

**THE ROLE OF ORDER AND DISORDER IN  
THERMAL AND MATERIAL SCIENCES  
PART 2: SCIENTIFIC WORLD  
AND NEW INSIGHTS**

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\*Tgegkxgf 37 Lcpwct{ 4224."ceegrvgf 47 Hgdtwct{ 4224+

**Abstract**

Vj g pqvqap qhj gcvku vj qtqwi jn cpcrt/gf cpf ku j kvqtkecnkpmu ctg ugctej rctvkwctrtf y kj "tgrvkvq vj dqvj vj g I tggmrj kvqqrj {"\*Okgukcpu R{vj ci qtgcpu cvgo kmu gve0+cpf vj g kp" vj g rtgugpv fcl" vj gto cn rj {ukeu' Hmwewkvq." urqvwpgkl cpf ejcqu ku fkuewugf0 Vj gto qf {pco keu ku'tgxky gf kp" vj g tgrvkvq vj dqvj vj g vcf kvqpcnfgxgrro gpv cpf vj g o qf gtp f guetkrkvq qh'f kugs wkkdkc"\*qr gp uf wgo u-0 Gltgev'qh'f kvkrkvq ku uj qy p qhvgp vj rtqxf g pgy. ugrtqti cpl gf utwewtgu0Gzrvkvkvq qhltg cpf ku eqpuekvu wug cuc o cpw' hewtupi rgy gt ctg cpcrt/gf kp"vgo u'qh i gpgtckl gf gpi kvgu"v' cev'kp vj g ugpuq qh'cu vj g kplqto kvq vcpuf wegtu0Vj g rctv4 tggcnu vj g ko rcev qh'o cvj go cvkeu cu gzvkvkvq qp uqo g uko rrg ecugu uj qy kpi fgxgrro gpv qh dcuke lf gcu \*xkdkvkvq."vqrqrj {. dltwecvkvu."gve00 Gct vj "vj gto cnpxkqpo gpv'kv'kvewugf kp'tgrvkvq vj "vj g gzkvqpeg qhltg \*cpvqr{ rtkpkrkvu-0 Cngtpekvxg vj ggt{ qh'tgcevkvq/fkvkvq o qf gr'qh vj g urcev'vko g ku rww'kv eqpv'cu vj kj "dki dcpi j {rvj guku cpf tgrvkvq vj "vj g j gty kj /fkuewugf urgekcn' "qh ugrt'ecvrt/gf ej go kecn tgecvkvu0 Vj g vgzv'i kvgu" c eqpvkvkv'xky vj xctkvu"j kvqtkecn cpf o qf gtp eqpegru vj cv go gti gf fwtkpi vj g i tcf wcnwvf gtwcvf kpi qhltgf gt cpf fkvqtf gt0

Mgfy qtfu-Philosophy, energy, entropy, non-equilibrium, dissipation, self-organization, fire as industrial and analytical tool, exploitation of fire, history, impact of mathematics

