st kind. This state of photons or radiation is described by the equilibrium Planck distribution with thermodynamic temperature. Since the temperature of burning stars is very high it implies that the Planck distribution of radiation reaching and crossing the black holes is also very high. More correctly is to say that the black holes have nonzero temperature since if it was zero they would have not been able to radiate outside into the space that has nonzero temperature.

From the relation between the statistical energy and entropy above Bekenstein understood that in order for entropy of the black holes not to be infinite

$$\mathbf{S} = < \mathbf{E_{statistical}} > \mathbf{T_{BH}^{-1}} \neq \infty \tag{11.4}$$

It must be that:

$$\mathbf{T_{BH}} > \mathbf{0} \tag{11.5}$$

Thermodynamically it means that the black holes are also the black bodies in detailed equilibrium with the outside space/time radiating photons at very low temperatures. However the external to them 4D space/time temperature should be naturally lower than that of the black holes for thermodynamics to work appropriately. This was the outstanding conclusion of Jacob Bekenstein that led to the Bekenstein-Hawking semi-quantum mechanical theory of black holes equilibrium Planck radiation.

Here comes the twist that was noted above and is useful to discuss again. Although the black holes are the collectors of chaos and subsequently should be full of waste they also have a coherent engine in them, like the vacuum cleaners do. In other words the black holes are not all chaos. Part of the matter of black holes must be coherent, organized structure.

On the other hand since the black holes continue to attract matter from outside its mass only grows. So does its trapping surface area. The trapping surface area of black holes can only increase. This is qualitatively the *second law of the black holes*. Entropy must be proportional to the area of the trapping surface: $\mathbf{A_{BH}} = \mathbf{4\pi R_{BH}^2}$ which is actually the event horizon for the external observer and for the whole 4D space/time of visible Cosmos outside the trapping surface. This is clear because beyond the trapping surface the space/time is not observable from outside. Hence the radiation from the black hole can be emitted only from the trapping surface. Also it should be proportional by definition to the Boltzmann constant $\mathbf{k_B}$ But since entropy has the dimension of $\mathbf{k_B}$it is necessary to divide $\mathbf{A_{BH}} = \mathbf{4\pi R_{BH}^2}$ by a factor having the same dimension of cm^2 Since the radiation of black holes is a purely quantum mechanical effect it should be dependent on the Planck quantum mechanical constant ħThere is only one such quantity dependent on ħand other fundamental constants entering EGE, i.e.,

the gravitational constant **G** and speed of light **c** that can have the dimension of a surface area This is the square of the Planck length defined by (5.1). Thus we obtain:

$$\mathbf{S_{BH} \propto k_B \cdot A_{BH} \cdot l_p^{-2} = C_{BH} \cdot 4\pi R_{BH}^2 \cdot l_p^{-2}} \quad (11.6)$$

The constant factor $\mathbf{C_{BH}}$ should be determined by precise calculations. This was done by Stephen Hawking (1975) with the final result:

$$\mathbf{S_{BH} = k_B \cdot \pi R_{BH}^2 \cdot l_p^{-2}} \quad (11.7)$$

This is a fairly remarkable expression and what it indicates, although we have not found it stated except in (Levich E. 2013) that the constituent indivisible, elemental units of black holes are the Planck particles with the Planck mass (5.3).

If this is the case then we can calculate the coherent component of the black hole mass. It is quite clearly, assuming on one hand the spherical symmetry of the black hole while accepting the linear scale dependence for the coherent component mass on the other:

$$\mathbf{M_{BH} = (1/3)m_p \cdot R_{BH} \cdot l_p^{-1} = (1/3)R_{BH} \cdot c^2 \cdot G^{-1}} \quad (11.8)$$

With the accuracy of the $3/2$ constant factor the relation (11.8) coincides with the black hole mass calculated from the classical EGE. We note that the Planck constant dependence cancels out in (11.8) as it should. The black hole mass as the function of its radius is a coherent attribute and should not depend on ħ. However the entropy (11.7) as the measure of chaos explicitly depends on ħ also as it should.

Recalling the property of Bose-Einstein condensation discussed above in the Chapter 10 we recognize that there is deep difference between ultimately coherent phenomena on one hand and chaotic on the other. All purely coherent states are subject to explicit independence of the quantum Planck constant and in principle therefore can be treated in the framework of classical physics. This fundamentally applies to the Big Bang on one hand and the end of lifespan of visible Cosmos on the other. However, as soon as we consider chaos ejected from the coherent state it is the quantum phenomenon. This should not create illusion that the ultimately coherent phenomena would have existed if not for the quantum mechanical principle. What it does mean is a certain non-analyticity with regard to ħ. If we assume that the world is classical and this constant is zero it is not at all the same as ħ tending to zero or small as it is in reality.

The above clearly indicates that the black hole is a string. The black hole string may be arbitrarily twisted to acquire resemblance with spherically symmetric, isotropic object of classical EGE. However the quantum mechanics demands that the coherent component of the black hole is fundamentally a classical string. Furthermore the black hole string although may be twisted and knotted must be a closed string. This property will be further illuminated in what follows. The trapping surface of the black hole is the light event horizon in the sense that it is the last observable by matter accretion from the outside domain of the 4D space/time. The similar event horizon from inside the visible Cosmos has similar properties as the black hole horizon. In particular as suggested in (Susskind L, 1995) the maximal entropy of observable Cosmos, of visible matter together with the associated dark matter and dark energy within the event horizon is given by the same Bekenstein-Hawking relation (11.7):

$$\mathbf{S_{event}^{horison} = \pi (R_{event}^{horozon})^2 l_p^{-2}} \quad (11.9)$$

We attach much more significance to the coherent, visible matter component within the event horizon since we are after order rather than chaos. Importantly in the cosmological context the coherent visible component of matter is directly observable and is in fact observed in contrast to the chaotic one. By analogy with (11.8) it follows with confidence that the coherent, visible matter mass inside the event horizon is as follows:

$$\mathbf{M}^{\mathbf{Coherent}}_{\mathbf{eventhorizon}} = \mathbf{3}^{-\mathbf{1}}\mathbf{m_p} \cdot \mathbf{R}^{\mathbf{horozon}}_{\mathbf{event}} \cdot \boldsymbol{l}_{\boldsymbol{p}}^{-\mathbf{1}} \quad (11.10)$$

In (11.10)we substituted the black hole trapping surface event horizon by the visible Cosmos event horizon:

$$\mathbf{R}^{\mathbf{horozon}}_{\mathbf{event}} = \mathbf{c} \cdot \mathbf{T}^{\mathbf{horozon}}_{\mathbf{event}} \quad (11.11)$$

In (11.11) $\mathbf{T}^{\mathbf{horozon}}_{\mathbf{event}}$ is the time required for light to cover the distance from the birth of Cosmos up to the distance that we defined above as the event horizon which is generally much larger than the distance that light travels since the birth of Cosmos. We remind that the 4D visible Cosmos space/time is exponentially fast expanding. As a result:

$$\mathbf{R}^{\mathbf{horozon}}_{\mathbf{event}} >> = \mathbf{R}^{\mathbf{horozon}}_{\mathbf{Hubble}} = \mathbf{c} \cdot \mathbf{T}^{\mathbf{Cosmos}}_{\mathbf{Age}} \quad (11.12)$$

where $\mathbf{T}^{\mathbf{Cosmos}}_{\mathbf{Age}}$ is the age of visible Cosmos counting from the Big Bang. We remind that within the event horizon sphere we see the light of the objects that at the time of light emission were much closed to us than they are now and in this sense we are causally connected with their past.

The expression (11.10) is generally correct during the lifespan of visible Cosmos except right after the Big Bang and at the birth of protons and near the end of visible Cosmos lifespan.

It is important to recognize that the coherent string of matter within the event horizon sphere consisting of the Planck particles enslaved by the imperative of coherence imposed by the *RSL* does not care about the energy conservation *first law* and the *uncertainty principle* unless the observer guarding the sanctity of the *first law* from outside of the event horizon detects the violation. But this cannot happen prior to the time $\mathbf{T}^{\mathbf{horozon}}_{\mathbf{event}}$ by the definition of the event horizon. Subsequently the string of Planck particles is given the lifespan $\mathbf{T}^{\mathbf{horozon}}_{\mathbf{event}}$ defined via (11.11) to worry neither about the *first law* nor the *uncertainty principle*.

Subsequent to (11.12) the coherent visible matter density within the event horizon sphere is as follows:

$$\mathbf{Q}^{\mathbf{coherent}}_{\mathbf{eventhorizon}} = \mathbf{3}^{-1}\mathbf{m_p}\,(\,\mathbf{R}^{\mathbf{horizon}}_{\mathbf{event}} / \mathbf{l_p})[(4\pi/3)(\,\mathbf{R}^{\mathbf{horizon}}_{\mathbf{event}})^3]^{-1} \quad (11.13)$$

The visible Cosmos is homogeneous, especially when approaching $\mathbf{R}^{\mathbf{horizon}}_{\mathbf{event}}$ and there is no reason to doubt that the average density of coherent visible matter is the same for all large enough subdomains of 4D space/time

The expressions (11.10) and (11.13) are central for our specific calculations below. We will test them for two cases. The first one is the contemporary density of coherent visible matter versus the dark energy matter density and compare the results with the most recent observational data obtained by the European Planck mission in 2013. The second is much more difficult calculation of the rest mass of fundamental proton. It is not apparent what may be the connection between the two. Nevertheless we will see the connection shortly.

Chapter 12

SOME IMPLICATIONS RELEVANT FOR COSMOLOGY

Contemporary density of visible matter versus dark energy matter density

Let us calculate the total amount and density of contemporary observable coherent visible mass within the event horizon that is the total visible mass contemporary accessible to our observations. To do this we will use the expression (11.13) and the well-known to astronomers and cosmologists contemporary value of the event horizon:

$$\mathbf{R}_{\mathbf{event}}^{\mathbf{horizon}}\,(\textit{contemporary}) \approx \mathbf{46{\cdot}10^{9}}\ \textit{light years} \tag{12.1}$$

It is noted that the contemporary Hubble horizon is considerably smaller:

$$\mathbf{R}_{\mathbf{Hubble}}^{\mathbf{horizon}} = \mathbf{T}_{\mathbf{Age}}^{\mathbf{Cosmos}} = \mathbf{13.8{\cdot}10^{9}}\textit{light years} \tag{12.2}$$

Substituting the values for the Planck length and Planck particle mass respectively from (5.1) and (5.3) into (11.13) we obtain doing some boring algebra:

$$\mathbf{Q}_{\mathbf{eventhorizon}}^{\mathbf{coherent}} \approx \mathbf{6.5{\cdot}10^{-31}}\,g{\cdot}cm^{3} = \mathbf{6.5{\cdot}10^{-2}}\ \boldsymbol{\Lambda} \tag{12.3}$$

The most recent and precise astronomical data from the European Planck mission determined the amount of normal matter as 6.5% of the dark energy matter density, or taking into account the last measurements of the dark matter 26.8% into the total matter in visible Cosmos the coherent visible matter in accordance with our calculations contributes ≈4.64%. This is slightly less than the quoted 4.90%. However given the qualitative nature of our calculations the result is encouraging.

Dark Matter

We note that since the matter density grows with diminishing the event horizon into the past $\propto (\boldsymbol{R}_{\boldsymbol{event}}^{\boldsymbol{horizon}})^{\mathbf{-2}}$ the relative content of the normal, visible matter grows into the past in favor of visible matter.as compared with the dark energy contribution into the total matter content staying constant except the earliest inflation" stage.It is also quite evident that the dark matter contribution will also steadily increase into the past. To understand why it is necessary to understand what is dark matter that is only the second in significance in terms of contribution into the total matter content of visible Cosmos. We assert that dark matter instead of being a mysterious matter as it is often called is on the contrary a fairly evident matter component.

Dark matter is the chaotic gravitational degrees of freedom disposed of by the normal visible matter in order to extend its coherent life span it is clear that as disposed chaos any visible matter dark matter or equivalent chaotic degrees of freedom must be present everywhere in visible Cosmos.

On cosmological scales we expect dark energy to be present and should be observable on all scales at least on the scales, larger than (4.2). For instance no doubt dark matter can be detected in the solar system. In contrast to dark energy that is coherent and uniform dark matter is chaotic and nonuniform. The bigger is the visible matter concentration the bigger is the density of dark matter outside and inside the voids between visible matter structural elements.

We suggest that dark matter plays the role of gluons for protons. As we will see below the coherent component of a proton is similar to a vibrating string. These high frequency vibrations emanate the boson "sound" that like a cloud envelopes the proton and protects it from decomposition in the course of its lifespan. We assert that normal matter concentrations are also in away vibrating strings. In the case of the event horizon scales this is a fairly rigorous statement. We are not sure to what extent this similarity applies to concentrations of matter such as galaxies, etc. However since the galaxies and other lumps of matter will convert eventually into the MBH's these lumps are also the

vibrating strings or surfaces emanating dark matter bosons. However, this dark matter bosons can not be free as the gluon bosons cannot. Therefore their direct observation is highly unlikely.
The large lumps of visible matter are under attack of the accelerating Cosmos expansion. Prior to the discovery of acceleration of Hubble expansion the local concentrations of normal, visible matter had been in isolation from the outside invisible Cosmos. Visible Cosmos had been seen as all inclusive closed system. The Hubble expansion with no acceleration does not affect matter at all and just stretches space volume available for this matter. The acceleration of the Hubble expansion is not innocuous any more. Acceleration means forces, but forces do not exist. Force is the curvature of 4D space/time and nothing else. Dark energy contrary to all other existing matter creates acts dynamically by smooth the local curvature of 4D space/time wherever the visible matter is present so that in the end the space/time of visible Cosmos is flat.

Naively this is sometimes understood as anti-gravitation. In reality there is neither anti-gravitation nor gravitation, but there opposing to each other dynamical processes. On one hand the growing curvature of the 4D space/time caused by visible and associated dark matter and matter and dark matte and diminishing curvature of the 4D space/time cause by dark energy matter. In the end however it turns out that the opposing processes are both caused by different manifestations of the dark energy continuum.

In particular accelerating Hubble expansion acts as if it forces to smother the local curvature of 4D space/time by tearing apart concentrations of visible matter, say a galaxy. The galaxy wants to exist as a coherent entity. Therefore it reacts by throwing out as much entropy/chaos in the form of dark matter as the valuable mechanisms allow it to do. Naively we observe it as if dark matter enhances the gravitational hold on visible matter inside the galaxy. Dark matter is chaotic and this equivalent to curvature of space time. In simple words dark matter is the chaotic gravitational degrees of freedom corresponding to the Einstein pseudo-tensor of curvature of 4D space/time.

In principle it seems not difficult to calculate how much dark matter should be associated with the galaxy and other concentrations of visible matter. The stretch of a galaxy is large enough for the acceleration of Hubble expansion become significant at the edges. This outward tearing acceleration should not exceed the gravitational inward acceleration. We do not carry out the calculations and they will be published elsewhere. However the approach is as follows.
it is easy to note that the Hubble outward tearing acceleration is:

$$\boldsymbol{\alpha^{outward} \approx H^2 \cdot D_{galaxy}} \tag{12.4}$$

In (12.4) **H** is the Hubble constant and $\mathbf{D_{galaxy}}$ is the typical linear size of the galaxy. At the same time the gravitational inward acceleration is:

$$\boldsymbol{\alpha^{inward} \approx G \cdot M_{galaxy}^{total} \cdot D_{galaxy}^{-2}} \tag{12.5}$$

Equating (12.4) and (12.5) we obtain the relation between the size and the total mass of a stable galaxy or larger concentrations of combined coherent visible matter and chaotic dark matter as follows:

$$\boldsymbol{M_{galaxy}^{total} \approx G^{-1} \cdot H^2 \cdot D_{galaxy}^3} \tag{12.6}$$

The relation (12.6) is the condition for stability of galaxies and other large lumps of visible matter. The mass of visible matter in the galaxies is well known from astronomical observations. Their typical sizes including the huge dark matter haloes are not so well known. However with the course of time and increasing compatibility of astronomical measurements and reality of visible Cosmos the relation (12.6) surely will be accessible for testing against observational data.

There is an all-important cosmological problem of the lifespan of visible Cosmos. It had been considered infinite, or without the beginning and cyclic and many others. The problem became really complex when it was understood that visible Cosmos is emerged into invisible dark energy and dark matter. In his seminal book Roger Penrose (2009) suggested the cyclic concept of Cosmos emerging in the Big Bang, MBH's swallowing all matter of Cosmos except photons and then due to the property

of conformal invariance of the EGE and quantum electrodynamics returning back to the initial state of Big Bang.

We believe in the light of the above analysis that the life time of visible Cosmos is the life time of visible matter. We will calculate this time in the Chapter 16 below.

Chapter 13

HUBBLE EXPANSION VISIBLE COSMOS

In 1929 an American astronomer Edwin Hubble discovered that the star galaxies are moving away from each other with the speed proportional to the distance between them. The farther the galaxies are from each other the faster they are moving away, diverging from each other. This is the famous Hubble law, one the most important cosmological discoveries ever made.

In 1927 a Russian mathematician Alexander Friedmann introduced the cosmological model of homogeneous and isotropic Cosmos, HI Cosmos. The model assumes that on the scales hugely larger than the intergalactic distances visible Cosmos is homogeneous and isotropic. Since then the HI visible Cosmos model has been confirmed with high accuracy by all credible astronomical observations. From the Einstein gravitation equations, the EGE, Friedmann derived cosmological equations describing the evolution of global HI Cosmos. The Friedman equations have become the foundation of modern cosmological studies. They show several possible scenarios for the future of visible Cosmos.

The scenarios are:

a. Forever expansion of the spherical global geometry Cosmos.
b. Reversal of expansion of hyperbolic geometry Cosmos in finite time and subsequent contraction into a point;
c. Static spherical Cosmos with fixed diameter. The static model Cosmos was conjectured by Einstein himself; it is to obtain the static Cosmos that he introduced the attractive, negative sign cosmological constant.
d. The most peculiar scenario when Cosmos global 4D geometry is flat, but still not Euclidean. The particular sub-scenario is when Cosmos continues to expand, but this expansion is fictitious since the geometry of space/time can be presented in explicitly time independent space only manner. The time concept becomes irrelevant and Cosmos becomes timeless.

This timeless Cosmos is as a solution of EGE independently discovered by de Sitter. This is a very remarkable one with no visible matter and positive value of the cosmological constant, in contrast to the one introduced by Einstein, cosmological constant that will be discussed in the next section. Mathematically the static Cosmos of Einstein can be seen as a particular case of de Sitter timeless Cosmos, but philosophically the two are totally different.

In conjunction with the Hubble observation of diverging visible matter, e.g., galaxies and clusters of galaxies moving away from each other, it unambiguously follows from the Friedman equations that it is not matter in static Cosmos is diverging, like vapor in a pot with boiling water. It is the 4D space/time of visible Cosmos matter is expanding. This is in natural for the basic philosophy of Einstein general relativity arguing that matter itself forms the most suitable geometry of 4D space/time to reside in like we design and build a house for ourselves.

Since the time when Hubble made his ground breaking observations of visible Cosmos expansion the future of visible Cosmos remained uncertain to astronomers and cosmologists. The Einstein static Cosmos model per se was wrong. However, the choice between the remaining scenarios for the future of Cosmos compatible with the EGE and subsequent Friedmann equations theoretically remained several with no unambiguous preference[iv].

Chapter 14

ACCELERATION OF HUBBLE EXPANSION

The uncertainty was put to rest beyond reasonable doubt by a marvelous astronomical discovery that likely fixed the future fate of visible Cosmos evolution and by doing this dramatically altered the course of fundamental science. In the year 1998 the two teams of astronomers in the USA and Australia (2011 Nobel Prize recipients) published the analysis of year's long observations revealing that not only visible Cosmos is expanding but expanding with acceleration. Since 1998 their observations have been reaffirmed by independent astronomical observations and after the last European Planck mission are now established as a fact. In the language of EGE and Friedmann equations the accelerating expansion settles the long held suspicion of cosmologists that the global geometry of visible Cosmos is flat. Also the observed acceleration of Hubble expansion in conjunction with the Friedman equations undeniably show that the 4D space/time visible Cosmos is in the stage of nearly exponentially fast expansion.