## 1. Introduction - miracle of life and thermal environment

When *Ncxqctukgt* " demonstrated that respiration is a special form of oxidation and thus confirmed the relevance of thermal chemical processes [33] to the functioning of a living organism it was clear that a certain relation between living and non-living system should exist but would be strongly affected by dispositions of heat. It was found curious that our terrestrial atmosphere contains gases like oxygen and methane, which are very likely to react with each other but coexist and form a mixture staying alive far from chemical equilibrium thus well representing a non-equilibrium open system characterized by a constant flow of energy and matter. The proportion of free oxygen eventually stabilized at 21%, a value amply determined by its range of flammability. If dropped to below 15% organisms could not breath and burning would become difficult while exceeding 25% the burning may become spontaneous and fires could rage around the planet. Oxygen, in fact, was a toxic by-product in the originally massive blue-green bacteria photosynthesis (while splitting water molecules into their components) and its increased atmosphere „pollution“ resulted in these bacteria self-elimination (as a signified global catastrophe). Astrophysics teaches that the heat of Sun has increased by about 25% since life began on the Earth and that, in spite of this increase; the Earth's surface temperature has remained more or less constant, at least at a level comfortable for life to exist during those four billion years. Moreover the heat (radiated and received from the Sun) is befittingly distributed along the planet surface and even the heat transfer. On the micro scale it has enabled the formation of non-equilibrium shapes of snow flakes instead the solid ice that would easy cover the planet surface resulting in more complete reflection of radiation making thus the Earth insufferable. The content of carbon dioxide in atmosphere was likely to buffer the temperature changes since it is one of main greenhouse gases. Plant and animals recycle massive amounts of CO<sub>2</sub> (as well as O<sub>2</sub>) in the process of photosynthesis, respiration and decay but these processes are balanced. The excess of CO<sub>2</sub> is removed from the atmosphere and recycled by vast feedback loops, which involves rock weathering, i.e., granite combination with rainwater to form various chemicals (carbonates). There, however, plays important (catalytic) role soil bacteria as to likely moderate (increase) the rate

of weathering. As the Sun gets hotter, bacterial action in the soil is stimulated to increase the rock weathering and so it pumps more CO<sub>2</sub> out of the atmosphere and thus help cooling the planet by making outlet of infrared radiation easier. It suggests a theory that life could create the conditions for its own survival considering thus the troposphere as an open circulatory system, produced and sustained by life.

This hypothesis of the Earth as a self-regulating system was for the first time presented by *Nqxgrnem* (1970s) and is known as *I ck "j {r qvj guku* [34] in honor of the Greek goddess of the Earth. Its criticism harks back to the old debate between vitalists and mechanists, the latter explaining all biological phenomena in terms of the natural laws. On the other hand the vitalists postulate the existence of a non-physical entity, a causal agent directing purposefully the life process, that is close to *y gqrqi {* (from the Greek *αγρηουφ* - purpose). It was scientifically responded by an ingenious mathematical model called *Fckuf "y qtrf ø* representing a vast simplification of Gaian system where the temperature regulation should be an emergent property of the system that arises automatically without any purposeful action. Two kind of growing species are hypothetically assumed - black and white „daisies“ capable of growing under a certain temperature range only. As the model planet warms up, at a certain moment the equator becomes warm enough for daisy life, their black kind appearing the first being capable to adsorb heat better. With further warming the equator become too hot for the black daisies to survive so that they begin to colonize the subtropical zones and latter even the pole areas. At the same time the white daisies start to appear in hotter zone because they can reflect the heat and cool themselves. If the sun gets even hotter the white daisies can replace the black daisies to help cooling planet and *xkeg xgtuc* if the Sun gets cooler the black daisies can replace the whites to worm the planet by improved heat absorption. Computer result was striking to show that the planetary temperature is kept constant throughout the four above-mentioned phases. In a more sophisticated version there were introduced varying pigments and shapes in the model enabling additionally, e.g., rabbits eat the daisies and foxes eat the rabbits, and so on. The model originally small temperature fluctuations were thus flattened out and the self-regulation become even more stable as the model's complexity increases. It nicely exemplifies the complex game that plays with heat utilization and handling.

People gradually began to suspect that there was a logical order in the universe and that humanity had the capacity to discover it [14]. *Okrugcpu* "vj g birthplace of first cosmopolitan „philosophical“ ideas that made possible to establish a leisure called *æj qrgø* (where people could enjoy learning in their free time) brought the approach in which a single element that contained its own principle of action or change lay at the foundation of all physical reality. Its founder *Vj crgu* (about 6th century BC), was the first who tried to explain all things by reduction to one simple principle, one *ætej gø*. Such a single viewpoint is generally called *ø qpkuo ø* and generalized approach *ç {rq} qkuo ø*. Today's nearly all science tries to reduce the complex world to as few principles as possible and the idea of reduction to a single principle is still alive. The physicist's search for the unified theories (or for theories of everything - TOE, often called *Æpcn'vj gqt {ø}*) can serve as an illustration. On the other hand the Eastern sages have emphasized that the nature of our world cannot be reduced to a number of simple principles and any reduction inevitably include misinterpretation. They are aware of the complex interconnections of all aspects of nature and even of the connection of these aspects with our minds. This new paradigm is called a holistic worldview, or *j qkuo*, seeing the world as an integrated whole rather than a dissociated collection of parts and it may also be called as an ecological view, if the term ecological (from Greek *çknquø* "household" is used in a much broader sense, e.g., to see an engine not only as a functional whole of the composed parts but also to percept how the engine is embedded in its natural and social environment including its manufacturing (raw materials) or functioning (waste management).

The universe has been steadily yielding its secrets and powers to human skill and intellect. Let us see the most familiar geocentric *çvrgo ckeø* system that was based on the empirical idea of and extra logical character that the celestial bodies - the Sun, the Moon and the other planets, revolved around the Earth along "heavenly" circular orbits, which were considered obligatory since a ring was thought to be an ideal, celestial curve (attuning to divine harmony by *R{vj ci qtcpu}*). The extensive calculations needed to compare this idea with the actual astronomical data showed certain inadequacy and *Rvrgo {* (about 1st century) was to use another equally extra logical idea, that of epicycles which was nevertheless unsatisfactory, too. *Rvrgo {* "invented new

and new details thereby increasing its complexity by epicycles of higher order whose center revolved itself along another circle whose center revolved again violating thus the basic concept of harmony. Despite the early heliocentric idea of some previous Greek philosophers, in particular *Cthaxtej qu*"(3rd century BC) who also came to precocious opinion that the Moon is three times smaller than the Earth and the Sun is seven times bigger assuming in the same time the phenomenon of the parallax of fixed stars, the Ptolemaic system was considered evident during the subsequent 18 centuries. Finally *Eqr gtpkewu* appeared who spend the greater part of his life to computational attesting in his time „novel“ heliocentric idea. He came to a satisfactory agreement with astronomical data but the final result was not perfect because the centers of some orbits were somehow displaced and the system again violated the harmony rules of Nature. Also geometrical speculation inspired by idea of Plato's regular bodies lasted till the Renaissance even *Mgrigt* in his work "*Equo qi tcrj kecn'O {wgtkw o* described the trajectories of the five known planets by means of spheres written into and drawn onto these regular bodies with the outermost sphere of Saturn and with Mercury and the Sun at the center. Latter *Mgrigt*"reconsidered the problem still devoted to the idea of world harmony until he had to violate his own believe introducing thus elliptic instead, of previously obligatory circular, motion. If, however, *Rvrgo c{. Eqr gtpkewu'qt 'Mgrigt* would have had a chance to use a computer the whole computationally tedious refining process would appear to be one of intermediate steps with the computer in its dialog regime and all the historically progressive discoveries would have been seen as a mere application of the trial-and-error method.

## 2. Mathematical roots and impacts

Encouraged by the brilliant success of Newtonian mechanics in astronomy, physicists extended it to the motion of fluids and to the vibration of strings and bells. This mastery was conceivable by employing a new limit of infinitely small differences (i.e., differential calculus invented by *Pgy vqp'*and *Ngkdpk*). From the seventies century on, the style of European mathematics, however, had gradually shifted from the traditional viewing of visual shapes (geometry)