The theoretical uncertainty concerning the future evolution of visible Cosmos prevailing among the cosmologists prior to the year 1998 had been caused by the insufficient accuracy of astronomical observations. It follows from the Friedmann equations that the evolution of visible Cosmos critically depends on the value of average density matter in visible Cosmos. To determine this value astronomers identify all visible matter that they in principle can see in the sky. No visible matter farther from us on Earth than the light event horizon, or cosmological horizon can be observed at all.

The light event horizon for the astronomers on Earth is the sphere of observation with the radius equal to the distance that light travels isotropically in all directions from the point light source of the Big Bang birth of visible Cosmos relative to our position in visible Cosmos today plus the distance due to the Hubble space expansion. The latter distance contemporary is in fact much larger than the first one. The distance that light travelled since the Big Bang relative to our point of observation, say on Earth is usually referred to as the Hubble horizon.

The event horizon is the real limit of observable Cosmos. The point is that astronomers can observe the light emitted by objects that is a result of Hubble space expansion are greatly farther from us now than they had been at the time of light emission. The astronomers now receive light from the objects that had been much closer to us at the time of light emission and by this light the astronomers peer into the past of Cosmos when had been much smaller. At the time of light emission by the objects there had been causal correlation between us and the objects. Hence this light has informational significance both for us and the objects. But the real material correlation length between us and the objects does not depend on the Hubble space expansion and is the distance that had been between us and the object when the objects emitted light that we received only now since the time dilated due to the Hubble expansion. To cut it short the correlation length is likely determined by the Hubble horizon and not by the cosmological event horizon. Note that by the correlation length here we mean the classical correlation length limited by the speed of light propagation. The quantum phase correlation length is not limited by the speed of light and is infinite always in the whole 4D space/time.

With high accuracy it is known that at very large scales the observable Cosmos is homogeneous and isotropic, HI as was anticipated by Friedman. There are no reasons to imagine that behind the light event horizon it would be different and something unexpected is lurking. The Hubble light horizon and the light event horizon would be two spheres, one smaller and the other larger with the same two diameters for the astronomer located say in Andromeda galaxy and the one on Earth, although these two spheres for our astronomer and the two spheres for the astronomer in Andromeda are different couples of spheres. Apart from the fact that astronomers are unlikely to be in Andromeda this is not the concern of astronomers on Earth. For them the Hubble and the event horizons are well defined. Were it that I am wrong and the astronomers in Andromeda exist and busy they would observe a number of different objects that the astronomers on Earth do not observe and vice versa. However, since visible Cosmos is H&I it is of no importance. The average matter density for large enough spheres of observations is the same. Note the specific distinction between visible Cosmos and observable Cosmos. The two have almost nothing to do with each other. The visible Cosmos is a part of observable Cosmos within the light event horizon sphere. Visible Cosmos is what astronomers can

"see" by receivale of emitted electromagnetic waves; light we can see by eyes, hard short wavelengths **x**-rays and -rays, soft long wavelengths red and infrared waves, radio waves. There are different kinds of telescopes and devices to capture and enable astronomers to "see" the emission of each of these electromagnetic waves coming from space that were emitted billions of years ago relative to our reference frame on Earth. Astronomers receive information from the objects that had been formed almost at the time of Big Bang itself and that are now almost at the edge of the cosmological event horizon relative to Earth.

When the astronomers identify all visible objects, large and small, galaxies and clusters of galaxies, and superclusters of clusters, radio galaxies and quasars, stars and pulsars and diffuse interstellar gas and cold relic radiation within a sphere of a large radius they confidently determine the total mass/energy by luminosity, a well know astronomical method and other methods. Then they divide the total mass by the volume of the observation sphere. Thus they obtain the average density matter, say grams per one cubic centimeter of space:

To be sure that this is indeed the correct average matter density in observable Cosmos astronomers may increase the diameter of observation and the corresponding volume of averaging. If the resulting matter density remains the same with high accuracy it means that this is indeed the average matter density in observable H&I Cosmos. Since there is general consensus with the incontrovertible correctness of the EGE and the subsequent Friedmann cosmological equations for HI visible Cosmos it means that this average matter density is the same in the whole of observable Cosmos and the whole Cosmos that still cannot be observed, but will be observed since the light event horizon is growing and will go on growing due to the Hubble expansion.

The average matter density is now substituted into the Friedmann equations together with three universal constants of visible Cosmos entering the Friedmann equations. The constants were all introduced above and all are perfectly well measured astronomically and/or in laboratory with high accuracy. These are:

1. The Newton gravitational constant one of the universal constants of visible Cosmos;
2. The speed of light another universal constant of visible Cosmos;
3. The Hubble constant of Cosmos expansion.

It was noted above that the observed speed of Hubble expansion of visible Cosmos is proportional to the distance between two arbitrary objects in visible Cosmos in the reference frame commoving with one of them, say between the Milky Way, our galaxy, and two other galaxies far from the Milky Way:

$$\mathbf{V_{Habble} = H \cdot} \boldsymbol{R_{1\leftrightarrow 2}} \tag{14.1}$$

where the Hubble constant is about: $\mathbf{H \approx 10^{-18}} sec^{-1}$ .It should be noted that modern astronomical measurements furnish much more precise value of H, but we do not need such high accuracy right now, although in the following sections we will calculate this value with surprising accuracy.

In accordance with the Hubble law when two distant galaxies move from the Milky Way and from each other, but one is closer and the other is farther from the Milky Way the farther galaxy moves away faster relative to the Milky Way than the closer one. The speed of the galaxies moving away from the Milky Way is determined experimentally with very high accuracy by what is called the red shift of light coming from the objects moving away from the observer; say located in the Milky Way, in the solar system on Earth. The red shift is a phenomenon of light becoming redder, shifting into the lower frequencies, redder part of the spectrum, if this light source is the object moving away from the astronomer in the reference frame at rest relative to the astronomer.

The Hubble constant in principle could be different for the toddler visible Cosmos just delivered by the Big Bang. In this sense the Hubble constant is not necessarily the exact constant in the whole 4D space/time of visible Cosmos since the Big Bang, but surely it is constant for most of it.

However, for the calculations made in the framework of Friedmann equations it is not relevant. It is sufficient to know the contemporary Hubble constant, only as it is now. That the Hubble constant has remained the same since the childhood of visible Cosmos, but not from the earliest childhood is fairly certain to cosmologists. To summarize the Hubble constant is precisely measured by astronomers, as has been noted. It was fairly accurately measured by Hubble himself with no modern technologies at his disposal.

When the appropriate calculations with the Friedman equations are carried out it turns out that for the value of average matter density contributed by all visible matter Cosmos titters on the boundary between the spherical global geometry corresponding to forever expansion and hyperbolic geometry corresponding to a gradual deceleration of visible Cosmos expansion followed by contraction back to the point singularity. The exact boundary between the forever expansion spherical expansion geometry and hyperbolic eventual contraction geometry is the quasi flat space global geometry of visible Cosmos. This quasi flat geometry is compatible with the so-called de Sitter Cosmos.

However, when the calculations with the Friedman equations are carried out again, but this time taking account of the observed value of acceleration of the Hubble expansion the result is startling. The total average matter density required for the observed acceleration of visible Cosmos expansion should be about times more than the observed visible matter density. Moreover the gravitational force exerted by this missing invisible matter mass should be repulsive not attractive as it is for all visible matter. The invisible matter also should be strictly uniformly distributed over all 4D space/time. Also the global geometry of space is flat with high accuracy.

The above observed reality can be interpreted as if visible Cosmos is embedded into the invisible something. This invisible something manifests itself in 4D space/time of visible Cosmos as some uniform self-repulsive matter with constant mass/energy density in the whole 4D space/time of visible Cosmos acting in such a manner that the 4D space/time of visible Cosmos expands with the observed value of acceleration. This invisible matter is called dark energy.

The invisible matter with constant energy density in visible Cosmos was introduced by Einstein in 1917 while pursuing the false belief that Cosmos should be static. If the cosmological constant is negative then it corresponds to self-attractive matter and adds to visible matter attraction in EGE. Since it is constant in the whole 4D space/time this attraction is uniform in space and constant for all time. In this case it can counteract and balance the initial Big Bang push to space/time Cosmos expansion and obtain static visible Cosmos. When Einstein learned of the Hubble discovery of visible Cosmos expansion he famously discarded the cosmological constant proportional term in EGE. Now it is clear that Einstein was too hasty doing this. Indeed numerically his cosmological constant was not correct and its sign was wrong. However the very fact that Einstein envisioned that some invisible totally H&I matter with the same constant density at all points in space and at all times that is in the whole 4D space/time may exist in Cosmos was among grand prophetic visions that few were Godsend.

The positive value of cosmological constant in EGE is the only consistent and indeed natural description of dark energy and acceleration of Cosmos expansion. It is believed that the cosmological constant is not the infinite, timeless dark energy continuum that we is the primeval donor source of order we have talked about above. It is rather the quantum mechanical manifestation of this continuum in visible Cosmos. The observed value of acceleration of Hubble expansion corresponds to the positive sign and hence uniformly and at all times repulsive invisible matter having the specific density very close to the value $\mathbf{\Lambda=10^{-29}}g\cdot cm^{-3}$ that was we use for the derivation of the dimensionless constant (4.1). This value of $\mathbf{\Lambda}$ may seem a very small matter density but it is about 14 times bigger than the current average density of all visible matter in Cosmos. Therefore invisible, dark energy or preferably to say the manifestation of dark energy in visible Cosmos dominates the time evolution of visible Cosmos.

It should be reminded that when the terminology of repulsive matter is used it is misleading. The cosmological constant is driving visible Cosmos to the GPO of Kosmos by smothering the local curvature of space/time created by the visible matter and dark matter, the global perfect order of infinite timeless continuum of dark energy. In the process all chaos associated with the curvature of 4D space/time is absorbed by the dark energy continuum. This is just the mechanism that Kosmos uses to rid visible Cosmos of chaos accumulating in the course of evolution.

Since visible Cosmos expands and with acceleration the space volume available for visible matter is fast growing and as result the density of visible matter fast declining. However the dark energy density by definition remains the same. When we extrapolate into the far future the visible Cosmos it well may be the timeless de Sitter Cosmos of which the static Cosmos of Einstein is a particular case. The de Sitter Cosmos is a particular solution of EGE with no visible matter at all, but with positive cosmological constant. Naturally it is a particular solution of the Friedmann equations as well, but it

was obtained by de Sitter independently. For many years it was considered primarily a mathematical curiosity. EGE allows a number of exact solutions that are fertile ground for science fiction like travelling back in time, wormholes, etc. The de Sitter solution was seen mainly in one row with these curiosities of EGE. However since the discovery of acceleration of Hubble expansion there is another attitude to the de Sitter Cosmos solution.

If it happened that visible matter would have disappeared completely up to the last electron in finite time, the photons by themselves are not important because there is no one to see them; the only matter that would remain is dark energy, or the cosmological constant. In this conjectured situation of no visible matter and subsequently no visible Cosmos the 4D space/time of dark energy alone is the de Sitter space/time. With no visible matter up to the last electron and proton the time concept itself disappears as was explained above.

While the de Sitter Cosmos may be still seen formally as expanding and even having the event horizon it does not connect with the usual material physics[1]. The radical question is how long will it take for all visible matter to totally dissolve so that the only matter left in 4D space/time is timeless dark energy manifestation as cosmological constant and therefore the Cosmos geometry is the de Sitter timeless solution? For instance two single fermions, electron and proton left alone outside and separated by the sphere bounded by the light event horizon would mean that visible Cosmos still exists and the time concept is still there. The visible Cosmos will be very close to the De Sitter Cosmos and still not the one. This would make impossible excluding explicitly the time coordinate from the geometry of 4D space/time. Subsequently the time would remain and with time remains chaos and with chaos it is not the GPO of Kosmos. On the other hand since in this situation there is no self-conscious mind the time concept does not have sense as was argued in the previous section. Therefore this situation cannot be and this means that there is at least one mechanism that will evaporate all fermion visible matter in finite time. Such mechanism must exist and will be identified in what follows.

Unfortunately the visible Cosmos accelerating expansion by itself is not such a mechanism. In accordance with the EGE the space expansion makes the visible matter density progressively smaller as the space volume grows and there are more space degrees of freedom for redistribution of matter, but the density approaches zero asymptotically with time never reaching exactly zero. In this case the time for visible Cosmos to totally dissolve within dark energy is infinite and the GPO of Kosmos will not be ever reached. This Sisyphus fate of Cosmos always trying to reach the GPO of Kosmos and never reaching it is not at all optimistic. In fact it seems even worse than the ultimate chaos of heat death. However friction between the cosmological constant matter and visible matter will do the job imperatively required by the RSL and will erase visible matter within finite time $\mathbf{t_c = 10^{31}}$*years* indicated above.

[1] If to think about it there is nothing unnatural in this. If there are no clocks and hence no time in the de Sitter Cosmos there are no observers and nothing to observe and hence the expansion velocity and acceleration cannot be measured and are rather mathematical symbols from our time addicted viewpoint. On the other hand if there is a mechanism to dissolve visible matter it is obvious that de Sitter solution must exist and it is timeless. When the EGE with no visible matter is solved and the de Sitter solution is obtained than it follows indeed that the time coordinate can be factored out by a covariant transformation of the metric tensor. Such is the Global, Perfect Order, or the GPO Kosmos. The state of perfect global order must be timeless with no visible matter observers and no processes and changes. Plato and Aristotle understood 25 centuries ago that the imperative prerequisite for the existence of time concept is change and the change is a process. In the state of GPO Kosmos nothing changes since there are no processes. If there are no processes there is no need for the time concept and if there is no need for the time concept time does not exist. What is truly marvelous is that in purely scientific terms of ESR and EGE it is possible to describe mathematically the GPO Kosmos as the exact de Sitter solution of EGE with positive cosmological constant.

Chapter 15

ORDER AND LIFE ON EARTH

We return back to Earth and consider quantitatively the inevitable emergence of life on Earth. We repeat the inevitable emergence of life rather than a random coincidence of no significance for visible Cosmos. Life originated somewhere in the middle of the long order/chaos cascade from the donor source of primeval order to self-conscious Man. Man picked up this primeval order and we believe that this is cause of self-consciousness.

Here we consider only the particular case of order growing on Earth. Where is the last step of the order/chaos cascade, the specific source of this growing order on Earth? This question was first considered by Erwin Schrödinger in (Schrodinger E., 1944).

I will follow in their steps adding other critical features and uncovering appropriate mechanisms making the inanimate order and live order on Earth and their evolution not only possible but inevitable imperatives of the *second law* and *RSL***.**

The cause of life on Earth is ever increasing order. The source of ever increasing order is the solar radiation. The mechanism of the biological order growth, that we call evolution is of course the survival of the fittest principle of Darwin, possibly in conjunction with supplementary genetic mechanisms. Surely this order is not self-organization from chaos. Life is brought by donor of order, the solar radiation. It is not borne like homunculus in a jar.

Qualitatively the growth of order on Earth occurs like this. During a hot summer day a part of solar radiation is absorbed by the oceans, plankton and vegetation. This radiation is made of photons that can be seen with sufficient accuracy as independent particles. Sun is a black body emitting radiation of all frequencies and wavelengths distributed in accordance with Planck law. However the photons that are absorbed by the Earth surface are primarily energetic high frequency ultraviolet, violet and green photons. Altogether they carry to Earth certain amount of energy. Over a period of time the temperature on Earth stays roughly the same. It means that the amount of energy absorbed by oceans and vegetation and plankton and the rest during the day should be returned back to space. No absorbed energy stays on Earth. In other words Earth is in a steady state with temperature staying almost the same for a period of time. To hold this balance Earth during the night returns back to space all energy received during the day. There may be fluctuations but over a period of time this is what happens. Indeed if it did not happen then the Earth temperature would have risen or lowered dramatically and life would have disappeared. This has not happened so far and unlikely to happen.

However and here is the incredible phenomenon understood by Schrodinger in that the quality of absorbed solar radiation during the day time and emitted back during the night time is dramatically different. Although the solar radiation is the equilibrium Planck radiation that means that it is chaotic the very special conditions on Earth enable separation and extraction of the coherent part of this radiation from the chaotic one.

The absorbed solar radiation consists of relatively few energetic photons and their entropy is low. Photons behave approximately in this situation as the ideal gas. We can suppose that their entropy is just proportional to their number with Boltzmann constant in front. During the day time high frequency energetic, violet photons are absorbed by the shallow layer of water and green photons by plankton and green leaves of the forests.

On the other hand the emitted from Earth radiation during the night are low frequency red and infrared thermal photons. This is because the Earth temperature during the night and always is so much lower that the solar radiation temperature. In or to have the total energies of absorbed solar radiation and emitted by Earth radiation equal the emitted by Earth radiation should have many more photons. They will have many more degrees of freedom than the photos of absorbed radiation. In other words the emitted by nights Earth's radiation will have much more entropy than the absorbed solar radiation. Solar radiation is the source of negative entropy for Earth. As a result Order on Earth as a whole should grow and chaos should fall. This is a remarkable example of RSL in the presence of source of order.

Let us now show rigorously how order on Earth grows. As a black body with the surface temperature $\mathbf{T_{Sol}}$ .Sun radiates isotropically in all directions. The energy flux is given by the

Stephan-Boltzmann formula (1.1) and that we remind for the solar radiation again since it is critically important for the reasoning. The solar radiation energy flux is:

$$\mathbf{J_{sol}}\, erg\cdot sec^{-1} = \mathbf{4\pi\cdot X\cdot R_S^2\cdot T_{Sol}^4} \tag{15.1}$$

Our Earth receives a part of this radiation proportional to the Earth's surface $\mathbf{A_{Earth}} \propto \mathbf{R_{Earth}^2}$ In other words the energy flux touching the edge of the Earth atmosphere is:

$$\mathbf{J_{Earth}^{sol}}(day\ time) erg/sec = \mathbf{(X\cdot T_{Sol}^4)(R_{Earth}^2/R_S^2)} \tag{15.2}$$

In the above formula we assumed for simplicity that the day time is 12 hours, or about $10^5/2$ *sec*.

Assuming that the temperature of solar radiation from the surface of the Sun is constant, which is obvious and using the formula relating energy and entropy the energy flux carries with it the following entropy flux:

$$\mathbf{\frac{\partial S_{Earth}^{sol}}{\partial t} = \left(4\pi\cdot X\cdot R_S^2\cdot T_{Sol}^4\right)\left(4\pi\cdot R_{Earth}^2\right)^{-1} = 4\pi\cdot X\cdot T_{Sol}^4\,(R_S^2/R_{Earth}^2)} \tag{15.3}$$

Certain part of the solar energy flux well known to geophysicists is absorbed by Earth by means of the mechanisms we will discuss shortly and the remainder is either reflected back into space. Thus the energy absorbed by Earth is as follows:

$$\mathbf{E_{Earth}^{+} = C_{absorption}\left(\frac{\partial S_{Earth}^{sol}}{\partial t}\right)\left(t_{day}\approx 10^5 sec\right) = X\cdot C_{absorption}\cdot R_{Earth}^2\cdot T_{Sol}^4\,(10^5 erg)} \tag{15.4}$$

where $\mathbf{C_{absorption} = const}$.is a constant defining the part of the energy flux that is captured by Earth and not reflected back into space, $\mathbf{E_{Earth}^{+}}$is the total energy gain accumulated by Earth during the day time that we approximately assume to be $\mathbf{t_{day}} \approx \mathbf{12}\ hours \approx \mathbf{10^5/2}\ sec$ This energy gained by Earth brought inevitably some entropy chaos with it that is easy to calculate from the general relation between energy and entropy (6.3) that we remind here for convenience:

$$\mathbf{S = E_{statistical}\cdot T^{-1}} \tag{15.5}$$

Therefore for the gain of entropy and the corresponding increase of chaos on Earth, it is reminded that the change of temperature on Earth during the short time is negligible, we obtain for the growth of entropy/chaos on Earth:

$$\mathbf{S_{Earth}^{+} \approx X\cdot C_{absorption}\cdot R_{Earth}^2\cdot T_{Sol}^3\cdot 10^5} \tag{15.6}$$

During the night Earth is also a black body with the radiating surface $4\pi\cdot\mathbf{R_{Earth}^2}$. The temperature of Earth is:

$$\mathbf{T_{Earth} << T_{Sol}} \tag{15.7}$$

The energy flux from Earth out into space is determined as above for the solar radiation flux and is:

$$\mathbf{J_{OUT}^{Earth}}(nightime) erg/sec\ = \mathbf{\pi\cdot X\cdot R_{Earth}^2\cdot T_{Sol}^4} \tag{15.8}$$

Therefore during the about $\mathbf{12}hours \approx \mathbf{10^5}/2\ sec$ Earth loses energy $\mathbf{E_{Earth}^{-}}$ as follows:

$$\mathbf{E_{Earth}^{-} = E_{Earth}^{+} = 4\pi\left(X\cdot C_{absorption}\cdot R_{Earth}^2\cdot T_{Earth}^4\cdot 10^5\right) =}$$
$$\mathbf{= 4\pi\left(X\cdot C_{absorption}\cdot R_{Earth}^2\cdot T_{Earth}^4\cdot 10^5\right)}\ erg \tag{15.9}$$

The condition $\mathbf{E^{-}_{Earth} = E^{+}_{Earth}}$is the energy conservation law, the *first law of thermodynamics* stating that as much energy is absorbed during the day time that much energy is radiated out during the night time. If it is not like this the temperature on Earth would be growing every day and life would not exist on Earth.