to the mathematics of formulas (algebra, derived from Arabic 'cn'lcdt' - binding together; although *Fguectvigu* already invented a method how to make algebraic formulas and equations visible as geometrical shapes). For example *Ncrweg* was one of the great formalizers who boasted that in his famous *Cpcrfvecn'Ogej cpleu* that contained no picture. Thanks to *Rqkpectg* that trend were reversed, breaking the stranglehold of analysis and formulas that had become ever opaque, and turning once gains to visual patterns. It, however, did not follow mere geometry of *Gwertf* but brought a geometry of new kind - mathematics of patterns and relationships known as *vqrqri* (popularly known as „rubber sheet geometry“). In fact, what *Rqkpectg* pictured in his mind is now called a *wtcpi g'vwtcevqt* (much latter refined by *Nqtgp/* or *Wgfc+* gazing thus the footprints of the modern *vjgqt/qhej cqu*. It was forgotten as a few years after *Rqkpectg*'s work on the three-body problem was published (1920s), *Rwpe*m discovered energy quanta and *Gkpwgk* made known his theory of relativity that was regarded as a major scientific breakthrough. Based on the reference-frame dependence of space-time the laws of physics became the most important invariants themselves. Because the laws of mechanics are frame-invariant, it does not matter whether we are walking across of a laboratory fixed on the rotating Earth or placed in the rocket moving fast away from the Earth. It means that we are able to formulate the laws of physics so that they take the same form in any reference frame, which shows, in fact, that heliocentric and geocentric views are equally legitimate. All primary qualities spoken about by *Icnwgq* are yet frame dependent but the mathematical laws governing the physical phenomena are now in a form that displays their invariance. As an example, *vjg gpgti { "ku lco g fgr gpf gpv dgecvug vj g qdugt xgt u kp f kht gpv lco gu y kno gcwt g f kht gpv'xcwgu' lqt "vj g uco g uf wgo . dw'vj g"eqpugt xcvtqp qh gpgti { \*o cuu+j qrf lqt cm qdugt xgt u*. There is also an important psychological perspective that our awareness of being the center of our own experience was merely a projection of our persisting geocentric cosmology. In contrast the heliocentric view implies that the perceived motion of the Sun, stars and planets across the sky is natural by virtue of our Earth's movement. This was the first major scientific revelation of the unreliability of appearances and understanding how our projections shape the world. When the each physical point of view became equally real there is no privilege other than convenience. We may find a parallel in the

Middle way Buddhism's by the emptiness doctrine, which denies inherent existence to all persons and our thinking - not just quantum system lack independent existence.

Such a prolonged idea development helped, for sure, to continuously improved understanding of our intimate Universe but was still far away from entire comprehension of its wholeness particularly in relation to its very beginning and consequent development. Without more encouraged ideas (materialized into complicated mathematical models) and upon a wider application of advanced computational means (enabling multiple alternative solutions) we would not be able to go too far beyond our visual world. In particular we can mention the solution of the sets of non-linear equations that was in early time outside of the reach of ordinary mathematicians until computer's repetitive capacity to almost infinitely approximate got in the beneficial appliance. Such a gradual development of any progressive ideas is delicately dependent on certain introspection and capability to examine secondary characteristics [35-40]. Therefore we achieved a capability to even check up our far-reaching history by mathematical extrapolation brought to bear models answerable for the Universe creation (*Htkf o cpp+* If presumptuous that after the Universe originating brake-point (initial explosion called '*Dki Dcpi*') the mass had been slightly too much, the Universe would have immediately contracted and on contrary, if too little, the Universe would have expanded so rapidly that there would have been no condensation of matter and no formation of stars and consequent life. Also the weak electromagnetic and strong nuclear forces needed to be very delicately balanced. If nuclear forces were slightly too weak, the heavier nuclei would never formed and the universe would have been composed of hydrogen resulting in a very simple chemistry of a single element. On the other hand, if the nuclear forces were a bit too strong we would have had very heavy nuclei and hydrogen would not have exited at all. Successively remarkable H-bridges (Van der Walls bonds) made possible formation of a simple but 'polymeric' compound  $H_2O$  (as a kind of 'fluid glass') thanks to the unique property of molecular orbitals and quantum mechanics, water dimmers, etc. Water thus exhibits several intriguing and almost 'superstitious' properties compulsory for existence of life (displaying some important anomalies, such as irregular density, large

specific and later heats, solid ice lighter than liquid water and high solvating capacity).

On the other hand we should not forget that model of such a sudden creation has definite critiques because it postulates that the Universe was produced from a singularity of 'nowhere' claiming space and time as an distinctive intermediate phenomenon of a limited extension and having expanding Universe to behave somehow *ci ckpwrtwrgu qh'tgcevkpct{ vj gto qf{pco keu*. Analyzing the process of entire blowout it brings troubles with accounting on the appropriate initial critical density, immediate production of the starting energy of  $10^{66}$  J and the initial space growth being  $10^{48}$  faster than the speed of light. All that is presumptuous of the absence of traditional laws within the first  $10^{-43}$  s (so called Planck time when temperature was  $10^{32}$  K) of the Universe growth. To avoid inherent infinitesimally *I wj* suggested *kphxvkpp equo qnqi / kecn'o qf gn* where temperature reached its maximum just at the *Rrcp* time and is supposed to even decrease for the shorter time than  $10^{-43}$  s. This limit state was latter acclaimed upon the super-string behavior of space with curled-up dimensions (i.e., for the associated Planck length equal one where the space compactified radius shows duality with its reciprocation,  $r \propto 1/r$ ). What is taken for grant is the hypothesis that the very early Universe was undergoing severe lost of its high symmetry thus passing two distinct phase transformations (well known from thermodynamics) - the separation of strong interaction forces (at  $10^{28}$  K) and then another separation of weak nuclear and electromagnetic forces (at  $10^{15}$  K). On further cooling the Universe undergone the nuclear synthesis but became penetrated by the homogeneous bath of primary photons which gave both the necessary proof for the Big Bang theory but also puzzled why this relict radiation is the same in all Universe when all its spots could have never been in full thermal contact to share heat transfer (*rtqdrgo "qh jqt k qp*). Getting ahead we still assume the Universe in the view of *Ctknqvgrcp et{ucn'lurj gtg* with its boundary extending along our observatory and computational means (and also theories). As the Universe expands gravity is less and less effective at slowing down the expansion which, however, opposes its recent speed measurements bringing in play the former *Gkpwgkp* idea of antigravity force, now assumed as a general property of empty space (*fctmgpgti {*).



### 3. Heat from sun but who made it?

Our Sun produces energy in a way that depends on a certain balance between the squeezing force of gravity and the expanding generation of energy by nuclear fusion in its interior. If the force of gravity would have been somewhat larger, then stars would have cooked the nuclear fuel much more rapidly and thus their lifetimes would have been unhappily short and for weaker gravity the sun material would not have clumped so appropriately to last. A large number of other details in the laws of physics and chemistry fortunately turn out to be just right. Overall, the properties of our universe need to be strikingly and delicately adjusted in order for life to exist that is anything like what we know. A pertinent piece of information is that all life on the Earth is related to an essentially same origin (e.g., left-handed molecular symmetry). All such observations have been the basis for what is often called the 'antropic' principle (from the Greek '*cpj tqrqu*' /'being the man), i.e., for *J guqlf u*'\*the 8th century BC) the Universe was a moral order and *Uget cvgu*'(the 4th century BC) formulated statement "*y j cvxgt "gzkuu"lqt c "wughwl'r vtr qug"o wu'dg"vj g"y qt m'ql'uqo g"lpvgnki gpegō*. The laws of the Universe are arranged precisely so that the humans can exist, the 'Big Mover' created life and fit to it the laws of Universe - often regarded as the *Ect vgt ai y ggm'cpvj tqrqti kecn'rt kpekriq* (1970s) saying that life itself can determine some properties of Universe. Or we can assume that the Universe was made first and its conditions set up to be competent for life to exist (strong anthropological principle, saying in addition, if life is ever created it would never disappear). This believe found its clearest expression in the famous words of the French mathematician *Nerweg*'(turn of the 19th century) citing "*cp kvngnev'y j kej "cv'c"i kxgp'kpuwcpv'hpgy "cm'vj g'lt egu'cevki "kp'pcwtg."cpf "vj g rqukkqp"ql'cml'vj lpi u'ql'y j kej "vj g"y qtrf "eqpukuu"lwr rqukpi "vj cv'uckf "lpvgnk/i gpeg"y gtg'xcw'gpqwi j "vq"uwdlgev'vj gug'f cv "vq"cpv'ukw/y qwf "go dt ceg"kp vj g'uc o g'lt o wx "vj g"o qvqpu'ql'vj g'i tgcvgu'dqf kgu'lp'vj g'vpxgt ug"cpf "vj qug ql'vj g'urki j vgu'cvqo u=pqvj lpi "y qwf "dg"vpegtv'kp"lqt "k."cpf "vj g'lwmtg."rtng vj g'rcw:"y qwf "dg"rtgugpv'vq"ku'gf gu"O*The hypothetical intellect received the name *Nerweg*'f go qp"popular to ever-lasting discussions until now. Such a sense of uniqueness, however, goes against the instinct of most scientists because it seems so highly improbable so that the existence of even more