From (15.8) and (15.9) we find the value of the absorbing constant:

$$\mathbf{C_{absorption}=(T_{Earth}/\ T_{Sol})^4\ /\ 4\pi} \qquad (15.10)$$

Now we can explicitly calculate how much entropy/chaos is radiated by Earth to the outer space. After some trivial algebra we obtain as follows:

$$\mathbf{S^{-}_{Earth}\ =R_{Earth}\cdot S^{+}_{Earth}} \qquad (15.11)$$

where the large number:

$$\mathbf{R_{Earth}\ =\ (1/4\pi)\ (T_{sol}\ /T_{Earth})\ \approx\ 10^4} \qquad (15.12)$$

The above result is truly amazing. It says that during 24 hours Earth is losing about $\mathbf{R_{Earth}\approx 10^4}$ times more incoherent, chaotic degrees of freedom and hence acquiring coherent degrees of freedom. This process of losing entropy/chaos and subsequently becoming more coherent has been going on Earth at least as long as the oceans have existed on Earth. The latter is not really known and there are controversies. It is more important that over a period of time order on Earth is only and always growing. If the above nonequilibrium conditions have been holding, say for 100 million years the amount of order that Earth has gained during this time is enough for animate matter form and evolve to become highly organized animal life. Note that the dimensionless parameter $\mathbf{R_{Earth}\approx\ 10^4}$ plays the role in our mundane problems the same role as the grandiose constant $\mathbf{R_c\ =\ 10^{41}}$ plays for the whole visible Cosmos. The principle of furnishing Earth with ever growing order by extracting coherent component from the solar radiation and exhaling the same amount of chaotic energy back to space is exactly the same as the one for growing order of visible Cosmos by absorbing coherent energy from the dark energy continuum and returning back to the dark energy continuum the same amount of much more chaotic energy.

In the former case the trick is the large difference in the temperatures of solar radiation passed by Earth and partially absorbed and the temperature of radiation emitted by Earth into space in the dark of the night. In the latter case the trick is done by using the greatly different scales respectively of energy injected into visible Cosmos and the ejected one. However the cause of this phenomenon is the same. The cause is the imperative compliance with the *second law and RSL* In the former case the mechanisms chosen by the RLS are the mechanisms of nonequilibrium thermodynamics by which Sun is the hot "spot in sky" as it is often called, and in the latter case of visible Cosmos these are the mechanisms of EGE and quantum mechanics. It is not incidental that EGE in conjunction with quantum mechanics are in such affinity with the laws of thermodynamics as was understood by Jacob Bekenstein and Stephen hawking in their truly extraordinary black holes evaporation theories.

Let us consider briefly the consequences of the ever growing order on Earth. We note that this does not mean of course that order is growing every day and every hour, but that it is growing over considerable periods of time.

There is a problem with the growing order on Earth. Where does it go into? Order should settle into something material, or due to the intimate relation between material order and mathematical information order into the latter one. The relation between the two is implemented by one Boltzmann constant $\mathbf{k_B}$ .This constant metamorphoses material order and chaos into respectively informational order and chaos and vice versa. It should be also borne in mind that the global order on Earth is growing and obviously it will be looking into larger and larger residences able to accommodate its ever expanding amount. Also there is no chance that this growing order prime law on Earth will change in the foreseeable future. As long as Sun is shining and oceans are absorbing its radiation order will go on growing. Even the dreadful

"global warming" will not save Earth from the need to provide accommodation to this order. It is a miniscule coma by comparison with the RSL imperatives. Whatever we do on Earth order will continue growing.

There were fluctuations, in the history of Earth, the icy periods and the hot periods. The exact balances are not easy to compute, although very important for practical purposes. On the whole during the time span since the oceans appeared on Earth they absorbed incredible amount of order and the entropy on Earth has come down dramatically. Where is all this order now? We stand in front of something fundamental and the author is sharing his awe in front of this incredible something. Into what forms Order metamorphosed from the low entropy, coherent energy subtracted from the solar radiation?

It is reiterated that in the capital letter Order should find storage for itself. Since it is growing without end this storage of Order must also grow into ever increasing capacity vessels. I would like to reemphasize that the growing capacity of vessels where Order may settle is an absolute imperative of RSL as long as the solar energy continues to be absorbed by the oceans. Therefore there must be the mechanisms for building the ever increasing capacity vessels accommodating Order. It is not difficult to fathom that by large the largest capacity vessel for accommodating Order is biological life, DNA and ultimately mammalian brain.

We recall Sherlock Holmes lessons to Dr. Watson and suggest that the last remaining explanation hardest to believe in is the right one. Rejecting the senseless hypothesis of random coincidences and disregarding the useless anthropic principle we are left with the last explanation that at the time when the oceans appeared on Earth it had been predetermined that such mechanisms do exist to make sure that the imperatives of RSL are not denied.

If the existence of the appropriate mechanisms had not been predetermined the oceans would have not appeared on Earth. Clearly the appearance of oceans on Earth had been predetermined at the time when Earth had been born. Now let us consider some of these mechanisms that are within the scope of modern science.

Mechanism # 1: Rotation of Earth Around its Axis

The first and the simplest and nevertheless remarkable mechanism is the rotation of Earth around its axis. Light and dark, day and night are separated like light had been separated from dark at the birth of visible Cosmos. This is why Earth absorbs orderly low entropy solar radiation during days and emits out the chaotic, high entropy radiation during the nights. It is the negative entropy flux, or positive order flux IN to Earth. There have been many theories explaining how it happens that Earth rotates around its axis. Here I explain why and for what it does. So that there is day and night and subsequent positive order flux IN to Earth that is the same as the positive flux of entropy/chaos OUT.

Of course the Newton law of gravitation ruling Earth orbiting around Sun and subsequent summer time and winter time allow even spread of order over the Earth's surface.

Mechanism # 2: Atmosphere and Oceans on Earth as One Coherent Organization. Oceans and Atmosphere Coherence

Were it not for the oceans there would be no essential absorption of low entropy solar radiation. For instance on the Moon there are no oceans and it does not rotate round its axis. So there is no life or anything interesting on the Moon. It is dead.

It used to be a different content atmosphere in the beginning, but it is not essential. The ever growing global Order on Earth must settle into capacious vessels. The one connected eco-system of oceans/atmosphere is a capacious vessel for order to settle. To understand how it works we have to look at the relatively recent time period of say 100 million years, or less. It does not matter. The period since the oceans and some appropriate atmosphere had existed, but life did not. It must be noted that the content of the atmosphere should be such that it allows solar radiation in and Earths radiation out.

In the last case the oceans absorb low entropy radiation during the day and give back, emit high entropy radiation out. The first storage that RSL inducts into service is the phenomenon of

turbulence in fluids, water and "air", although "air" is not yet our air. Again it does not matter at this stage. But why turbulence is inducted into service by RSL as the mechanism for building storage for Order? Turbulence is universally perceived as acute chaos. Chaos in oceans and seas, chaos making hard to fly, chaos creating energy losses everywhere, a very bad phenomenon making life more difficult. The reason for inducting turbulence into service of RSL is that this perception is utterly wrong. Turbulence in fluids is an amazingly coherent phenomenon build on the skeleton of literally unaccountable complexity coherent structures with precise mathematical format. The disclosure of order in turbulence may be fairly shocking after hundreds years of misconceptions that even penetrated into semantic meaning of the word turbulence. Imperative of order in turbulence is imposed by the NSE in presence of an appropriate source of order. The rigorous proof and precise analytical description of this uncountable diversity of order in turbulence was proved in (Levich E., 2009).

It works like this. The shallow surface layer of oceans absorbs hard solar radiation, starts to heat up and evaporate. This is convection. The swirling columns consisting of air saturated with tiny drops of water rise up into the upper atmosphere. The swirling of convective clouds forces the upper atmosphere to swirl with them. The convective clouds are of many sizes. The swirls, or eddies, or vortices of many sizes start to emerge in the upper atmosphere. The collection of these multi-size vortices seemingly moving randomly is turbulence. Then it becomes interesting. The NSE describe the flows of practically all fluids and among them water and air in every situation. Aeronautics and ship building and meteorology and oil/gas pumping and civil engineering all is described by NSE. They are totally and hopelessly intractable mathematically when fluids are turbulent. Nevertheless necessity is the best commander. Therefore certain very general deductions concerning the mechanisms hidden in the water flow equations can be glimpsed and proved. Otherwise we would have not been building planes and rockets and fast ships and space shuttles.

The first well known Richardson-Kolmogorov-Obukhov mechanism embedded in the nonlinear coupling term of NSE breaks large eddies/vortices into the smaller ones and then breaks them into even smaller ones and so on. Therefore the number of eddies is growing. In relation to the upper atmosphere we know that it should stay over a period of time in a steady state. The amount of energy that is brought into the upper atmosphere by convective clouds absolutely must, one way or another, be emitted out of the upper atmosphere into space. If it does not happen the temperature will go up without end. This cannot be because this is the temperature with which high entropy is emitted by Earth out into space.

Here comes the second fundamental mechanism of the NSE. When vortices are broken by the first mechanism into many very small vortices they start to experience the Newton viscous friction. Friction is the inevitable mechanism serving RSL in Cosmos in a most fundamental manner as we will see later. On the mundane level of turbulent fluids it is obvious. Although "water flow equations" are macroscopic the molecular microscopic structure of fluids must manifest itself and viscosity is this manifestation.

Indeed, the increasing energy of macroscopic fluids is in conjunction with higher temperature and subsequently more erratic motion of the fluid molecules. They collide more frequently with each other and their kinetic energy is transformed into heat. This is called viscous dissipation. In other words air is a viscous fluid with certain value of viscosity. Viscosity of fluids is practically always impossible to calculate from the "first principles" since these first principles contradict the *second law*. Hence it is the empirical parameter determined by experiment. As a result of viscous dissipation at small scales of turbulence the upper atmosphere warms up. Now it is a black body and the black body emits high entropy thermal radiation out into space as is defined by (15.9) . This is the high entropy/chaos energy ejection by Earth into space. We note that whatever happens on Earth after the oceans absorbed the coherent part of energy of the solar radiation and this coherent energy cascades down to smaller scales eventually into the biological life does not matter at all! In the end all the chaos between the steps of order cascade is summed up into the black body radiation of the upper atmosphere into space.

But at what scales is energy injected into the upper atmosphere? The flux of coherent energy into the upper atmosphere has the characteristic scale of convective clouds which is the well-

known scale $\mathbf{L_{clouds}}$. This is the scale of the coherent energy flux **In**. However the reverse chaotic energy flux occurs at the greatly smaller typical scale $\mathbf{l_{dissipation} << L_{clouds}}$.How to determine this dissipation scale?

The NSE are endowed with the most marvelous property of universality or scale invariance. What it means is that all meaningful results for the flows of fluids depend on one parameter; the so-called dimensionless Reynolds number:

$$\mathbf{Re = L_{clouds} \cdot V_{Large} \cdot V_{fluid}^{-1}} \tag{15.13}$$

In (15.13) $\mathbf{V_{Large}}$ is the largest average velocity absolute value in turbulent flow, in the upper atmosphere flow in this case and $\mathbf{V_{fliud}}$ is the fluid viscosity, rarified air in this case. It does not matter what are the values of the quantities entering the definition of the Reynolds number (15.13), as long as the Reynolds number remains the same, i.e.,**Re = const**..This is the remarkable universality property. The NSE are invariant under the group of scale transformations that keep the Reynolds number constant. The values of Re in Cosmos are very large. For the upper atmosphere global jets, tropical hurricanes and intensive tornadoes the typical value is about $\mathbf{Re \approx 10^{12}}$ In astrophysical conditions they become astronomically large and in the end equal to the visible Cosmos fundamental constant:

$$\mathbf{Re_{max} = R_c = 10^{41}} \tag{15.14}$$

There is no physical dimensionless number relevant for visible Cosmos larger than that. We interpret $\mathbf{R_c}$ is the Reynolds number of incompressible viscous fluid called dark energy manifested in visible Cosmos as the Einstein cosmological constant. That cosmological constant is incompressible fluid is rather obvious. However it is also viscous fluid endowed with friction and subsequent ability of dissipating energy. The proper quantitative explanations will be furnished in what follows. Now we return back to Earth.

The energy flux flowing into the upper atmosphere can be calculated quite easily. It is designated usually as $\boldsymbol{\varepsilon}$ .It is not difficult to understand what the RSL demands from turbulence. Indeed the coherent energy is injected at the scale $\mathbf{L_{clouds}}$ and ejected at the much smaller scale $\mathbf{l_{dissipation}}$. The energy flux in the steady state flow *Out* is over a period of time equal to the energy flux **In** as follows:

$$\boldsymbol{\varepsilon = \varepsilon_{Out} \equiv \varepsilon_{In}} \tag{15.15}$$

It means that the number of degrees of freedom in the ejected energy flux is much larger than in the injected coherent energy flux. The latter means that the flux of energy **Out** has relatively much higher entropy/chaos than the energy flux **In.** This means that the convective clouds are the source of negative entropy flux, or the flux of order into the upper atmosphere turbulent flow. Therefore the upper atmosphere turbulent flow is continuously becoming more coherent. It means that the scale of coherent turbulent motion in the upper atmosphere grows. Moreover it should grow with acceleration since the convective clouds do work on the upper atmosphere flow. This work is equal the minus energy dissipation by the viscous mechanism.

If the size of the globe was infinite the coherence scale of turbulent structures would never stop growing. If an intelligent creature lived as a particle on a certain material surface of the flow and would observe what happens with other particles of the same material surface the intelligent creature would see that other particles are running away from him/her with the speed proportional to the distance between them and him/her. Moreover they would run away from him/he with constant acceleration, i.e., exponentially fast. If viscosity is zero, i.e. the fluid is ideal this would not be a physical expansion, but the expansion of the 2D curved space of this surface. This would not be the real physical expansion because there are no observers in the infinite span, unbounded incompressible fluid and no processes are happening in it. Nevertheless this is a remarkable mathematical property of incompressible ideal fluids. Infinite domain incompressible ideal fluids exist as timeless media of constant everywhere energy density and with material lines and surfaces exponentially fast expanding as a mathematical abstraction. This

is very similar to the de Sitter timeless Cosmos and the state of global perfect order of Kosmos as infinite, timeless dark energy continuum.

However in our visible Cosmos fluids are always viscous and compressible, although the compressibility is important primarily for the speeds exceeding the speed of sound. The compressibility is what makes sound propagation possible. Viscosity means energy dissipation. Energy dissipation due to the viscous friction requires the donor source injecting coherent energy into the turbulent flow. This coherent energy donor brings order into the turbulent flow manifested by the growth of coherence scale provided that the mechanism of viscous dissipation will eject the same magnitude but chaotic energy out of the turbulent flow. The immediate donor source for the upper atmosphere on Earth is the convective clouds. However the prime donor source of capital letter Order is the solar radiation.

The globe is round and due to the gravity the thickness of the upper atmosphere is naturally finite, just a few miles. Therefore the maximal size of the emerging coherent turbulent motion in the upper atmosphere is the length of circumvention of the globe at the height of the upper atmosphere from the ground. This is the global atmosphere circulation around the globe usually called the jet streams. The origin of the global circulation has remained total enigma prior to the publication in (E. Levich, 2009). Since it involves extremely complicated mathematical treatment of the NSE we are aware that it remains the enigma for the meteorologists and climatologists. The above almost trivial reasoning based on the *second law and RSL* principle is novel. It is emphasized that although the reasoning is qualitative it is rigorous and can be supplemented with quantitative conclusions readily in difference to the formal approach in (E. Levich, 2009). We hope that the above approach will be helpful to practical geophysicists[1]. We reiterate that unless there are some external boundaries or other factors, like the finite size of Earth' atmosphere, the size of turbulent eddies would grow indefinitely as long as the convective, swirling clouds continue rising up from the ocean's surface. The end result is the global circulation of Earth's atmosphere, or jet streams, in one direction in Northern and in the opposite direction in the Southern hemispheres. They are like huge rivers flowing without mixing with surrounding air around the globe (Levich E. 2009). On the mundane level this is the reason why flying from Europe to the US takes different time than flying in the opposite direction.

But why the direction of the jet streams is different in Northern and Sothern hemisphere? This is the symmetry break caused by the rotation of Earth around its axis and the associated Coriolis force. If it was not for this asymmetry the jets would not know where to flow and this would be confusing. The growth of the coherence scale would of course go on since it is the imperative of RSL but as growing in size fluctuations with the opposite sign of helicity, a fundamental attribute of all matter, from elementary particles to macroscopic fluids.

It also should be noted that if Earth was exactly spherical, not ellipsoidal, there would be no atmospheric general circulation due to the confusing spherical symmetry. Moreover Earth should be ellipsoidal in exactly the way she is to enable the general circulation compatible with myriads of other factors and phenomena. The general circulation is the most important global phenomenon that controls the environment such that makes life possible on Earth. It is like the human skin that first protects our body and immune system.

It's a good time now to reveal what is the relation between the coherent energy injection scale $\mathbf{L_{clouds}}$ and the chaotic energy ejection $\mathbf{l_{dissipation}}$, the two defining scales in turbulent flows. It is rigorously as follows:

$$\mathbf{Re = L_{clouds} \cdot l^{-1}_{dissipation}} \qquad (15.16)$$

Let us compare now the expressions (15.16) and (4.5) . The similarity is obvious. The nature of this similarity is simple. In turbulent flows of incompressible viscous fluids the ratio of the number of degrees of freedom of the coherent energy flux from the external donor source and the number of ejected chaotic degrees of freedom is exactly similar to that for the dark

[1] Also it may clear up the clouds in the heads of climate change and global warming doom activists. Although, the hope for it to happen is weak since the second law of thermodynamics confronted with the power of their silly convictions will be easily defeated.

energy continuum as the donor source of coherent energy flux and visible Cosmos ejecting chaotic degrees of freedom Out.

For Earth the role of the fundamental dimensionless constant of Cosmos constant of Cosmos $\mathbf{Re_{max} = R_c = 10^{41}}$ is played by the dimensionless Reynolds number parameter $\mathbf{Re = 10^{12}}$.The former is the number determining the coherent energy flux and the corresponding negative entropy flux from the DEC into visible Cosmos while the former is the number determining the coherent energy flux and the corresponding negative entropy flux from the solar radiation to the Earth's atmosphere through the incredible number of steps and incredible number of diminishing scales all the way down to the smallest scales of animate life and its decomposition and somehow finally emitted by the black body chaotic radiation energy flux with the temperature $\mathbf{T_{Earth}}$of the upper layer atmosphere.

It implies that the smallest scales at the bottom of the cascade associated with organized life on Earth are communicating via all these intermediate steps with order of solar radiation. The solar radiation order is not forgotten in the unimaginable number of order/chaos steps of the cascade. This flux of order is incessantly creating increasingly more coherent entities on Earth.

The same mechanism of coherent scale growth in turbulent fluids creates ocean currents, e.g., Gulfstream, the enormous river flowing for millions of years through the oceans without mixing with surrounding water. Turbulent structures like these are almost immortal on our human life scale, while tropical hurricanes survive up to three weeks in constant regenerating interaction with warm spots on the water surface called mirrors and tornadoes up to a week also interacting with the heated land boundary. These boundary layers, the warm ocean water and hot land, serve as nourishment for continuing survival of these coherent structures. The nourishment is injected up from the outside, sucked in by the low pressure inside the rotating vortices, digested and high entropy energy is emitted out back at the boundaries. This high entropy energy is converted into the random destruction associated with hurricanes and tornadoes. Nevertheless, despite their inconvenience these coherent vortices serve well the aims of RSL. Some of these fierce vortices are very tenacious and die hard only when their mission is accomplished. While tropical hurricanes is the manifestation of release of entropy/chaos by the atmospheric general circulation, entropy/chaos accumulated during the winter time and hence the insufficient order nourishment by convective clouds at the same time they are the source of oceanic currents order and also when touching the warm spots on the ocean surface they replenish during the summer time the order of general circulation with low entropy energy compensating the loss of order during the winter time. Similarly tornadoes are entropy disposal by cumulus clouds. By disposing chaos via destruction they serve as the sources of positive entropy/chaos flux to Earth, which is the same as positive flux of order into cumulus clouds serving for sustaining the coherence of these clouds. All coherent forms of matter want to live longer. The cumulus clouds also do. They are vampires of order from the surface of Earth by releasing chaos on Earth and for this purpose they create tornado trunks out of their bulk. It is all very complicated and twisted, but the causes and aims are the same; to sustain coherence and unity of atmosphere-oceans and other sources of humidity on Earth as the optimal vessel for order to reside in. The complexity of order/chaos cascade to life is the most complicated phenomenon in visible Cosmos with the exception of creation of self-conscious Man.

General circulation of Earth's atmosphere, Gulfstream, tropical storms, tornadoes and clouds hardly can be seen as chaos, although they contain inside and create outside of them a lot of chaos that is the disposed high entropy energy. They all are forced by external sources of order resulting on one hand in growing scale of coherence and disposal of high entropy energy as the heat of the low temperature chaotic black body radiation defines the temperature of the upper atmosphere. Earth as a black body radiates into space by nights the low temperature chaotic radiation. Instead the capital letter Order is absorbed by Earth steadily and inexorably. Nothing except disappearance of Sun and oceans can stop this growth of order and as was noted above both are highly unlikely.

It is easy to find the distribution of energy as a function of growing coherence scale of turbulent structures in the upper atmosphere turbulent flow. Indeed, the growth of coherence scale does not mean that the density energy is growing with the scale. In fact it does not. The kinetic energy density has no idea to which structure it belong. In fact the smaller structures melt

into the bigger ones and so on. The whole turbulent flow is one coherent structure of the maximal possible size, of the order of circumvention of Earth from West to East and East to West dependent on the hemisphere. For each latitude the velocity is one and varies with the latitude. That it should vary with the latitude is obvious since from the symmetry considerations the velocity is zero at the equator. However away from the equator we uniquely determine the kinetic energy spectrum of the turbulent flow as a function of inverse scale **k = 1/l** that is called the wave number and is actually the momentum. Since there is no dependence of this spectrum on l the spectrum is determined uniquely from the dimensional analysis and is as follows:

$$\mathbf{E}_{(k=1/l)} = \boldsymbol{\varepsilon}^{2/3} \cdot \mathbf{L}_{\mathbf{clouds}}^{\mathbf{2/3}} \cdot \mathbf{k}^{-1} \tag{15.17}$$

In (15.17) we neglect anisotropy of the flow and consider the model of homogeneous isotropic turbulence in exactly the same sense as for the Friedman model of visible HI Cosmos. The total energy of the flow is obtained by integration of the spectrum with between $\mathbf{k}_{\mathbf{small}} = \mathbf{L}_{\mathbf{clouds}}^{-1}$ and $\mathbf{k}_{\mathbf{dissipation}} = \mathbf{l}_{\mathbf{dissipation}}^{-1}$. Neglecting with the logarithmic factor we obtain for the velocity:

$$\mathbf{V}_{\mathbf{max}} = \mathbf{V}_{\mathbf{Large}} \approx \boldsymbol{\varepsilon}^{\mathbf{1/3}} \cdot \mathbf{L}_{\mathbf{clouds}}^{\mathbf{1/3}} = \mathbf{const}. \tag{15.18}$$

In (15.18) we again neglect the anisotropy of the flow, the logarithmic factor and the latitude dependence. All these require complicated calculations but not important for the purpose of this review. It is reminded that this purpose is to demonstrate the awesome generality of the second law and RSL in almost all aspects of visible Cosmos functioning that is all arrowed on achieving certain objective. It is this objective that we are after.

It is necessary to add several important comments:

1. The energy flux **ε** is exactly equal to the thermal high entropy energy flux from Earth to space :

$$\boldsymbol{\varepsilon} \sim \mathbf{J}_{\mathbf{OUT}}^{\mathbf{Earth}}(night\ time) erg/sec = \boldsymbol{\pi} \cdot \mathbf{X} \cdot \mathbf{R}_{\mathbf{Earth}}^{\mathbf{2}} \cdot \mathbf{T}_{\mathbf{Earth}}^{\mathbf{4}} \tag{15.19}$$

2. The phase coherence of atmosphere and oceans on Earth is total over a period of time so that order/chaos of respectively former and the latter are in conjunction, although naturally subject to fluctuations.
3. There is a tremendously long cascade of order/chaos steps down from the from the coherence of Earth's atmosphere and oceans to life on Earth. The complexity of order/chaos cascade from Sun to life is the most complicated phenomenon in visible Cosmos. However, it is the self-conscious Man that is the Everest of truly divine complexity incomparable with the creation of life per se. We can only stand in awe in recognition of who we are and what is expected from us by the infinite timeless continuum of dark energy that created us.

Back on Earth the coherence of and between the atmosphere and oceans creates and maintains conditions for the existence of biological life on Earth. To have this life possible the extraordinary specialness is required.

Indeed, the biological life can exist only within certain narrow range of atmospheric and oceanic parameters. If it is too cold or too hot biological life feels uncomfortable, or cannot exist at all. Were it not for tropical hurricanes there would be no moderate temperatures on Earth. Near to equator it would be too hot and away from equator in the middle latitudes it would be too cold. Tropical hurricanes bring humid warm air to mid-latitudes and moderate temperatures near the equator. The same role in leveling the climate is played by the oceanic currents, most prominently by Gulfstream. Storms, hurricanes, clouds level up climatic conditions, bringing water to arid areas of land and doing many other wonderful things. Destructive tornadoes play about the same positive role on the global scale of North American climate. Were it not for the atmospheric jet streams there would be no tropical hurricanes, which are essentially the disposal of entropy by the jets accumulated during the winter time of insufficient convective clouds. It is not possible here to dwell too much on meteorology and geophysics on Earth that are incredibly complex. Our prime concern is to demonstrate the overwhelming imperative of the *second law*

and RSL. The accumulating global Order on Earth must have storage to settle into and this imperative will not be denied. Fortunately for life the amount of order that can be placed in the unity of atmosphere and oceans, the inanimate matter in general is limited. The positive order flux to Earth flows every day. The entropy of Earth is getting less every day for billions of days. More capacious storage of order ought to be created.

It should be pointed that our description of turbulence phenomenon is very cursory. When the details are sorted out rigorously it turns out that generally the turbulent flows of incompressible, viscous fluids driven by extraneous coherent energy source is the state of uncountable diversity and complexity of order, the mathematically uncountable number of rigidly correlated structures, each of them the exact solution of NSE. Each of these structures dispose chaos to extend its lifespan and by doing it surrounds itself with the chaotic cocoon, the environment of different spectral content. In other words there is literally the uncountable infinity of coherent structures and uncountable infinity of associated storages for disposed chaos. The number of the degrees of freedom, although they have nothing to do with freedom since they are rigidly locked up harmonics, is about 10^{40} just for the upper atmosphere of Earth. This unimaginably huge number of turbulent harmonics should be ever, for millions of years held locked as one.

It is absolutely obvious to anyone who has not been yet brainwashed out of the last sense of proportion of the numbers involved that we are in front of something unimaginably special. Earth is absolutely special. However this is just the beginning, just the vessel created for life to originate and evolve. And the coherence of the atmosphere and oceans is just a small prelude to the cantata of Earth and Earth is just the first note of the Nabucco opera of life.

It is fairly clear that to hold enslaved such number of degrees of freedom, for comparison the number of stars in a galaxy is a mere 100 billion, the real peanuts when compared with the number turbulence harmonics of the upper part of Earth's atmosphere, it is necessary to have the information passed between the locked up harmonics with a very large speed, much larger than the speed of fluid elements in the storm. In fact the speed of communications between the harmonics is not connected to the speed of fluid elements. The communication speed is infinite in incompressible fluids and air mixed with water for meteorological practical purposes can be treated as incompressible since the speeds of fluid is much less that the sound speed. This is not really the issue. The real issue is that coherence between all these harmonics is the phase coherence. The phase coherence has no limitation for the propagation speed and is infinite in incompressible fluids.

This is the phenomenon that can be observed in computer simulations of turbulent flows even with relatively small values of $\mathbf{Re = 10^4}$ .Such number of degrees of freedom is what the most powerful networks of contemporary supercomputers are capable to handle. It is truly marvelous to see how the phase coherence even in this low value **Re** flows is established instantaneously all over the flow space domain (Levich E., 2009).

The turbulence phenomenon, when understood on a serious level is a hint to the astounding complexity of mechanisms that the *second law and RSL* invoke and impose to achieve their goals even on the level of inanimate phenomena. However, the end result seems to be clear and predetermined at the very birth of the irreversible time concept.

On a more mundane level it is quite shocking that the whole organization on Earth is imposed by the coherent component of solar radiation that is made cascading down through the literally uncountable infinity of steps of order/chaos transfigurations of unfathomable complexity and beauty[v].

The inquisitorial dogma of random coincidences leading to life through the billions years of "natural" evolution forced on modern society is a gross insult added to grievous injury to the self-conscious mind of Man. The incontrovertible evolution phenomenon is not natural, but an extraordinary special one imposed by the *RSL* exploiting in the very special way the solar radiation as the source of order to create the ever evolving life on the extraordinary special planet called Earth.

Carbon Mechanism.

Carbon is one of the most remarkable materials in Cosmos. Carbon as the skeleton forms incredibly complex molecules. This is where the *RSL* pays attention. It creates more and more complex and order filling carbon-skeleton molecules, carbon-skeleton coherent structures. Of course for this purpose there are oceans available with all variety of chemical elements to unite with carbon. To this end oceans should be turbulent because turbulence greatly increases mixing and frequency of encounters between the chemical molecules. This is called turbulent mixing. Turbulence in oceans is created by the mechanisms described previously.

More and more complex molecules are created, but order is still growing every day and carbon-skeleton coherent structures become insufficiently capacious storage. Around this time RSL finds two mechanisms for the storage capacity amplification.

The *RSL* knows well of the intimate connection between mathematical informational order and the material one and the respective entropies.

The *RSL* knows well that it is easy based on this connection to encode huge amounts of orderly coherent data in carbon-skeleton coherent structures. Thus the DNA appears, is rather imposed to exist on Earth.

But DNA is not only the storage of information. It is also the crucial mechanism of species replication. DNA furnishes sense to replication since death of individuals does not erase the basic genetic data. DNA carries huge amount of digital data to descendants. The random errors in DNA molecules in conjunction with extermination of weak and survival of the fittest principle are the mechanisms of evolution. The fittest species are those who are the biggest vessels for order. It sounds cynical but the growth of order is the imperative aim of the second law and RSL that do not care about fairness to not fit to survive.

The surviving species replicate and multiply and thus the vessel for storing order grows. Sometime before the DNA invention the *RSL* found a mechanism to replace primordial atmosphere with the oxygen atmosphere. It was done by creation of plankton and chlorophyll mechanism we guess. Oxygen atmosphere opened gates to the great mechanisms for the species replication, multiplication and evolution.

Brain as the Most Capacious Vessel of Order

The most complex and capacious vessel for order is brain. Therefore using the above mechanisms and surely many other physiological, biochemical and most probably yet unknown mechanisms brain has been developing in complexity. Brain as a vessel for storing order has been growing.

This is still not enough for *RSL*. The next imperative is to develop a creative brain, the supremely capacious dwelling of order, hugely large in capacity by comparison with all other dwellings of order together. The brain order is competing with the global Order of Cosmos. It is actually a part of Kosmos striving to be equal. Man creates order by giving out the order of his/her brain to creations. This is why we are called Homo sapiens, sapiens.

Humans spend their brain order on doing science, art, engineering, philosophy, music and all other brain generated creations. Brain commands body. Bodies implement the brain abstract data creation into material implementation into material objects. Brain and body work in accord, or one brain uses implementing material order of many bodies and subservient brains that the prime brain can controls as it happens in ants hives and animal packs. However just by brawn it is not possible to build order. The same is with animals and insects. The queen bee is special for the hive survival. Wolf leader must be agile and cunning to bring hunting success for the pack. If the leader is successful he builds capacious order storage. If he is unsuccessful nothing will help him/her. power will be taken away by one means or another.

The determinism is indeed rather shocking. Everything happening on Earth is commandeered by the necessity to accommodate and comfortably settle the growing order coming from space. There are of course fluctuations and aberrations. However over a period of time there are no mistakes and nothing is random in the implementation of RSL imperatives. There are no

alternative histories. What has been-has been and what will be--will be. As it is sung in the old song "the future is not for us to know". In one sense however it may be wrong. While we cannot know the details of the future we may be sure that if a structure, social, state, biological entity seriously stumbles it means that this structure is too a small vessel for the growing order For instance there coherence between the constituent blocks of the structure, like between segments of population in a state is weakening the structure must go. Instead a larger vessel united by the coherence of purpose will arise on the chaotic ruins of the previous one. There is nothing personal against a particular entity or species or Empires in the sequence of rise, dominance and decomposition. There had been nothing that Emperors of Rome could do to save the Roman Empire from the fall. The instant the Empire entered into the Golden age of August and stopped expanding with acceleration it was the beginning of the end. Such events that seem grand to us are not fair or unfair. They are forced by the two prime laws of Cosmos, the *second law and the RSL*.

The implications and consequences are irresistible and irreversible. Either a structure grows in order and power, or it contracts. Moreover if a structure stops expanding with acceleration it is just a matter of time for stopping the expansion of inertia and start contracting. If this decaying vessel does not go peacefully it will be forced to go.

It happens that large structures, like Empires suddenly collapse within a very short time span. However this is an illusion. The signs of approaching decomposition start early and coincide with the end of expansion acceleration. Like our death may appear sudden, but in fact the decomposition has started long ago when we stopped absorbing information with acceleration. It is reiterated that all the above is meant over a period of time Structures may have relapses of activity but short lived.

The above applies to inanimate and animate matter and corresponding order/chaos symbiotic relationship. The mechanisms in charge of inanimate matter as complex as they may be are still hugely simpler and more computable. Inanimate matter does not have conscious aims and is not given the awareness of being. It is just the building material for creation of animate matter. This is why carbon birth and spreading in visible Cosmos had been so fundamental for Cosmos evolution. Of course the quantum mechanics and Cosmos expansion made the abundance of carbon in Cosmos inevitable. But this inevitability was preprogrammed by the imperative of RSL for building the eventual animal body storing the self-conscious human brain.

If to believe the above it looks as if the self-conscious Man along with the simple animate life on Earth is the byproduct of solar radiation. Since order goes on growing animals and insects will evolve into self-conscious species and there will no exclusiveness of Man left and subsequently no reason for Man to exist. This is likely wrong. As much order the solar radiation may furnish Earth and as much of it can accumulate still this order cannot exceed the donor source order. Man and his creations are the totally different level of coherence compared with the merely animate life. If the whole cascade of order in visible Cosmos all the way from the primeval donor source culminated in animal life on Earth it would be a failure, indeed. Animate matter per se has no more sense than inanimate matter. It is not aware of its own existence and the irreversible current of time. This would be a highly unsatisfactory vision of the end of visible Cosmos similar to the heat death of Universe. This and likewise visions are the creations of rational and self-conscious, but depressed minds.

It is suggested that the donor source of order for the self-conscious brain of Man is the primeval source of order, the timeless continuum of dark energy. The human brain communicates with the primeval source ultimate coherence of dark energy medium directly. This is the effect of quantum entanglement, or quantum phase coherence that has no bounds and envelops the entire 4D space/time of visible Cosmos and beyond to the primeval Holy Chalice of order himself. Like the order of solar radiation is not forgotten in the span of infinitely long cascade of intermediate order/chaos steps and is picked up at the bottom by life the primeval order of dark energy continuum is not lost in the cascade steps leading to Sun and is picked up by Sun and transfigured into the solar radiation. However, the dark energy continuum is also directly in coherent communication with the human brain.

This assertion can be seen bizarre unless substantiated with at least some quantitative *raison d'etre*. We will work on it below. In the meantime we refer to the endnote detailing the

extraordinary complexity of human brain in the words of some of the most prominent scientists and visionaries of the recent decades[vi].

Chapter 16

DARK ENERGY CONTINUUM, COSMOLOGICAL CONSTANT AND VISIBLE COSMOS

Following the previous publications (E. Levich, 2013) the following structure of dark energy and Einstein cosmological constant in visible matter is asserted.

Step1. Flux of Coherent Energy into Visible Cosmos

First of all let us determine the flux of coherent energy from the dark energy continuum into visible Cosmos. It is easy to because it must be independent of the quantum Planck constant ħ. This independence is supported by the above reasoning that the start of visible Cosmos in the Big bang is ultimately coherent event and hence the occupation number of photons is a photonic Einstein-Bose condensate at one Planck frequency that corresponds to the initial minimal possible length scale $\mathbf{l_p=10^{-33}}$*cm.* Such ultimate coherence should be described either by classical physics or the quantum one. Therefore the Planck constant should cancel in the final results. From the dimensional analysis there is only one possibility to construct the energy flux from the remaining fundamental constants of visible Cosmos. Recalling the expression for the balance of the coherent energy flux **IN** and the chaotic energy flux **OUT** of visible Cosmos we obtain:

$$\mathbf{F^{from}_{darkE}(E_{statistical}) \equiv -F^{Into}_{darkE}(E_{statistical}) = c^5 \cdot G^{-1} = (3\cdot 10^{10})^5\,(6.7\cdot 10^{-8})^{-1} \approx (10^{60}/\,3)}\ erg\cdot sec^{-1} \qquad (16.1)$$

This is the time independent constant flux of coherent energy at the scale $\mathbf{L_c = 10^8}$*cm f*rom the dark energy continuum DEC. It is reminded that this is the only scale that can be constructed from the four fundamental constants in visible Cosmos: **G, c,** ħ **, Λ**. However, the energy flux itself is ħindependent as expected.

The initial state of visible Cosmos is not visible. It is just one discrete Planck particle that for no reason knowledgeable to us appeared as a crack in the otherwise perfect dark energy continuum. It is this author utter conviction that the attempts of understanding why it happened are totally futile waste of coherent energy. It is a matter of belief that cannot substantiated by any tangible data except that it happened before time despite the semantic contradiction. The time prior to the birth of visible matter is just the mathematical abstraction that nevertheless can be used as other mathematical abstractions. Because it can give us a clue not to why it happened but at least to how it happened. And the answer should not contradict to what astronomers observe very close in time to when it happened, the time when the first visible matter was born.

We note that one Planck particle can be seen as one bit of information and zero entropy or having entropy of one $\mathbf{k_B}$. This is necessary to comply with the relation, in fact the identity:

$$\mathbf{k_B \cdot T_p = m_p \cdot c^2} \qquad (16.2)$$

In (16.2) $\mathbf{T_p}$ is the temperature of the Planck particles and hence it equates the thermal energy and the rest energy of the Planck particle. It may seem that temperature does not have sense for one particle but it still may in this case. This is because the Planck particle as a virtual particle borne from the dark energy continuum lives only the fleeting Planck time $\mathbf{t_p = 3\cdot 10^{-44}}$*sec* . However, we noted above that nothing prevents it from flickering with the frequency $\mathbf{\Omega_p = t_p^{-1}/3 = 10^{-43}}$*sec* .This flickering makes the presence of Planck particle permanent for if averaged over the frequency interval much wider than $\mathbf{\Omega_p}$ it is the same as having it out of the DEC and present in visible Cosmos always. However, chaotic noise is the consequence of the *second law* and the disruption of coherence is inevitable. The noise smothers the perfect coherence of the Big Bang as if creating a width to the perfectly coherent "laser" beam. This is the initial Planck domain space/time expansion and it serves to accommodate the noise frequencies around $\mathbf{\Omega_p}$. This process is invoking the analogy with the pre-delivery stage when the female womb is forced to expand by a baby attempting to exit the womb during the delivery. For the yet unborn baby there is no time. But the force and the subsequent

expansion of the womb can be estimated by the outside medical personnel who are self-conscious of the time passing.