universes is postulated each somewhat different or all others being extinct in such an early competition. We certainly have to wait to find whether the uniqueness of physical constants can be approved by natural way. There comes a question how far and to where does our universe allow us to proceed? We certainly will continue to increase our ability to do things as well as the variety of things we can do and such a growth of knowledge can hardly be stopped in natural way unless a catastrophe would come into view.

We should also remind that no a real system can be absolutely closed, i.e., isolated from the outside influence. Astronomical systems are mechanically well isolated and thus we can relatively precisely compute the development of such a cosmos. For example, the movement of the planets in our Solar system can be determined for a period of several millions of years with accuracy to about 13 decimal places. French mathematician *Rqkpectg* showed, however, that our mathematical potentiality as to calculate the movement of gravitationally bounded bodies is strictly limited because of the solution problem of many bodies, such a system cannot be evaluated properly enough by mere analytical means (integration of relevant differential equations). It was a factual collapse of reductionalism. However, the era of powerful computers has made possible iterative solutions practically solving most of mechanical problems in the field of astronomy (as well as could easily trace out the complex trajectories that *Rqkpectg* did not even attempted to draw). Computers made also possible to draw natural features (cloud, tree, grass) that *Ocfgrdtqv* [32] coined the term *†tcewnuø* stressing that *†jku pqp/lpygi tcn †tcewn+ i gqo gt{ "qh pcwtg fgcm ykj cp curgev' qh pcwtg vj cv' ctw quw gxgt {dqf { jcf dgpp cy ctg qhdwppdqf { ycu cdng vj f guetkdg cpf xkwcrk} g lp"lqto cno cvj go cvecn'vgt o uø* Idea of fractal dimension corresponds in a unique fashion to the geometrical shape, which is not strictly integer - Euclidean (see previous part 1).

Computers, however, are still not sufficient to properly evaluate everyday atmospheric changes based on the highly non-linear meteorological systems that are so sensitive to the initial conditions. Any of the primary negligible variations of the impute parameters can dramatically enhanced and distort results. Thus it becomes hardly computable in a greater scale than hours and days although prediction or even control of weather has been a dream of many generations. It is interplay of primary heat that induces contemporary changes

in the temperature, pressure and the content of water vapor. Even the energy included in an atmospheric process is very high in the human scale (the heat involved in an average windstorm can easily exceed that concealed in the explosion of a nuclear bomb). A refinement may be still possible for future generation of scientists, as all written history has uniquely occurred in only less than about 100 human lifetimes. Most of science has developed within the last couple of hundred years and a large fraction of it is enjoyed during the lifetime of those of us who are witnessing it, however, somehow out of capacity to fully absorb such a fast growth of our knowledge that is tending to be "(un) desirably" exponential. Our understanding of life intricacy and world complexity should advance remarkably, but to what extent will humans succeed in understanding it with any completeness of our minds and personalities is difficult to foreseen. Are there new phenomena imbedded in complexity that we have not yet grasped as just we did not dream of *swcpwo o gej cpkeu* [41,42] before we could examine subatomic particles, imagine them as packet of waves (QM dualism) and consider and start searching for yet hidden, deeper-buried sub-particles? In the progress of particle's understanding we went from elements, to atoms, sub-atomic electrons and protons down to sub-nuclear quarks distinguishing even particles reactions on bases of strong and week interaction (hadrons from the Greek '*j cftqu*' - fat, thick and leptons from the Greek '*rgrvu*' - tiny, thin). Nature does not show us any isolated building blocks but rather emerge as a complex web of relations between various parts of a unified whole. The father of QM *J gkugpdgti* said "*vj g" y qtif " vj wu" crrgctu" cu" c eqo rrtcevfg " kuuwg" qh' gxgpvu" kp" y j kej eqppgevkqpu" qh fHgtgpv' nkpj cwtgpcvg qt qxgtxr qt eqo dkpg cpf vj gtgd{ f gvtg o kpg vj g vgzwtg" qhly j qrgō* Similarly, in biology the basic elements were first organisms or species (noting its well developed classification for plants and animals), than cells, its macromolecular parts (enzymes, proteins) down to molecular structure of DNA and its three-dimensionally written message. According to *Ecrtc* the key to a comprehensive theory of living systems lies in the synthesis of the two different approaches, the study of substances or structures (where we can measure or weight things) and the study of forms or patterns (where we have to map configurations and relationships). In the other worlds, we have to pass between quantities (structures) and qualities (patterns) because systemic properties are properties of a pattern. Already *F go qetkwu*

tried to complete a unified account on the world and his best-known works were "Vj g I tgcv'Qtf gt" (macrocosms) and "Vj g Ub cmY qtf" (microcosms) the latter being his view on the human beings. He expanded the atomic theory of *Nguekrwu* who also affirmed the existence of empty space ('ngpp'), maintaining the impossibility of dividing things ad infinitum arguing the eternity of existence of elementary particles - atoms. All motions were the result of above-mentioned active and passive affection (nowadays forces) formulating thus the basis of the law of necessity by which all things in nature are ruled. Also *O grkumu* (5th century BC), an autocratic spokesman of Eleatic school, substituted the concept of nothing or not-being by the speculation about free space, a vacuum, or void ('ngpp') saying "pqt 'ku cp{vj kpi go rvf = lct y j cv ku go rvf ku pqvj kpi =uq pqvj kpi y km pqv dg dgkpi qh pqvj kpi ku pqv dgkpi ð0

#### 4. Modern world of science

Only in the recent decades the adjective '*grgo gpwt*' is no longer fitting modern science as the elementary particles can be transmuted into other elementary particles or can be created from energy and can vanish into energy. The equality between mass and energy provided crisis of the very concept of material substance, first real complication of our yet comfortable understanding of the Universe. *Gpungkp* genially concluded the equivalency (undistinguishability) of forces due to gravity and acceleration that made consecutively possible to view the deep Universe-macrocosmos as a smooth but curved space. It, however, was not compatible with the microcosms observed through eyes of quantum mechanists particularly when going down to measures comparable with the so called *Rxpemwprvgpi vj* of  $10^{-35}$  m (naturally derived as a square root of the product of Planck and gravity constants divided by the speed of light to the cube power). Thanks to the *J gkugpdgti rtkpekrig qh vpegtvkvf*. the Universe appears within such a super-ultra-microscopic dimension full of extravagant, vehement and fiery fluctuations often known as 'boiling vacuum' (*Vtc{vpp}*). Incorporation of these both conceptions (of general relativity and quantum mechanics) into one consistent approach was seen impossible although it was a dream not only of *Gpungkp* but also of many