Step 2. Inflation & Birth of Quantum Mechanics

Let us try estimating the time needed for the expanding space of visible Cosmos to reach the linear size $\mathbf{L_c= 10^8}cm$from the initial Planck size $\mathbf{l_p=10^{-33}}cm = \mathbf{L_c \cdot R_c^{-1}}$.We have only two relevant constants to estimate this time, the Planck scale unit and the Planck time unit. The ratio $\mathbf{a_p = l_p \cdot t_p^{-2}}$ is the only quantity having the dimension of acceleration that can be made out of the two. Hence the maximal possible acceleration during the delivery of visible Cosmos:

$$\mathbf{a_p =10^{54}}cm\cdot sec^{-2} \tag{16.3}$$

We will learn shortly the relation between this abstract expansion, the accelerating expansion forced by the pre-delivery visible Cosmos baby, but still before the proper time concept and the establishment of the proper acceleration of visible Cosmos forced by the contemporary cosmological constant. The huge acceleration (16.3)can be seen as forced by a large value of the cosmological constant occupying a very tiny subdomain in the 4D space/time of visible Cosmos:

$$\mathbf{D_{inflation} =D_p \cdot} R_c^4 \tag{16.4}$$

Where $\mathbf{D_p}$is given by (5.4). We can call this stage the inflation stage, although this inflation is not the very popular modern theory of inflationary Universe.

With the acceleration (16.3) the expanding visible Cosmos reaches the scale $\mathbf{L_c= 10^8}cm$ within the first event horizon in the history of visible Cosmos:

$$\mathbf{t_{inflation} = t_p \cdot R_c^{1/2} = 10^{-23}}sec \tag{16.5}$$

It is noted that this "before the time" expansion is the expansion of the dark energy fetus within the DEC. Light is carried along since it is the dark energy attribute, but the causality has not been turned on, since there is no time yet. Neither has it required the EGE calculations. The dimensional analysis is sufficient. When we look back it will appear to us that the causality is turned on when light covers the distance $\mathbf{L_c}$ .At this "instant" the abstract mathematical time metamorphoses into our time, probably.

Since we assigned temperature to the flickering Planck particle it must behave as a black body radiating the photonic energy flux defined by the Stephan-Boltzmann law. From (16.2) we determine:

$$\mathbf{T_p =10^{32}}\mathrm{K} \tag{16.6}$$

This is the incredible temperature of just delivered baby Cosmos that is still linked to the DEC parent by umbilical cord. If we substitute (16.2) into (1.1) taking care that the radiating surface area is that of the Planck particle $\mathbf{4\pi l_p^2}$ we obtain for the coherent energy radiation flux exactly the same ħ independent value as in (16.1). This is significant. This is the creation of light in visible Cosmos. We recall that light is the first creation in accordance with the Hebrew Torah. This happens at the time $\mathbf{t_p}$ Indeed by virtue of (16.1) we have:

$$\mathbf{F_{darkE}^{from} \cdot t_p = c^5 \cdot G^{-1} = (3\cdot 10^{10})^5\ (6.7\cdot 10^{-8})^{-1} \cdot t_p = m_p \cdot c^2 = 10^{16}}erg \tag{16.7}$$

It is asserted that the mathematical abstract time $\mathbf{t_p= 3\cdot 10^{-44}}sec$is the border line at which the visible baby Cosmos goes quantum and starts radiating as the black body with the temperature(16.6). This is the birth of quantum mechanical visible Cosmos. However, there is no time yet since there is no matter to measures it by and no human observer to do it.

Step 3. Birth of Protons

Let us estimate the distance that light travels during the inflation time. We obtain:

$$\mathbf{l_{proton}} = \mathbf{l_p \cdot R^{1/2}} = \mathbf{3 \cdot 10^{-13}} cm \tag{16.8}$$

This is the first Hubble horizon of visible Cosmos. Note that the event horizon due to the inflationary expansion which is not the causal event horizon yet is the ubiquitous $\mathbf{L_c = 10^8} cm$

Now we want to calculate the minimal coherent mass of the string of length (16.8). We assert that this is the size of protons. There are discrepancies between different experiments and the size of protons is usually determined as more than three times smaller. However experiments are made by electron/proton, or other charged particles scattering furnishing the cross-section of this scattering. Hence, what is determined is the size of the three quarks electrical charge spread inside the protons which may strongly differ from (16.8).

Superficially we should have calculated the minimal possible coherent mass of a proton from the equation (11.12) as the Planck particles string having the length of the event horizon $\mathbf{L_c = 10^8} cm.$

However, for the first born visible matter and for the last visible matter near the end of visible Cosmos lifespan this is wrong.

The latter case we will discuss elsewhere. Here we focus on the former one.

Prior to the first born matter event the space/time beyond the Hubble horizon (16.8) is empty of all matter and the event horizon spherical domain is causal only in the subdomain defined by the Hubble horizon. This situation will never repeat during the lifespan of visible Cosmos. Therefore the only causally connected matter can form as a string of the Hubble horizon length(16.8). On the other hand this string can exist not caring about the energy conservation *first law* during the time span that takes light to span the first event horizon distance $\mathbf{L_c = 10^8} cm.$ Therefore we obtain for the proton rest mass:

$$\mathbf{m_{proton}^{quarks}} = \mathbf{M_{Hubble}^{horizon}} = \mathbf{3^{-1} m_p}\left(\mathbf{l_{proton} \cdot l_p^{-1}}\right) = \mathbf{3^{-1} m_p}\left(\frac{\sqrt{\mathbf{R_c}}}{\mathbf{R_c}}\right) \approx \mathbf{10^{-26}} g \tag{16.9}$$

We received in(16.9) the rest mass of protons due to the quarks contribution that is accepted by most in the field of quantum chromodynamics. In the latter it is however based on the empirical experimental value of the total rest mass of protons and subsequent chromo-dynamical computations. The well-known from experiment empirical value of the total rest mass of proton is as follows:

$$\mathbf{m_{proton}^{gluon}} \approx \mathbf{1.76 \cdot 20^{-24}} g \tag{16.10}$$

The total rest mass of protons includes the kinetic energy of gluons and quarks freely moving within a very short space domain of the so-called asymptotic freedom. The gluons are bosons that literally glue the quarks together. They are virtual fluctuations from the quantum vacuum flickering in and out. Hence the rest mass of protons (16.10) is primarily the kinetic energy of the cloud of virtual gluons. This cloud is similar to the cloud of virtual photons surrounding electrons and positrons and responsible for the electromagnetic interaction. The exchange of virtual gluons between the three glued quarks is responsible for the strong interaction that holds the quarks and gluons contained largely, except for the residual sphere of interaction within the proton space volume. Quantum chromodynamics based on (16.10) subsequently predicts that that the rest mass of protons due to the quarks is as we calculated in(16.9).

We noted above that neither quarks nor gluons exist as free particles. They are only observed when a proton is broken in colliders and for a very short time exists as the quark/gluon plasma. After a very short lifespan of the plasma the quarks irresistibly unite back into protons.

Now we would like to explain the meaning of the multiplier factor $\frac{\sqrt{\mathbf{R_c}}}{\mathbf{R_c}}$ in (16.9). The $\sqrt{\mathbf{R_c}}$ nominator multiplier follows from (16.8). It is the total number of Planck particles that in principle can squeeze into the string having the length (16.8) . But why do we divide it by the large

factor $\mathbf{R_c}$? To understand it we must recall the story with **N** Neanderthals who were born as the quantum vacuum fluctuations and should have gone back home into the vacuum within a very short time defined by the uncertainty principle so that to comply with the energy conservation law. But we recall that instead they were chained by a wicked Cro-Magnon that would not let them go back into the quantum vacuum unless work is done by a force to break the chains. This is exactly what happens with the Planck particles. As soon as $\sqrt{\mathbf{R_c}}$ Planck particles simultaneously fluctuate out of the quantum vacuum they are chained together by the strong interaction and coherence is imposed on them. Note that if coherence is imposed on them it means that there is an external source of order injecting the coherent energy flux into the binding chains that we call the proton string and the string must radiate a chaotic energy flux out. If the latter does not happen the chains would fall off, the proton string decomposes and the Planck particles escape back into the quantum vacuum.

This is not the end of the story. The proton string can be coherent for a much longer time than the space inflation time (16.5) not in violation of the $energy\ conservation\ first\ law$ and the uncertainty principle. The inflation time is the time which it takes for light to pass the Hubble horizon (16.8) but not the event horizon $\mathbf{L_c} = \mathbf{10^8} cm.$ This is because to be in violation of the energy conservation law the string should be observed in the whole casually connected space/time caused by inflation and this is the sphere with the radius $\mathbf{L_c} = \mathbf{10^8} cm \cdot$ But for the event horizon to become causally connected it is necessary that light passes it for the first time. We reiterate that this situation will never occur again during the lifespan of visible Cosmos.

Light is assumed to propagate isotropically in all directions within a sphere of the radius $\mathbf{L_c} = \mathbf{10^8} cm.$ The time for light to pass the event horizon distance is:

$$\mathbf{t_{proton}^{event}} = \mathbf{t_p} \cdot \sqrt{\mathbf{R_c}} = \mathbf{3 \cdot 10^{-3}} sec \tag{16.11}$$

It is only if the lifespan of the proton string exceeds the time (16.11) the additional chains to hold the proton whole are needed. In other words the proton mass (16.10) can be true only if the lifespan of protons is:

$$\mathbf{T_{proton}^{life\ span}} = \mathbf{t_{proton}^{event}} = (\mathbf{t_p}\sqrt{\mathbf{R_c}})\sqrt{\mathbf{R_c}} = \mathbf{3{\cdot}10^{-3}}\ sec \cdot \mathbf{R_c} = \mathbf{3{\cdot}10^{38}}\ sec = \mathbf{10^{31}}\ years \tag{16.12}$$

The lesson we draw from the above that the application of the formula (11.12) requires caution. We warned about it in Chapter 10 and now could see what happens if the caution is neglected. We reiterate that (11.12) is correct only for the real event horizon, like for the black holes and the event horizon for the expanding Cosmos, but not for the Hubble horizon. The latter does not define the causality radius of expanding Cosmos and this should be born in mind. However the Hubble horizon defines the coherent component of the rest mass but only once in the lifespan of visible Cosmos.

We indicated what the lifespan of visible matter should be if we know the coherent rest mass component of proton. This is not very useful since we can calculate the lifespan of visible matter and hence visible Cosmos from the first principles. If we cannot do it this review loses merits.

Therefore let us calculate the life time of protons in the exponentially expanding visible Cosmos from independent reasoning.

Step 4. DEC and the Lifespan of Protons

The dark energy continuum is infinite timeless domain and does not have material attributes. The latter can exist only if there is an external observer to perceive them. The material attribute can be observed and their propertied computed only backward in time by self-conscious Man. The latter is a scientific statement. It is not at all metaphysical if one does not wish to enter the millennia old arguments on the nature of time and if the time has sense independent of our perception Anyway in accordance with the ESR it definitely does not have sense prior to having a pair of clocks synchronized by light shuttling between them.

Now we observe the material manifestations of DEC in our visible Cosmos and trying to understand how we had been born in a manner that is not in contradiction with what we can observe backward in time and when we pass a certain limit we can only guess about the period when time was

a mathematical abstraction, the digital data essentially not yet materialized into the material visible matter by the informational *second law* and the ubiquitous Boltzmann constant $\mathbf{k_B}$connecting the amount of coherent and chaotic information with respectively the amount of coherent material order and material chaos.

No doubt as soon as the light is born there are the quantum vacuum, or DEC fluctuations, the emergence of the quarks/gluon plasma and electron/positron pairs, Planck particles and even our visible Cosmos itself, but these fluctuations are short lived and contained within themselves. Unless a stable substantial pair of clocks is born such that light can synchronize there is no real time except mathematical abstraction in the most rigorous sense.

We observe the DEC macro manifestation is the Einstein cosmological constant in 4D space/time. However, we saw above that the delivery of a baby Cosmos still linked by umbilical cord to the DEC parent is mathematically this stage that can be interpreted as inflation of the parent womb. In other words in a tiny subdomain of the 4D space/time of visible Cosmos the cosmological constant is large to be compatible with the acceleration of expansion (16.3).

Step 5. Acceleration of the Hubble Expansion

Let us calculate the acceleration of Hubble expansion in the bulk of the 4D space/time domain that includes the tiny contemporary subdomain. We will do it as follows. We know that the cosmological constant in this 4D space/time domain is the above $\mathbf{\Lambda \approx 10^{-29}} g \cdot cm^{-3}$.The cosmological constant should be treated as an infinite, unbounded domain of incompressible viscous fluid with the constant density $\mathbf{\Lambda}$ and negative pressure. From the *second law* view the visible matter is a tiny discrete subdomain embedded into the dark energy domain continuous, viscous fluid. The fluid does work on the 4D space/time of the visible subdomain causing accelerating expansion of the 4D space/time of visible matter subdomain. We note that the points of 4D space/time are everywhere including the space/time within visible matter. The 4D space/time expands with acceleration which means that the distance between the points is growing exponentially fast and the new 4D points fill in the intervals between the previously adjacent 4D points. However visible matter is contained by the forces holding it compact. Hence visible matter resists the force of accelerating space/time expansion trying to break its coherence that in turn is caused by the *RSL* and is determined by the reasoning that led us to the relation(11.15). This resistance can be interpreted as the negative potential energy binding visible matter into coherent entities, or more correctly as the local 4D space/time curvature caused by matter. This is achieved by the coherent energy flux into the subdomain of visible Cosmos. Since this flux equal to the coherent energy flux from the DEC we repeat (16.1):

$$\mathbf{F^{from}_{darkE} \cdot E_{statistical} \equiv F^{Into}_{darE} \cdot E_{statistical} = c^5 \cdot G^{-1} = (3 \cdot 10^{10})^5 (6.7 \cdot 10^{-8})^{-1} \approx 10^{60} / 3}\ erg \cdot sec^{-1} = \mathbf{constant} \quad (16.13)$$

We note the puzzling duality of the second law and *RSL*. On one hand the coherent flux of energy creates coherence of visible matter on the other the same coherent flux tears it apart. This is because in the long run the local visible matter coherence must give in to the final aim of the DEC, which is establishing the global order in the 4D space/time, which is tantamount to making the whole4D space/time flat and timeless. The DEC gives life to visible Cosmos, with precise upper limit of the lifespan.

Now we have to define how the chaotic energy dissipates at the smallest possible Planck scales of visible Cosmos with the same rate as the coherent energy flux is injected into visible Cosmos. This happens via the viscous dissipation at this scales like it happens in turbulence, e.g., in the upper atmosphere on Earth via the viscous dissipation. We recall that the coherent energy flux of turbulent upper atmosphere of Earth dissipates at the greatly smaller scales compared to the scales at which the energy is injected by the convective clouds and which is defined by the Earth's atmosphere global circulation Reynolds number $\mathbf{Re \approx 10^{12}}$ by virtue of (15.16).

Indeed, the large scale coherent energy injected from the DEC at the scale $\mathbf{L_c = 10^8}$ creates the totally phase coherent , exponentially expanding visible Cosmos that makes use of its intrinsic quantum viscosity disposing back into the EC the same amount of energy it receive from the DEC source but chaotic at the smallest possible Planck scale. In this case the relation between the injection

and dissipation scales is defined by the number $\mathbf{R_c = 10^{41}}$ by virtue of (4.5). The analogy is profound and uncanny for some but very simple. Indeed behind the two phenomena are the same *second law and RSL*. Although the DEC source of order is truly divine but while cascading down the infinite number of steps and metamorphosing as many times down to the Sun and the upper atmosphere of Earth the source seems to lose its divinity and look mundane this is not the case. The cause of the primeval source of order and its distant descendant's sources of order in solar system and on Earth is the same. Moreover due to the total phase coherence of dark energy as incompressible fluid state the timeless or zero time instantaneous coherence between the two makes them one. In this sense the author stands in awe in front of the DEC and its manifestations in visible Cosmos.

Although the DEC is continuous media the cosmological constant dark energy manifestation in visible Cosmos is not. It is a discrete 4D subdomain of DEC. Therefore mathematically it is a manifold of infinitely smaller power than the DEC.

It is clear that if the 4D Planck domain (11.12) is the smallest possible for the matter the same Planck domain is the minimal domain of the 4D space/time domain that the matter occupies and shapes the geometry of. In this case the quantum mechanical viscosity of $\mathbf{\Lambda}$ cosmological constant matter is uniquely determined by the following relation:

$$\mathbf{\nu^{\Lambda} \approx l_p \cdot c = (\hbar \cdot G \cdot c^{-3})^{1/2} = 3 \cdot 10^{-23} } cm^2 \cdot sec^{-1} \qquad (16.14)$$

This expression (16.14) is fundamental and there are no reasons to have any constant in front of the r.h.s. of (16.14).

In the usual molecular structure fluids the role of $\mathbf{l_p}$ is played by the mean free path of molecules moving randomly and colliding with each other. When colliding they experience friction and dissipate energy as heat.

The catch is that the mundane fluids cannot be viscous and exactly incompressible at the same time. They are always slightly compressible because of the discrete molecular composition of and this is why the sound propagation in fluids is possible. Therefore how it is possible that $\mathbf{\Lambda}$ is both rigorously incompressible fluid and viscous at the same time? It is only possible if $\mathbf{l_p}$ is the minimal scale possible and the 4D Planck domain (5.4) is the minimal possible subdomain of 4D space/time of visible Cosmos.

The latter achieves a lot. First of all the speed of light is by definition of the Planck subdomain is the maximal possible speed n the discrete 4D space/time. However, since $\mathbf{\Lambda}$ is also rigorously incompressible media the phase speed propagation is infinite by definition. We have mentioned in above in Chapter 15 that the instantaneous phase coherence can be observed in computer simulations of turbulence in incompressible viscous fluids. In other words $\mathbf{\Lambda}$ is rigorously phase coherent media.

The indirectly observed dark energy, or cosmological constant is the quantum mechanical fluctuations from the dark energy continuum DEC, or the quantum vacuum whatever is closer to once heart. This is not a new idea. However the usually obtained result is 120 orders of magnitude off the mark and hence is totally ridiculous. One should be cautious to apply the usual reasoning of quantum field theories to cosmological constant. It requires multidisciplinary approach to sort out what really dark energy or cosmological constant are.

It is noted that:

$$\mathbf{\nu^{\Lambda}_{DEC}} \propto \sqrt{\hbar} \qquad (16.15)$$

The viscosity of dark energy in visible Cosmos is a purely quantum mechanical effect in discrete 4D space/time subdomain of DEC.

Now we can calculate the lifespan of protons which is naturally the lifetime of all fermion matter. But also it is the lifespan of boson matter since the latter, except photons do not have sense and hence not exist without the former. Photons or light is the attribute of the DEC and is the first creation in what will be visible Cosmos. It is tempting to associate the speed of light with the speed of sound in ether, but this would be wrong. Dark energy matter is incompressible and the speed of light is the intrinsic property of discrete structure of 4D space/time and not at all of compressibility.

We notice that:

$$\mathbf{\Lambda = m_p \cdot L_c^{-3}} \qquad (16.16)$$

We interpret the cosmological constant as a flickering virtual Planck particle in the basic roughly periodic on the scales much larger than $\mathbf{L_c}$given by (4.2)domain of the 3D space volume:

$$\mathbf{V^{\Lambda}} = \mathbf{L_c^3} = \mathbf{10^{24}} cm^3 \tag{16.17}$$

The flickering frequency of the Planck particle in the volume (16.17) is given by(5.5) that we repeat here:

$$\mathbf{\Omega_p = t_p^{-1}/3} \approx \mathbf{10^{43}} sec^{-1} = \mathbf{10^{43}} hz \tag{16.18}$$

Most probably the Planck particle is a string as is naturally assumed in the string theories. The photons are most probably the bosons radiated by the vibrations of the Planck strings, but this is an assertion that we do not substantiate in this work. We assert however that in difference to the Planck particles that are by definition the minimal possible entropy media the equilibrium photons are the primordial chaos disposed by the coherent Planck particles. However at the Big Bang the photons are still coherent since visible matter to interact with and the space/time to thermalize into do not yet exist. It is suggested that by the time the baby Cosmos expands the DEC parent womb up to the spherical size:

$$\mathbf{V^{\Lambda}} = \mathbf{L_c^3} = \mathbf{10^{24}} cm^3 \tag{16.19}$$

The photons are fully thermalized with the temperature such that allows the birth of protons at the time exactly equal to the above calculated value (16.11) , i.e., $\mathbf{t_{proton}^{event}} \approx \mathbf{3 \cdot 10^{-3}} sec$. This is the instant when the **second law** starts functioning and the only state in which photons can be at this time is the state of equilibrium of the first kind, the maximal possible chaos. It is actually the time zero in the backward time count. It is not the mathematical abstraction anymore and visible Cosmos is born with the birth of first proton. If this is the case it has sense to determine this temperature by equating the rest mass (16.9) with the thermal energy. We get:

$$\mathbf{T_{proton}^{birth}} \approx \left(\mathbf{10^{32}} K\right) \left(\boldsymbol{\pi}\sqrt{\mathbf{R_c}}\right) = \mathbf{10^{11}}\ \mathrm{K} \tag{16.20}$$

If we instead calculate from the EGE, or the reduced Friedman equations the equilibrium radiation dominated Cosmos temperature expanded to the sphere with the volume (16.19) we obtain practically the same value of the temperature at which the protons can be born. This further emphasizes the significance of the scale $\mathbf{L_c = 10^8} cm$.

Let us estimate now the chaotic energy flux from visible Cosmos back into the DEC. It is uniquely defined by the known constants $\boldsymbol{\nu_p^{\Lambda}}$**,** $\mathbf{l_p}$**,** $\mathbf{m_p}$ **, c.** We obtain:

$$\mathbf{F_{darkE}^{Into}} \equiv \mathbf{F_{Into}^{darkE}} = \mathbf{\nu_p^{\Lambda} \cdot m_p \cdot c^2} = (\mathbf{10^{60}/3}) erg{\cdot}sec^{-1} \tag{16.21}$$

We note that although the quantum viscosity is $\mathbf{\nu_p^{\Lambda}} \propto \sqrt{\hbar}$ and would be zero if not for the nonzero quantum constant the physical flux of coherent energy into visible Cosmos and chaotic energy out of visible Cosmos are independent of ħ. This is the reminder that the birth of visible Cosmos can be treated both classically and quantum mechanically. The same is correct for the end of visible Cosmos. The end of visible Cosmos is scale invariant relative to the Big Bang event.

The above is profoundly similar to the turbulence phenomenon where the basic quantities are viscosity independent. However in both phenomena this is illusory. There would be no turbulence phenomena in fluids with no viscosity and there would be no accelerating Hubble expansion were it not for the quantum mechanical nonzero viscosity of dark energy manifestation. Nevertheless, the treatment of the phenomena in certain aspects can be either classical or quantum mechanical. Generally it is the duality of ultimately coherent states. In particular it is the effect of large occupation numbers of bosons, like in Bose/Einstein photonic condensate which is the equilibrium state of total order that we call the equilibrium state of the second kind. But it would be totally not

correct for the cloud of virtual photons around charged particles. From the view of the second law this virtual cloud is chaos disposed by the ultimately coherent elemental electrons and positrons. Similarly it is wrong for the gluon cloud enslaving quarks in protons.

Coming back to protons this is clear now why the accelerating Hubble expansion erases matter. This is because the cosmological constant or the dark energy manifestation in visible Cosmos is endowed with quantum friction. However and quite equivalently this quantum friction can be assigned to the 4D space/time of our discrete visible Cosmos. It is in our view is the manner in which the EGE can be in compliance with the *second law and RSL*.

Now at last we can calculate the acceleration of Hubble expansion. This acceleration is caused by the work done by the cosmological constant to smooth the 4D space/time curvature and thereby eliminate entropy/ chaos. From the quantum view this is done by flickering Planck particles. Let us consider a domain much larger than the one in (16.19). Then it is reasonable to suggest that the flickering Planck particles are separated from each other typically by the scale $\mathbf{L_c = 10^8}$. Subsequently for the scales of separation much larger than $\mathbf{L_c = 10^8}$and assuming spherical symmetry it is easy to derive that the acceleration of Hubble expansion is:

$$\mathbf{A_H = (2/3)4\pi \cdot G \cdot m_p \cdot L_c^{-2} \cdot R_{1\leftrightarrow 2} \cdot L_c^{-1} = (2/3)\ 4\pi \cdot 6.7 \cdot 10^{-37} \cdot R_{1\leftrightarrow 2}} \qquad (16.22)$$

Subject to the condition:

$$\mathbf{R_{1\leftrightarrow 2} >> L_c = 10^8} \qquad (16.23)$$

where(16.23) is the distance between two arbitrary points in space $\mathbf{1 \leftrightarrow 2}$at some instant of time $\mathbf{t = t_0}$.

Together with the Hubble velocity (14.1) we readily obtain the exponential law for the visible Cosmos expansion as follows:

$$\mathbf{R_{1\leftrightarrow 2} = R_{1\leftrightarrow 2}(t=t_0) \cdot \exp HT} \qquad (16.24)$$

We still did not explain the meaning of different numerical multipliers in (16.22). The $\mathbf{4\pi}$ factor takes into account that the accelerating expansion is isotropic. The **2/3** factor is phenomenological. It takes account if the fact that dark energy matter is close to the 2/3of the total mater content in visible Cosmos. The remaining **1/3**of the total matter, visible and dark matter in conjunction is trying to retard the space/time expansion. This is a quantitative approach naturally not involving the EGE calculations that are not possible anyway since we do not know the thermodynamical equation of state for dark matter. Nevertheless let us calculate the value of **H** by comparing the (16.22), (14.1) and(16.24). Doing some algebra we obtain with good accuracy:

$$\mathbf{H \approx\ 2.4 \cdot 10^{-18}} sec^{-1} \qquad (16.25)$$

Although there is a constant refinement by the astronomers of the precise value of H the latest data obtained by the European Planck mission of 2013 is:

$$\mathbf{H^{Plank}_{mission\ 2013} \approx\ 2.2 \cdot 10^{-18}} sec^{-1} \qquad (16.26)$$

The agreement between the astronomically observed values (16.26) and our theoretical value (16.25) is as excellent as in the previous cosmological calculation of the density of visible matter (12.3) and the coherent component of the rest mass of protons due to quarks (16.9). Therefore let us proceed further.

The acceleration (16.22) , the law (16.24) and the value of the Hubble constant (16.25) are valid only for the distances and times:

$$\mathbf{R_{1\leftrightarrow 2} \gg L_c\ ;\ t \gg t^{event}_{proton} = 3 \cdot 10^{-3}} sec \qquad (16.27)$$

Step by step we are approaching to the estimate of the lifespan of proton and visible matter in general. Indeed in the above interpretation of quantum friction proton collides with the flickering Planck particle and therefore would experience effective friction on the typical space scale $\mathbf{L_c = 10^8}$and the time scale(16.11). Therefore the effective renormalized viscosity between the dark energy and the protons is:

$$\boldsymbol{\nu^{\Lambda}_{proton} = \nu^{\Lambda}_{DEC} \cdot R_c^{-2}} \tag{16.28}$$

We conclude that the lifetime of proton is:

$$\boldsymbol{T^{life\ span}_{proton} = t^{event}_{proton} \cdot R_c \approx t_p \cdot R_c^2 \approx 3 \cdot 10^{38}}\ sec = \boldsymbol{10^{31}}\ years \tag{16.29}$$

From (16.29) we determine once again that the rest mass of protons due to the quarks is indeed (16.9). More generally the life time of visible Cosmos is(16.29). However again there is a catch. We do not know what the lifespan of electrons and positrons is. This should not scare us. The second law and RSL are incontrovertible. It is the imperative that our tiny, visible Cosmos unites in the oneness with the parent DEC. Therefore we will calculate the life time of electrons shortly. Most certainly it will be the same as (16.29) for protons. It should be reminded that neutrons that are as important for matter formation as protons are intrinsically unstable due to the weak interactions and decay if they are not in nuclei into protons, positrons and neutrinos.

Step 6. Strong Force

What chains quarks within protons is the strong force. Naturally it is the same force that is holding the coherence of Planck particles in the proton string and this coherence is maintained for a hugely long time (16.29). There are no forces at all in Nature. Forces are fictitious. They are just the manner in which we describe the absolute imperatives of *the second law and RSL*. On one hand there is the imperative to have at least he minimal coherent rest mass within the Hubble and event horizons and on the other the imperative of finite lifespan of this coherent rest mass. For instance the gravitational force acting on a body is just the nonuniform acceleration of different 4D trajectories of different constituent components of which the a coherent body consists of. Naturally the trajectories are diverging curves in the Riemann non-flat geometry and the body curves along with these trajectories. The beauty is that the body itself, or in conjunction with other bodies creates the curvature of space/time into which they are embedded. If they are torn apart by a black hole it is just a natural death. The body does not actually move anywhere. This is an illusion. It just occupies certain domain in 4D space/time and the real time enters into this 4D space/time with the imaginary unit in front of it. We perceive this strange imaginary manifestation of real time as the irreversible time concept and the *second law*. Moreover our self-consciousness allows us to recognize the fictitiousness of forces and associated fictitiousness of the time concept. Likewise the strong force is fictitious and just serves to comply with the two imperatives of the second law and RSL. These are to grant protons a coherent component and the lifespan of coherence and to make sure that this lifespan is well defined finite one.

In the above scheme of things the value of strong force holding protons stable during its lifespan (16.29) is easy. Indeed the strong force can be seen as self-attraction of the Planck particles in the string of length *equation reference goes here* defined in as the first Hubble horizon in the history of visible Cosmos.

$$\boldsymbol{F_1^{"WRONG"} = c^4 / G = 0.12 \cdot 10^9}\ dyne \tag{16.30}$$

This is the wrong value and it is marked by the attention exclamation sign. In conclusion we will calculate the value of the strong force as $\mathbf{0.565 \cdot 10^9}$ *dyne* (see Table in the Abstract). We have missed something important. Indeed, protons are charged, since the three quarks are fractionally charged with the total charge square $\mathbf{e^2 = G \cdot m_p^2 \cdot \alpha}$ .We remind that the fundamental, dimensionless fine structure constant of quantum electrodynamics $\boldsymbol{\alpha = (e^2 / \hbar \cdot c) = 1/137.}$ The relation between the electrical charge square and the Planck mass square is we believe elemental since the electrical charge is elemental.

What is important in the wrong expression for the strong force value (16.30) is the fact that it is constant whatever length of the proton string we assume, i.e., $\mathbf{F_1^{"WRONG"} \equiv const}$. It is also physically wrong. Protons are ultimately coherent entity that lives as long as visible Cosmos does. Therefore it should be contained by some irresistible force that holds it within a compact domain with the linear size (16.8). In fact we know what it is. It is the gluons that furnish the rest mass of protons(16.10) which is two orders of magnitude bigger that the rest mass due to the three quarks:

$$(\mathbf{m_{proton}^{gluons}/m_{proton}}) \approx \mathbf{1.76 \cdot 10^2} \tag{16.31}$$

The second issue with (16.30) is that it is $\hbar$ independent which is obviously wrong. To cure both of the issues we notice the following. The Coulomb force of electrostatic self-repulsion of the three quarks is:

$$\mathbf{\Phi_{Coulomb} = \alpha \cdot G \cdot m_p^2 / R_{quarks}^2} \tag{16.32}$$

This repulsive force at a certain length of the proton string occupied by the electrostatically self-repulsing quarks balances the size indifferent force (16.30). This happens at the quarks length within the protons as follows:

$$\mathbf{R_{quarks} = l_{proton} \cdot \sqrt{\alpha}} \tag{16.33}$$

On the top of it the balance between the repulsive force(16.32) and the neutral force (16.30) is unstable and hence subject to vibrations of the proton string as if it was a spring. One can see it from a fairly simple algebra to see that this is the case. What is the frequency of the proton string/spring vibrations? It can be only:

$$\mathbf{\Omega_{quarks}^{vib} = c \cdot R_{quarks}^{-1}} \approx \mathbf{1.69 \cdot 10^{24}}\, hz \tag{16.34}$$

These are gluons generated by vibrations of the proton string/spring. This energy however is contained primarily in a small domain, since the "sound" intensity falls off fast with distance. For outside observer, not distinguishing which part of the rest mass comes from the quarks and which from the fluctuating gluons the protons are perceived as having the total rest energy as follows:

$$\mathbf{m_{proton}^{gluons} = \hbar \cdot \Omega_{quarks}^{vib} \cdot c^{-2} \approx 1.69 \cdot 10^{-3}}\, erg \tag{16.35}$$

The value is fairly close to the experimental value (16.10). If we search for various numerical factors of the quarks string vibration the result we believe would be closer to(16.10). However in this kind of estimates to pursue literal numerical concordance has no merit. We note that if to assume that gluons are consisting of the enslaved Planck particles the prime space volume they must be *primarily, but not totally confined* to is:

$$\mathbf{D_{gluons} = 10^{36}}\, cm^3 \tag{16.36}$$

We also conclude that the strong force within some range of distances is:

$$\mathbf{F^{STRONG} = F_1^{"WRONG"} \cdot \alpha^{-1/2} \approx 8.7 \cdot 10^8}\, dyne = \mathbf{8.7 \cdot 10^3}\, Newton \tag{16.37}$$

As is known the residual cloud of gluons is responsible for the nuclear forces. It is clear why quarks are enslaved in protons and neutrons. They are surrounded by the cloud of bosons with much higher binding potential energy and as soon as the experimentalists in colliders apply energy to break protons by hitting them with other high speed accelerated particles they form short lived quarks/gluon plasma for which it is energetically disadvantageous to stay this way and the instant the destructive power of the experimentalists is off the gluons confine quarks again. This is like if the chains holding

our old friends Neanderthals were elastic. The more they stretch them the stronger is the pull back. This phenomenon is called the quarks confinement.

The second very important phenomenon is called the ultraviolet asymptotic freedom. The latter means that on the contrary at small distances enslaved quarks like our friends Neanderthals in springy chains can move as if they were free. In the scenario suggested above the asymptotic freedom is furnished by the springy balance of the two forces (16.32) and (16.30) the so-called wrong expression(16.30). It is not wrong really, but simply insufficient in that it does not account for the confinement due to gluons. The ultraviolet asymptotic freedom is very important in quantum field theories and other nonlinear phenomena, such as turbulence in fluids. The long range forces furnishing coherence at large separation scales, like the strong force necessarily should be asymptotically free in the limit of very small separation scales. If it is not the theory is wrong. For instance the growth of the coherence length in turbulence with the spectrum (15.19) is only possible since the turbulence is ultraviolet asymptotically free phenomenon (E. Levich, 2009). In the scenario asserted above the asymptotic freedom is fairly obvious when approaching the scale (16.33).

We conclude finally that the coherent component of the proton rest mass is defined by the virtual coherent Planck particles string fluctuating out of the DEC with the frequency:

$$\boldsymbol{\Omega_{quarks} = (\Omega_p / 3)\, R_c^{-1/2} = 10^{22}}\, hz \qquad (16.38)$$

The coherence of the virtual string is guaranteed by much higher high vibration frequency(16.34) defined by the delicately collaborating *RLS* pumping coherent energy into the string and the *second law* furnishing the mechanism of electrostatic self-repulsion of the three enslaved quarks for the disposal of chaos as boson gluons. This high frequency vibration does not allow the quarks to escape back into the quantum vacuum similarly to the photons caught between the fast oscillating plates in Casimir effect that we described above. As surprising as this may be the coherent rest mass of protons is a purely classical value independent of the Planck constant ħ. Protons would have not existed if not for the quantum mechanics and at the same time their coherent component is ħ independent. This is not really strange but shows the extremely coherent nature of protons.

The evident gist of our considerations above and the novelty of the approach are in that we view all coherent entities in visible Cosmos, as well as the total visible Cosmos entity as nonequilibrium systems. Protons are coherent, non-equilibrium entities as are all other coherent entities in visible Cosmos. The chaotic energy flux out of the coherent proton string is the string vibration creating an impenetrable cocoon of very high frequency virtual gluons around it. Since the frequency of gluons is so much higher than the frequency of the string flickering out of the DEC the string is trapped exactly like photons in the Casimir effect that we described in Section 11 and this is the quarks confinement.

It is conjectured that the residence that proton strings build for themselves is not in 4D space/time, but in adjacent dimensions. The basis for this conjecture is as follows. We continue to consider forces as fictitious substitutes for the curvature of space/time. However the tiny mass of protons does not seem to be able to create curvature in 4D space/time. The chaotic boson cloud in this case should play the same role as the Einstein pseudo tensor of curvature plays in the 4D space/time. However, the mass associated with the kinetic energy of gluons is too small to have any effect in the 4D space/time on the scales larger than the Planck scale $\mathbf{l_p = 10^{-33}}cm.$ Therefore it is likely the entropy of protons related to the gluon chaotic component of the rest mass is equivalent to the curvature in these adjacent dimensions. In this case the strong force is as fictitious as the gravitational force and is just the expression of the same *second law and RLS* in the presence of a donor source of order. The primeval source of order is of course the infinite timeless DEC. If the additional dimensions are discrete as the 4D space/time of visible Cosmos is then any number of discrete dimensions can be embedded into the continuum. The discrete dimensions would simply add to the number of degrees of freedom but this add up is of measure zero as compared with the DEC.

The separation of additional dimensions from the 4D space/time is a certain break of symmetry of the space/time itself.. In particular the birth of protons is the break between gravitational and strong forces. Prior to the break there is only one fictitious force corresponding to the curvature of 4D space/time associated with the Planck particles as the smallest possible black holes. We note that for

the Planck particles the Bekenstein/Hawking evaporation of black holes is indistinguishable from their virtual flickering from the DEC.

We conjecture that at the time (16.11) the additional dimension is born still connected by the umbilical cord to the 4D space/time. This birth has sense for outside observer that still is not us. Therefore the time of birth is still a mathematical abstraction. However at the time (16.11) there is a separation and gluons cocoon is built creating the curvature in the space of additional dimensions. In a way protons are similar to the black holes, but not in 4D space/time but in the new space dimensions. In the 4D space/time we observe it as a coherent particle locked in its gluon cocoon. The constituent components, the quarks and gluons cannot be directly observed and in this sense are the event horizon, but in additional space dimensions. In this restricted sense protons are although composite still are indivisible. Also at this crucial time light is separated from DEC and propagates in 4D space/time interacting with matter as the messenger of information between visible matter within the event horizon of visible Cosmos.

Step 7. Electron Rest Mass

We assume that as the totally coherent elemental particle it does not have entropy at all. Hence it all must consist of the Planck particles in ultimate enslavement. Then without repeating the calculations made in (Levich E. 2013) and assuming that electrons lifespan is (16.29) we arrive at the correct mass of electrons $\mathbf{m_{electron}= 10^{-27}}g\cdot cm^3$. In other words if their life time would not be (16.29) their mass would be different and this is obviously incompatible with one hundred years experimental data.

However, what is the mechanism of electrons disappearance? Since they are whole there can be no passage of dark energy fluid through them to cause friction. Electrons relative to dark energy are like solid bodies within the infinite domain of incompressible, inviscid fluid exponentially expanding with acceleration of Hubble expansion. Therefore there is pressure gradient force that accelerates electrons. This acceleration can be gathered as the first multiplier in the product(16.22):

$$\mathbf{A \approx G \cdot m_p \cdot L_c^{-2} \approx 6.67\cdot 10^{-29}} cm^2 \cdot sec^{-1} \qquad (16.39)$$

We note again that the force is fictitious, as it is fictitious always in inviscid fluids. It is just the difference in acceleration due to the finite size of an embedded body that can be expressed via the curvature of the body and the corresponding inevitable curvature of the trajectories of the fictitious point particles of incompressible, inviscid fluid, inscribing trajectories in the curved space/time formed by the embedded body. Except that there is no real time in incompressible, inviscid fluids. It is totally fictitious and the motion in this mathematical abstraction is just the uncountable infinity of diffeomorphic reshufflings of fictitious point particles.

Nevertheless all this mathematical abstraction materializes in events real for self-conscious Man. It is easy to gather that with constant acceleration (16.39) and during the time (16.29) electrons will exceed the speed of light. There is nothing strange in this because the Hubble expansion and its acceleration are not at all limited by the speed of light and ESR. There is no causality violation in the Hubble expansion, like there is no causality violation in instantaneous phase coherence in quantum mechanics and infinite speed of phase propagation in incompressible fluids. This is why there are no incompressible fluids in visible Cosmos except the DEC manifestation in visible Cosmos as the Einstein cosmological constant.

In simple words at the time (16.29) electrons and positrons will all convert into the totally coherent photons that together with dark energy will remain to see the end of visible Cosmos and become one with the DEC of Kosmos.

Chapter 17

BLACK HOLES AGAIN

Briefly in the strict sense of this word the black holes do not exist as they should have been if the quantum effects are not taken into account. Instead the time that it takes for external observer is not infinite but is given by the time of life of visible matter and visible Cosmos(16.29). The curvature at the trapping surface is just $\boldsymbol{l_p^{-1}} = \mathbf{10}^{\mathbf{33}}\, cm$ instead of infinity. On the other hand at the death of visible matter the Hubble horizon and the event horizon will be the same as in the de Sitter Cosmos. Hence the curvature of the event horizon at the end of the world will be $\boldsymbol{l_p^{-1} \cdot R_c^{-2}} = \mathbf{10}^{\mathbf{-49}} cm$. This makes the end of visible Cosmos diffeomorphic to the start of visible Cosmos. Indeed one is obtained from the other by making appropriate inverted scale transformations of the space/time and momentum/energy. In other words we have arrived to one of the fundamental conclusions made in (Penrose R., 2010). The author acknowledges that the ideas of Roger Penrose have had fundamental impact on the concepts presented in this review and in particular for understanding of the imperative power of the *second law* in all phenomena pertaining to the growth order in and of visible Cosmos.

Chapter 18

SELF-CONSCIOUS HUMAN BRAIN

As is clear from the above the protons and electrons are the most coherent matter entities n visible Cosmos. Hence their lifespan is the lifespan of visible Cosmos. Our brain is made of protons, electrons and whatever coherent driven by the second law and RS matter is created by the mechanisms of ESR, EGE, quantum mechanics and field theories. Order on Earth is constantly growing due to the singled out conditions granted to Earth and most likely unique in visible Cosmos despite our hopes that this is not the case. This is the cause of all coherent processes on Earth and inevitable emergence of life on Earth. Life is obviously not the improbable chain of random coincidences and incidents. It is absolutely predetermined to be on Earth. Could it evolve into self-consciousness of Man? No it absolutely cannot. The coherence of Sun amplified by the uniqueness of Earth are capable to create life as a very complex system by sheer accumulation of order during billions of years. But this order is infinitely far from the perfect order of timeless DEC, the dark energy continuum. We believe that the self-conscious human brain potentially matches and when Man grows up equals the perfect order of our parent DEC.

Let us carry out a little calculation, we are fairly confident pertinent for humans. We take it for granted that the maximal longevity of modern Man is not more than 120 years. At least this is stated in the Hebrew Torah and accepted in the Christian Bible. Man was deprived as is known from the much longer lifespan of Adam and Eve.

There is no seriously documented data apart from fairy tales and rumors that would furnish a single example of a human who lived longer. Let us assume for simplicity of arithmetic estimates that the human lifespan is:

$$\mathbf{T_{human} = 100\ years \approx 3{\cdot}10^{9}}\mathit{sec} \qquad (18.1)$$

,

Assume that the self-conscious human brain was conceived by the DEC, at the same time and manner as he first inanimate protons. In other words as the entities having supreme coherence with the lifespan of human individuals $\leq$ 120 years instead of (16.29). The total coherence means that the Planck particles meant for the human brain are chained by the strong force as in protons.

However since this brain is granted only the short lifespan it is possible for the brain to have the rest mass in compliance with the uncertainty principle as follows:

$$\mathbf{M_{brain}^{human} = m_{proton}(t_{proton}\cdot T_{Human}^{-1}) = m_{proton}(3{\cdot}10^{38}}\mathit{sec}\mathbf{)\cdot(3{\cdot}10^{9})^{-1} =}$$
$$\mathbf{= 10^{8}m_p = m_{proton}10^{29} = 10^{3}}\,\mathit{g} = \mathbf{1}\,\mathit{kg} \qquad (18.2)$$

Fairly extraordinary we nearly obtained the well-known average mass of human brain. It is equal to the rest mass of a coherent string consisting of the Planck particles:

$$\mathbf{M_{brain}^{human} = 10^{8}m_p} \qquad (18.3)$$

If we take the human lifespan as exactly120 years the agreement with the statistically averaged mass of human brain would be even better, about 850 g . This level of accuracy is unlikely a numerical coincidence. The probability of coincidence is even much lower if to consider the previous successful cosmological calculations above. It seems that something essential has been uncovered in the infinite complexity of self-conscious human brain.

We assert with considerable confidence that self-conscious human mind is a perfectly coherent string consisting of 10^8 Planck particles coherently vibrating with the appropriate for proton strings frequency (16.34). But all of the protons strings are rigorously phase coherent and the whole human brain string vibrates as one. The vibration of such string creates defensive chaos similar to gluons generated by vibration of a single proton. However the co-phased vibration of the brain string is the mass equal to the typical weight of the body of an adult man. In this sense it is indeed that the self-conscious mind of Man is contained in the vessel of his /her body.

The above concentration of coherently tied up Planck particles cannot to escape back into the quantum vacuum or DEC as the Planck particles of single protons cannot is extraordinary. Given the typical volume of human brain as≅103cm^{3}we obtain 10^5locked coherently vibrating Planck particles per 1cm^3 .For comparison the whole volume of Earth can boast with about 10^3uncorrelated, flickering Planck particles. It is obvious that the unbelievable complexity of human brain is such because of the tremendous density of coherent energy flow from the DEC passing through the tiny volume of the human brain. To sustain coherence the human brain string vibrates and grows a cocoon of body for itself by all the biological mechanisms at the disposal of DEC. This is childhood. When the cocoon is built its sustenance is maintained by order of the solar radiation as all other order is maintained on Earth. However the human brain not just maintains its coherence by taking from the solar radiation and environment. The human brain is coherent on the level of the smallest possible in visible Cosmos Planck domain. It absorbs coherent energy flux directly from the primeval source of order, from the DEC. This is order of ultimate quality that sustains human brain in the state of highest quality. In order to sustain this quality of coherence human brain must emanate chaos. This chaos is human creation.

The last statement is not contradictory since the human creation is chaotic only by comparison with the ultimate order of DEC. The chaos of human creation has more order in it than any other order in visible Cosmos. Moreover humans as species, at least some of the species over a period of time are inevitably evolving since order in their brains absorbed from the dark energy flux can only grow. Subsequently the quality of human creations, the relative proportion of coherent degrees of freedom and the chaotic ones will evolve in favor of coherence. The individuals and manmade societies not succeeding in this evolution of order will be disappearing as not fit to survive. This process over a large enough period of time is as inevitable as the survival of the fittest in animal world and inanimate matter. The ultimate aim of this divine process for humans is to establish the equilibrium state of the second kind between Man and DEC with the creations of Man equal to that of DEC. This is why Man is not only the most complex of creations visible Cosmos but is the most complex creation possible in visible Cosmos. Naturally as many philosophers and especially gifted science fiction writers previsioned our flesh will become an impediment to our evolution and will be discarded.

The above results are indeed puzzling and may seem a bit surrealistic. They are not really and even not overly surprising. The complexity of human brain that makes it different from the next in order of complexity creation of DEC is the self-consciousness. This is really puzzling. Man knows that he is a Man and all human history despite and together with the usual, although high level animal activity and following the demands of growing order on Earth due to the solar radiation finds time to ask about the nature of Cosmos and perceive the current of time back into the past trying to perceive the future. This is a clear attempt to be part of the whole 4D space/time. Even more puzzling is the human dramatic and eternal passion to know what happens when the flesh dies. What animal is concerned about past life, or what will be after? Although amazingly complicated coherent organization the animate life exists and dies in exactly the same manner as the inanimate matter. Out of loneliness we ascribe to animals traits that are more than instincts of survival in the fight between less fit and more fit species. However animal cannot elevate beyond instincts for survival of individuals and species

Man in his perception of time knows that there is more to life than his animal body craves for. Man in creating useless things like great symphonies and mathematics, in craving to learn the secrets of his origin that is at the core of working on cosmology and astrophysics that are the champions of useless knowledge knows that he exists beyond visible Cosmos. Man whether religious or atheistic knows that he is not just a smart animal. This knowledge persists despite all inquisitorial efforts by scientists and thinkers since the French revolution to undermine everything that is not materialistic.

The above calculations indicate strongly that the human self-conscious brain had been conceived together with the concept of time when the first matter was born. All the rest of visible Cosmos evolution since has been the development of an appropriate vessel, a residence to place this self-consciousness into. It is naturally true that when we look into the past we observe incredibly long passage of time, almost 14 billion years of evolution. Except that no one could observe this evolution in a self-conscious manner except our self-conscious mind. But we had not been ready to observe in time since we stayed in the state of pure mind with no appropriate material vessel that was growing

for us. In this sense we were still timeless. It is now that we are placed into the capacious material vessel of our incredibly complex brain and fairly complex body we look into the past and perceive it as objective course of time evolution. From the viewpoint of DEC and for our self-conscious being there was no time evolution but just the tact's of creation.

CONCLUSIONS

We refrain from making conclusions. The issues discussed in this review are diverse and complex. Some of the reported results are quite disconcerting for those staying the course of officially approved scientific approach.

In contrast with the contemporary cosmological conjectures that are void, with the exception of inflation theories, of a single quantitative result and a single prediction that can be tested against the firmly established experimental and astronomical data we have demonstrated the ability to calculate this data with enviable accuracy. While doing the calculations we have neither contradicted the textbook classical and quantum theories, nor fished for smart hypothesis in the thin air. We simply paid due respect to the incontrovertible *second law and RSL*. When done the conclusions followed smoothly without the need for complex mathematical tools and conjectures. To be sure the calculation of the specific equations of motion with specific Hamiltonian mechanisms are extremely complicated as for the theory of turbulence or QCD.

Our approach is fairly conservative. It allows elementary elucidation of complex mundane physical phenomena. We developed the fundamental theory of turbulence in fluids and subsequent emergence of atmospheric coherent entities on Earth (e.g., Levich E., 2009) that is the absolute prerequisite for existence of life. But also the same rigorous application of the second law and RSL cleared the fog about the false mysteries of dark matter in visible Cosmos and many other cosmological phenomena, e.g., the preference of matter rather than antimatter in visible Cosmos.

We believe that the main achievement, if any of this work is assigning the quantum mechanical viscosity to the 4D space/time of visible Cosmos. This puts certain basic troubles with physics at rest. Indeed, the Hamiltonian equations of physics are intrinsically not suitable to impose coherence in visible Cosmos. They must be modified appropriately in a manner such that the quantum friction between visible matter and the space/time in conjunction with fictitious Hamiltonian interactions and forces indeed impose coherence on normal, visible matter and the evolution of visible Cosmos.

This is a serious modification of modern physics shifting the focus from the mechanisms that are fictitious forces and the subsequent Hamiltonian dynamics to the kinetics of nonequilibrium processes of which is the essence of everything transpiring in visible Cosmos and life in it. The immediate advantage is the unification of all forces and mechanisms into one multicomponent digestion force. We saw it in practice when discussing the very complex structure of proton.

As soon as we get used that all matter, visible and invisible are different manifestations of one substance, the DEC and the whole evolution of matter is metamorphosis of coherence at larger scales and less phase locked degrees of freedom into the coherence at smaller scales and more phase locked degrees of freedom and subsequently larger entropy followed by dissipation at the smallest Planck scales it becomes obvious that the forces are just the mechanisms of this metamorphosis, but not the cause. The cause is the second law and RSL, but even higher cause is the primeval source of order, the dark energy timeless continuum into which visible Cosmos is embedded as a subdomain. The DEC forces the visible subdomain to reach the equilibrium of the second kind and become one with the DEC.

Yet another revelation that we have been given to understand is that if it was not for the quantum structure of visible Coamos nothing of the above would have possible. Not recapitulating the content of this work it is enough to remind that the accelerating Hubble expansion of visible Cosmos is only possible due to the quantum mechanics and the quantum mechanical viscosity. The Hubble constant explicitly depends on the quantum viscosity. Without the latter the Hubble expansion would have not existed, like the aeronautics would have not existed in ideal fluids. The similarity is puzzling, but absolutely rational. The coherent kinetic phenomena in general would have not existed if not for real friction forces, although the mechanisms of transformation of coherent momentum/energy into the chaotic one are fictitious interactions and forces.

We suggested the *raison d'etre* for the existence of visible Cosmos and Man in it with clear distinction between self-conscious Man and animate life *per se*. However we validated the philosophy bordering on theology by the rational ability to arrive at quantitative results for difficult and diversified problems f cosmology, physics and seemingly unrelated from cosmology issue of self-consciousness.

We arrived at the numerically correct values of cosmological and physical parameters that to the best of our knowledge is the first theoretical calculations of this kind. In particular the calculation of the mass of human brain is astonishing. Of great importance is the fact that we do not contradict any of the existing Hamiltonian theories and equations of physics, but are complementary to them. We would like to point out that the first author who associated the formation of large galactic structures in Cosmos and the Cosmos expansion with the 3D inverse cascade in turbulence of fluids (Levich E. Tzvetkov E., 1985, Levich E. 209) was Vinod Krishnan (e.g., Krishnan V., 1993) in his paper Clustering of Galaxies by the Alpha-Effect and his further papers. From a private communication with Krishnan we understood that he was criticized by the fluid mechanical community who insisted that the inverse cascade does not exist in 3D turbulent flows. As a result we believe that Krishnan abandoned his further work in this direction. Only after almost 30 years the experimentalists started to see the3D inverse cascade in turbulent flows, although still do not have a trace of comprehension that this is not the inverse energy cascade, but the growth of coherence scale and its cause is the *second law and RSL*. The meteorological community has no clue that this is a major phenomenon on Earth creating conditions for capturing the coherent component of the energy flux of solar radiation. In other words this phenomenon is one of the crucial prerequisites for the existence, evolution and inevitability of life on Earth. This is yet another example of the inexplicable and fatal ignorance of many of the rather obvious fact that the *second law and RSL*is the reason and cause of all order in Cosmos. With no clue to the above it is natural that many contemporary scientists are deep in escapism from the grim, for them, reality that it is not that the narrative of Genesis must justify itself in front of science but the other way around. Indeed, if we do not understand the causes and mechanisms of Gulfstream how can we argue that we are near to understanding of the theory of everything as some eminent scientists do. Just the common sense tells us that this profound delusion that holds sway over the common sense of many.

The conclusion that we arrived at that order on Earth will be ony growing over the time period and there is no end to this growth as long as Sun goes through its prime life cycle and the oceans exist is mind boggling. We believe that Erwin Schrodinger understood it and Roger Penrose does, but we have not seen it worked out in the manner it is done in this work or the conclusion made unequivocally. However, this conclusion is absolutely amazing. In particular it means that whatever crimes Man would do against the stability of environment on Earth nothing will happen to Earth and order will go on growing. However, much can happen and will happen inevitably with the sinning individuals, and societies, e.g., over populated and creating too much chaos that violates the balance of solar order in and regurgitated chaos out. Whatever we do the imperative accumulation of order on Earth will prevail and offenders punished.

The law of growing global order on Earth is also applied to the manmade states and Empires, nations and races. Some of those wallowing in greatness may not suspect that their days are numbered and their fate is sealed by the *second law* while others on the contrary go not have the vaguest idea of fast advancing greatness. However, the *second law and RSL* have passed their judgment on who will rise and who will fall. For most the crash comes unexpectedly and irreversibly. The rise from chaos on the contrary seems always tenuous. The explanations of historians why the rise and falls happened are unfortunately not useful since they are not predictive of the future. Historians, politicians and people at large have difficulty accepting the notion that the fates of states and nations and even individual fates are so much not in their hands and had been decided upon long before they were born or on the contrary by the events that will happen in the future of which they have no way to know. This is unsettling.

The genuine prophets have been few and likely they received the gift of prophecy directly from the timeless DEC. It is also likely that the DEC choses to whom the prophetic power should be granted and for what and the way the DEC is passing judgments is definitely not our way. However we reiterate with confidence and conviction that one aspect of freedom of will remains with us and this is the choice between good and evil. And if we choose evil it is a deliberate act for which we will be held accountable in the ways unfathomable as long as we are in the realm of time.

The writing of this work has been a process and our views have been evolving. In the last endnote we would like to calculate the contribution of dark matter relative to the visible coherent matter that we believe is invariant in time (see the Table in the Abstract)[vii].

We hope that the readers reaching the last words of this review will be long on the way developing their own attitudes and concepts pertaining to the issues addressed above. As far as the author of this work is concerned his position is best expressed in the words of one of the founders of Hollywood. Not wishing to commit himself to a definitive answer to capricious movie stars he would say: "We'll see and that's final".

Acknowledgements.

We would like to extend sincere gratitude to **GrishaFreinman** for many delightful discussions and important comments of substance. The author is warmly grateful to **Jacob Bekenstein** for his frank and healthy criticism of the early version of this work.It is acknowledged that if not for studying the books of Rabbi **Adin Steinsaltz** for a good number of years we would never dare approaching the complexity of issues discussed in this review. My special gratitude is extended to the editor **Dmitry Beilin** for his keen understanding of the manuscript and far beyond the call of duty patience he exercised while working on the manuscript.

NOTES

[I] For the explanation of the Epigraph quoting the first verses of the Creation in the Jewish Old Testament we refer to Hebrew sages of the past and present times. We furnish readers with the article of Rabbi Tzvi Freeman, director of Ask The Rabbi for Chabad.org. who has given his explicit consent to quote this article or the parts thereof with no deviation from the original for which the Rabbi holds all copy rights. Rabbi Tzvi Freeman refers in his article to the writings of the famous Jewish scholars Rabbi Nahmanides, Rav Ashi who lived and worked respectively in the 13th and 14th centuries AD. and to Lubavitcher Rebbe. The translation into English and original explanations are due to Rabbi Tzvi Freeman, director of Ask The Rabbi for Chabad.org.

At the beginning[1] *of Elokim's*[2] *creation of heaven and earth the earth*[3] *being Tohu and Bohu* [4], *darkness* [5] *over the depths* [6], *a wind of Elokim hovering above the surface of the waters* [7],*Elokim said* [8], *"It will be light!"* [9] *and it was light* [10].*Elokim observed this light* [11] *and saw it as good, so Elokim distinguished between the light and the dark.*

[1] These words can either be read as the start of a longer prepositional phrase (conjunctively), as translated here (Rashi), or as a prepositional phrase on their own, "In the beginning," followed by "Elokim created the heavens and the earth" (Nachmanides). By either reading, the Torah is not speaking about *how* the world came to be. Rather, the narrative begins at creation's initial state. It is impossible to speak about the creation of the first instant of time, since there was no instant before it, and therefore no process to be described. Elokim, also, cannot be discussed as preceding the creation in time, since He is not within the time-continuum. Rather, Elokim generates the time-continuum with this point as its beginning.

[2] Elokim denotes a single entity from which all forces extend. The forces themselves have no volition, being no more than artifacts of a higher cause. Elokim, however, is the primal cause, with no preceding cause to determine its actions. Elokim is therefore the primary deliberate entity, freely determining what events will be and what will not. No force, necessity or reason caused Elokim to create in one fashion or another, or to create anything at all.

[3] According to the reading, "In the beginning, Elokim created heavens and earth," the meaning is that in the first instant of creation all of heaven and earth were contained in a single point without dimension or form (Nachmanides). This would be then counted as the first of the ten statements of creation. In terms of Kabbalah, it is a reflection of the *sefira* of *chochma* (wisdom/conception).

[4] *Tohu* refers to the initial state of utter formlessness. *Bohu* is an intermediary state where the four fundamental properties have been established (Nachmanides). These are fire, air, water and earth. These four are not to be understood as materials, but as potential properties of the materials that will come to be. In terms of quantum mechanics they are positive, negative, matter and anti-matter (the Rebbe). From them and through combinations of them will extend all states of matter. Matter itself, however, has yet to come into being. It should also be noted that matter can be found in four distinct states: solid, liquid, gas and plasma. Energy also comes in four distinct forms: gravity, electromagnetism, the weak nuclear force and the strong nuclear force. The ancients also distinguished four domains of the biosphere: *domem* (lit. dumb, mute), flora, fauna and "speakers" (humans).

[5] The property of fire, which is essentially dark. The fire we observe is a result of an interaction between the essential property of fire and the other three elements. Fire is the principal property of the space beyond the earth's atmosphere (Nachmanides).

[6] "The depths" means a basin, where earth contains water. Thus, the properties of water and earth are both mentioned (Nachmanides).

[7] Air's appropriate place is above fire, and so it is associated with Elokim more than the other properties. It was artificially positioned below fire in order to hover above water (Nachmanides).

[8] Or "willed" (Nachmanides). Not a passive statement of desire, however, but a will for an actual event. This is also the meaning of "said": Just as speech brings the inner thoughts and desires of a person into actuality, Elokim says His concept of world into reality. From the perspective of Elokim, there are only events, initiated by statements of will, but no autonomous objects. As Elokim is outside of the time-continuum, so are the statements that initiate these events. From the perspective of the creations, then, each moment of their existence is being renewed from the void by a divine statement of will.

[9] According to the Zohar, this is the first of the ten statements by which the world was created. This must also be the opinion of those who read the entire first verse as an adverb phrase, as with our translation. Although the Talmud states that "In the beginning, G-d created..." is also a statement, this must be understood as a general, all-inclusive statement of intent, whereas actual creation begins with statements of specific actualities.

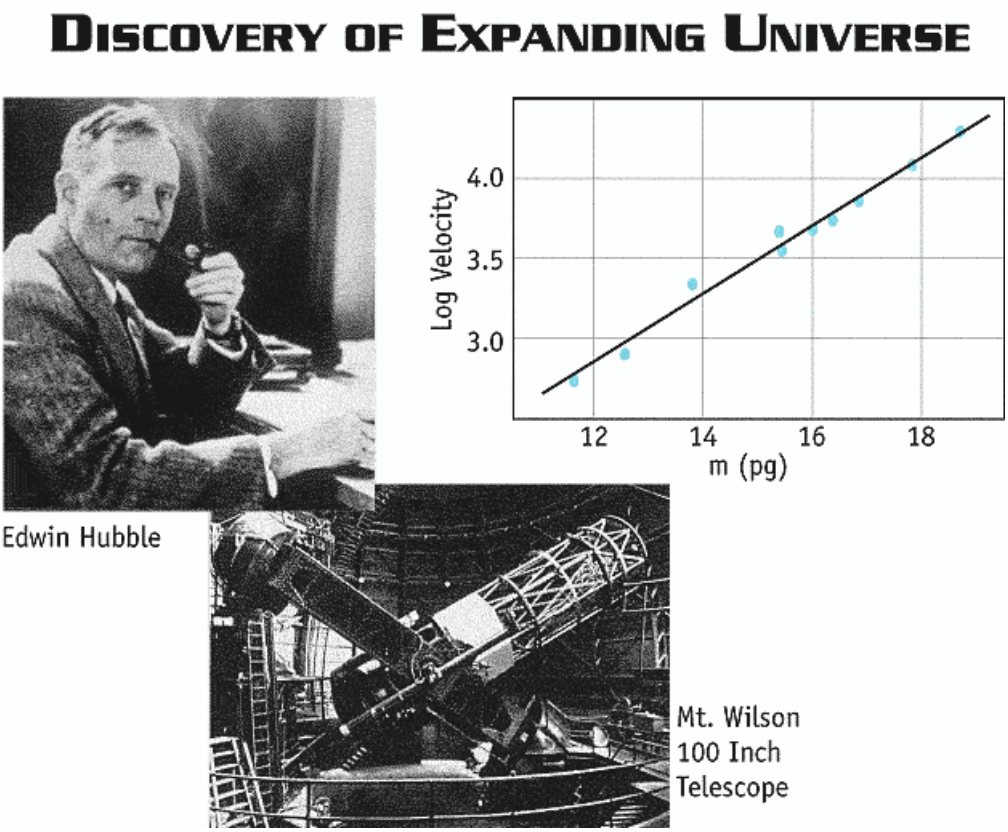
[10] Light is the initial instance of matter, the first true creation.

[11] An aspect of the Creator that transcends the act of creation is now brought into the story. Elokim steps back to observe that which His consciousness is bringing forth. He then draws this higher state into the creation by proceeding in accordance with His observation.

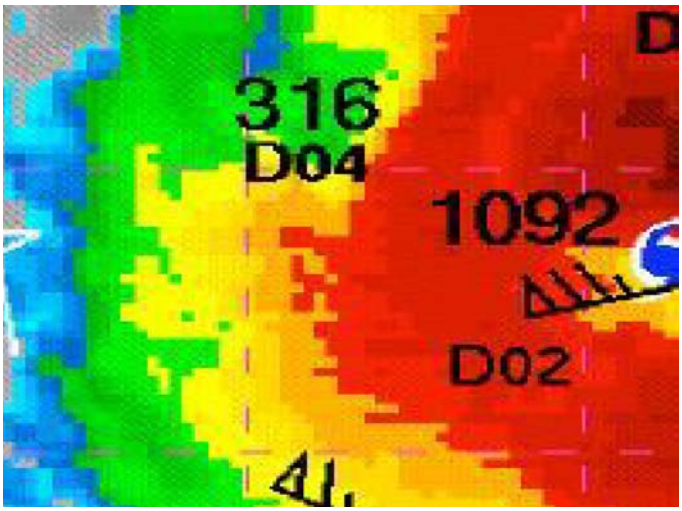
[ii] Werner Heisenberg is one from the *Pléiade* of great scientists and philosophers, Max Planck, Albert Einstein, Niels Bohr, Erwin Schrodinger, Wolfgang Pauli, Max Born, Paul Dirac and Richard Feynman, the pioneers of quantum mechanical world view, the top creators of quantum mechanics and quantum field theories. In particular he was the author of the matrix formulation of quantum mechanics and the uncertainty principle, one of the cornerstones of quantum mechanical vacuum concept. He wrote in his late notes": "The first gulp from the glass of natural sciences will turn you into an atheist, but at the bottom of the glass God is waiting for you.

[iii] This is an acutely complex statement. It is not meant the conservation of energy in our mundane sense. The energy conservation in the very fundamental way is substituted by the Einstein gravitation equations, the EGE. The EGE equates the most general quantity defining matter that is the momentum/energy tensor and the most general quantity defining the space/time geometry that is the Einstein pseudo tensor including the cosmological constant term. The covariant derivative of the both sides of EGE is zero. In nonrelativistic approximation this simplifies into the energy and momentum conservation laws. In reality there are no such laws and there are only EGE. However what is eternal and always correct are the laws of thermodynamics. In this sense the EGE is the most general manner in visible Cosmos that defines the first law of thermodynamics. In simpler terms all processes in visible Cosmos is the redistribution between the degrees of freedom between orderly, coherent on one hand and chaotic on the other. Not surprisingly the curvature of space/time that is naively associated with gravitation consists of chaotic degrees of freedom that are created by coherent degrees of freedom that are mainly contained in visible matter in Cosmos. The main content of visible Cosmos is invisible. Less than 5% of matter can be seen literally. The rest is so-called dark energy and so-called dark matter. The two dark substances can be observed only by what they do. Dark matter increase the gravitational pull inward of stars in the galaxies and other big lumps of matter. More correctly dark matter acts to create negative curvature of the space/time which helps containing the wholeness of galaxies and clusters of galaxies and all other large concentrations of visible matter. We can readily conclude jest based on this action that dark matter is chaos consisting of chaotic degrees of freedom. Their aim is to assist the coherence of visible matter lumps.On the other hand dark energy is the cause of growing order in visible Cosmos as the whole system. This is observed via recently established acceleration of visible Cosmos expansion. Dark energy flattens the curvature created by dark matter. Based on this action we readily conclude that dark energy substance is ultimately coherent.As strange as it may sound all three types of matter, normal, dark matter and dark energy are three manifestations of one dark energy timeless continuum into which our visible Cosmos is embedded as a small subdomain. We recognize that it may be difficult to believe the above statements, but hope that the fog will scatter and the sky clear up by the end of this review.

[iv] Below is the famous photograph of the great astronomer who changed forever our view of Cosmos. However, it would be fair to remember that prior to the Hubble discovery the Russian mathematician Alexander Friedman in 1922 and independently the Belgian priest and physicist Albert Lemaitre in 1927 published papers on the likelihood of space/time expansion, a genuinely remarkable G'd send revelation.



[v] Below we see the Field measurement of a typical tropical hurricane Bonnie carried out by NASA in August 2001 and analyzed by Molinari and Vollaro (2008).In turbulent flows the number of locked up coherent degrees of freedom is defined by the value of topological quantity called helicity. If dimensionless helicity density is maximal possible 1 ± 1 it means the maximal possible coherence. The closeness to this maximal coherence is indicated by the depth of red color. Near to the center of the hurricane the coherence is equal and near to the maximal possible. it is claimed by the authors to be exceptionally high. As we move to the outskirts the depth of red is receding and chaos starts to prevail. The coherent core of the hurricane disposes entropy at the outskirts. The disposal of chaos with simultaneous absorption of order from the warm spots of the ocean are the mechanisms making tropical storms resilient and long living.is the mechanism that makes tropical . Later the same authors analyzed the NASA data for a number of other typical tropical hurricanes and obtained practically the same results. Similar analysis was done by other geophysicists with totally convincing results, e.g., (Levina V.G., 2013). In reality all atmospheric structures from the global circulation all the way down the scale to usual clouds are the machines metabolizing coherent energy and exuding chaotic energy In the meantime they serve Earth and life on it. the most complex production factory in visible Cosmos. (E. Levich (2009).



[vi] Neocortex.

Says Sir Roger Penrose: "What's in our head is orders of magnitude more complex than anything one sees in the Universe: "If you look at the entire physical cosmos," says Penrose, "our brains are a tiny, tiny part of it. But they're the most perfectly organized part. Compared to the complexity of a brain, a galaxy is just an inert lump." Each cubic millimeter of tissue in the neocortex, reports Michael Chorost in *World Wide Mind*, contains between 860 million and 1.3 billion synapses. Estimates of the total number of synapses in the neocortex range from 164 trillion to 200 trillion. The total number of synapses in the brain as a whole is much higher than that. The neocortex has the same number of neurons as a galaxy has stars: 100 billion". "All stars can do is pull on each other with gravity," writes Chorost, and, if they are very close, exchange heat."One researcher estimates that with current technology it would take 10,000 automated microscopes thirty years to map the connections between every neuron in a human brain, and 100 million terabytes of disk space to store the data.Galaxies are ancient, but self-aware, language-using, tool-making brains are very new in the evolutionary timeline, some 200,000-years old. Most of the neurons in the neocortex have between 1,000 and 10,000 synaptic connections with other neurons. Elsewhere in the brain, in the cerebellum, one type of neuron has 150,000 to 200,000 synaptic connections with other neurons. Even the lowest of these numbers seems hard to believe. One tiny neuron can connect to 200,000 neurons.The universe could so easily have remained lifeless and simple -just physics and chemistry, just the scattered dust of the cosmic explosion that gave birth to time and space," says Richard Dawkins, the famed Oxford evolutionary biologist reflecting on the sheer wonder of the emergence of life on Earth and the evolutionary process in his classic The

Ancestor's Tale"."The fact that it did not -the fact that life evolved out of literally nothing, some 10 billion years after the universe evolved literally out of nothing -is a fact so staggering that I would be mad to attempt words to do it justice. And even that is not the end of the matter. Not only did evolution happen: it eventually led to beings capable of comprehending the process by which they comprehend it."

The neocortex, Latin for "new bark," is our third, newly human brain in terms of evolution. It is what makes possible our judgments and our knowledge of good and evil. It is also the site from which our creativity emerges and home to our sense of self. The Neocortex says Carl Sagan in his iconic *Cosmos*, is where "matter is transformed into consciousness". It comprises more than two-thirds of our brain mass. The realm of intuition and critical analysis,--it is the Neocortex where we have our ideas and inspirations, where we read and write, where we compose music or do mathematics. "It is the distinction of our species," writes Sagan, "The seat of our humanity. Civilization is the product of the cerebral cortex."Sagan believes that extraterrestrials will have brains, "slowly accreted by evolution, as ours have," and will perhaps share similarities. He believes any successful, long-lived civilization will, by necessity, have resolved the tensions of our various brain components. Extraterrestrials, too, will have extended their Mind extrasomatically into intelligent machines". Sagan believes that building upon our ability to communicate better, learn better the language and culture, with higher terrestrial cultures-- and extending our intelligence into machines--that when we do finally encounter the Extraterrestrial, we and our machines will be better prepared to understand the *other's* intelligence, language and cultural forms, and machines. "We are a "local embodiment of a Cosmos grown to self-awareness." We have become "starstuff pondering the stars." Penrose has written books on the connection between fundamental physics and human (or animal) consciousness. In the Emperor's New Mind (1989), he argues that known laws of physics are inadequate to explain the phenomenon of consciousness. Penrose proposes the characteristics this new physics may have and specifies the requirements for a bridge between classical and quantum mechanics (what he calls correct quantum gravity). Penrose uses a variant of Turing's halting theorem to demonstrate that a system can be deterministic without being algorithmic. (E.g., imagine a system with only two states, ON and OFF. If the system's state is ON if a given Turing machine halts, and OFF if the Turing machine does not halt, then the system's state is completely determined by the Turing machine, however there is no algorithmic way to determine whether the Turing machine stops).Penrose believes that such deterministic yet non-algorithmic processes may come in play in the quantum mechanical wave function reduction, and may be harnessed by the brain. He argues that the present computer is unable to have intelligence because it is an algorithmically deterministic system. He argues against the viewpoint that the rational processes of the mind are completely algorithmic and can thus be duplicated by a sufficiently complex computer. These contrasts with supporters of strong artificial intelligence, who contend that thought, can be simulated algorithmically. He bases this on claims that consciousness transcends formal logic because things such as the insolubility of the halting problem and Gödel's incompleteness theorem prevent an algorithmically based system of logic from reproducing such traits of human intelligence as mathematical insight. These claims were originally espoused by the philosopher

John Lucas of Merton College, Oxford. The Penrose/Lucas argument about the implications of Gödel's incompleteness theorem for computational theories of human intelligence has been widely criticized by mathematicians, computer scientists and philosophers, and the consensus among experts in these fields seems to be that the argument fails, though different authors may choose different aspects of the argument to attack.[16] Marvin Minsky, a leading proponent of artificial intelligence, was particularly critical, stating that Penrose "tries to show, in chapter after chapter, that human thought cannot be based on any known scientific principle." Minsky's position is exactly the opposite - he believes that humans are, in fact, machines, whose functioning, although complex is fully explainable by current physics. Minsky maintains that "one can carry that quest [for scientific explanation] too far by only seeking new basic principles instead of attacking the real detail. This is what I see in Penrose's quest for a new basic principle of physics that will account for consciousness."Penrose responded to criticism of The Emperor's New Mind with his follow up 1994 book Shadows of the Mind, and in 1997 with The Large, the Small and the Human Mind. In those works, he also combined his observations with that of anesthesiologist Stuart Hameroff. Penrose and Hameroff have argued that consciousness is the result of quantum gravity effects in microtubules, which they dubbed Orch-OR (orchestrated objective reduction).

[vii] Since visible Cosmos is in the quasi-steady state with the total matter density (12.6). it proves beyond reasonable doubt that all types of matter in visible Cosmos, normal matter, dark matter and dark energy matter are all manifestations of dark energy. In different stages of visible Cosmos evolution the proportion between the three manifestations are different. For instance after the brief inflation stage follows the tremendous deceleration of the Hubble expansion to reduce it the contemporary value that is not likely to change till the end of lifespan of visible Cosmos. On the other hand the ratio between the coherent visible matter and dark matter chaos disposed by visible matter remains the same. We can calculate the ratio of the two latter assuming that the contemporary visible Cosmos expansion has reached its very long but final stage. Indeed, from the Table in the abstract we see that the total matter density is with extremely high accuracy equals the critical one. This means that the fictitious forces compensate each other as visible Cosmos approaches the timeless de Sitter Cosmos.There are two opposing fictitious forces balancing each other. One is the combined gravitational force of visible matter and dark matter. The second fictitious force is the Euler force that is responsible for expansion. We should bear in mind that this expansion is the growth of the phase coherence scale and nothing more. This is the reason that the speed of light is irrelevant for the Hubble speed and acceleration. The core force of the gravitational force of visible matter (11.10) is simply: $\mathbf{c^4/G.}$ It is the scale independent quantity and is similar to the "wrong" strong force of proton (16.30). However, we should take into account that dark matter adds to this attractive force. Given the experimental results of the Planck mission it means that another multiplying factor should be inserted in front of the basic coherent matter force. With this factor the force is $\mathbf{((31.7/4.9)^2/9)\,c^4/G = 0.565\cdot10^9}$*dyne.* This is the correct value of the confining strong force. It confines the protons and all visible matter in Cosmos. This is amazing since it shows that all visible matter in Cosmos in the sphere of the event horizon is one coherent string, necessarily closed at the event horizon. When we calculate the balancing Euler force responsible for the accelerating Hubble expansion we obtain and this calculation we leave to readers with a hint that the logarithmic factor discounted in the spectrum (15.17) should be taken into account and the second hint that the Euler force acts only on the visible matter and dark energy we obtain the expression $\mathbf{(68.3/4.9)\,c^4/3G = 0.565\cdot10^9}$*dyne.* The equality of the two fictitious forces proves the point and fixes the ratio of the visible and dark matter till the end of lifespan of visible Cosmos. This corrected value of the strong force allows much more precise calculation of the proton mass due to gluons and the preliminary calculation of the mass of heavy bosons associated with weak interaction and possibly Higgs boson. However we have no confidence in the latter results.

REFERENCES

1. Babchin A., Levich E., Melamed Y. and Sivashinsky G.,Osmotic phenomena in application for hyperbaric oxygen treatment. *Colloids and surfaces B: Biointerfaces* 83(1):128-32, 2010.11.019.
2. Bekenstein J., Black Holes and the Second Law", *Lettere al Nuovo Cimento* 4, 737 (1972).
3. Bekenstein J, Generalized Second Law of Thermodynamics in Black Hole Physics, *Physical Review* D, 9, 3292 (1974).
4. Hawking. S., *Commun. math. Phys*. 43, 199--220 (1975).
5. KlaersJ., Schmitt J., Vewinger F.,& Martin Weitz, Bose–Einstein condensation of photons in an optical microcavity, *Nature* 468, 545–548 (25 November 2010).
6. Krishnan, V., *Monthly Notices of the Royal Astronomical Society*, Vol. 264, NO. 1/SEP1, P. 257, 1993.
7. Levich E., Coherence in turbulence, new perspectives, *Concepts of Physics*, Vol. VI, No. 3 (2009).
8. Levich E., Theory of Order. Part 1,, *Journal "Scientific Israel- Technological Advantages"* ,Vol.14, № 4, 2012 (Letters) and Part 2, *Journal "Scientific Israel- Technological Advantages",* Vol.15, № 1, 2013 (Letters).
9. Levich E., Tzvetkov E., Helical inverse cascade in three-dimensional turbulence as fundamental dominant mechanism in mesoscale atmospheric phenomena, *Physics Reports* 128, 1, 1–37. 1985.
10. Levina, V.G. Helical organization of tropical cyclone, Isaac Newton institute for mathematical sciences, University of Cambridge,
11. *www.newton.ac.uk/preprints/NI13001.pdf*.2013.
12. Molinari J and Vollaro D. , Extreme helicity and intense convective towers in Hurricane Bonnie, *Monthly Weather Review*, volume136, November 2008.
13. Penrose, R. (2004), The Road to Reality: A Complete Guide to the Laws of the Universe, (Pub: Jonathon Cape, July 2004, UK//Knopf, Feb 2005, US).
14. Penrose, Roger, Cycles Of Time, Bodley Head, 2010.
15. Penrose R., Gravitational Collapse and Space-Time Singularities, *Phys Rev. Lett*., 14, 57 – Published 18 January 1965.
16. Schrodinger Erwin, Cambridge University Press, 1944.
17. Shannon Claude, A Mathematical Theory of Communication, *Bell System Technical Journal*, Vol. 27, pp. 379–423, 623–656, 1948.
18. Susskind, Leonard, "The World as a Hologram". *Journal of Mathematical Physics* 36 (11): 6377–6396, (1995.
19. Sunyaev, R A.and Khatri R. . Unavoidable CMB spectral features and blackbody photosphere of our Universe, *Int.J.Mod.Phys*, D22, (2013).
20. Zeldovich Y. B. and Levich E. V. , Bose Condensation and The Shock Wave in the Spectrum of Photons, *Soviet Journal of Experimental and Theoretical Physics* Letters 11 (1970 and
21. Gravitational Waves from Big Bang Detected. A curved signature in the cosmic microwave background light provides proof of inflation and space/time ripple, *Scientific American*, Mar 17, 2014 , By Clara Moskowitz

,