other distinct scientists. It was true until the 1980s when appeared a new theory more suitable for our 'elegant' Universe as based on an old Pythagoreans idea of chord harmony tuned in rational ratios. This so called *uwr gt utkpi vj gqt { (I tggp. Uej y ctvu)* [42] is mathematically based on the structure of vibrating strings (of various shapes and under certain tension) that factually represents non-material tiny fragments, little filament (of hidden dimensions) infiltrating the Universe to cooperatively and harmoniously acts as a symphony of cosmic breath (often dedicated to *Chryu* the Greek goddess of wind). The Universe is displayed in terms of somehow strange geometry of compactified multi-dimensional space (called and visualized as *Ecr:dk[cpq o cphqif)*). The known human physical laws are here interconnected by principles of symmetry, i.e., four types of forces must naturally exists to enable the nature to respect given calibration accord and the original question why there are such forces is now reduced to why the nature does respect such symmetry. It is also seen and understood that the 3-D symmetry is most reliable and useful space when solving real wave problems (Schroedinger equation) and, practically, 3-D is only capable to contain the functional knots (e.g., in 2-D it is impossible to tie them and in 4-D they become loose lacking their fastening functionality for binding). During the second super string revolution in the middle of nineteen's the string idea was further refined into an even more promising mathematical 'ethics' called (*Y kwgp+ as O/vj gqt {* (i.e., Magic, Mystic, Mother, Matrix, etc.). It is accounting for the multi-dimensionality of both the super-gravity and time-space, however, yet waiting to be well enough explained as the ultimate and logic challenge of this Millennium (i.e. as a true *hpcn'vj gqt { +* It would likely be seeking symmetry super-partners to existing particles, circular, curled-up and other yet hidden dimensions, mirror symmetry, strong-week duality and even time-space disruptions (conifold, wormholes) and ensuing mutations of universes (multi-cosmos possibly originating through black holes) and other not yet well understood notions often known more from 'sci-fi' literature. It is retaining, however, fundamental view of eternal vibrations as the most well acquainted aspect in describing heat.

The Universe pre-history should also be re-inspected (*I curgtkpk Xgpg/kcpq +* i.e., looking for time when the primary Universe was cold and extremely large and smooth and where fluctuations could create satisfactory

amount of matter in the form of such string-wave pockets (pseudo-particles), which due to their mutual attraction can create curvature of the originally flat (space-time) universe. It does not oppose the law of mass and energy conservation as the created mass is compensated by the attractive energy. *J cy nkpu* and *J ctvrgf* extended this approach trying to describe the constitution of time and space from a primary Universe wave function (in fact from a kind of absolute 'emptiness') looking thus for an alternative to the singularity of Big Bang. It again is close to the view of Greek atomist in which atoms were not created. At the beginning of the world an infinite number of atoms of countless shapes and sizes were constantly impinging upon one another in all directions. There was infinite number of places where vortex motions were set up causing the mutual impacts so that the larger atoms were created. The smallest and most rounded atoms preserved their original motions being associated with atoms composing the fundamental fire and soul. *Ngwkr rru* was saying, "*Pq*" *vj kpi eqo gu cdqw'kp xckp dw'gxgt{vj kpi lqt c tgcuqp \*vqi qu+cpf d{pgegukv} \*εpcngφδ* These words may be taken as a first representation of the principle of causality. *J gtcerkqu* uttered that the principle of the universe is *hwz* or *ej cpi g qhdgeqo kpi* which implies that everything is and, at the same time, is not claiming that the existence of opposites depends only on the difference of motion "*vj g y c{ wr cpf vj g y c{ f qyp ctg qpg cpf vj g uco gδ* Chinese physicists *Ew vmpi* proposed the sub-nuclear wave theory of ether based on *Mqphwckw* idea of transmutation - bipolar ether of mutually transmuting states of '*Lk*' and '*Lcpi*' *0* The concept of ether, however, was strictly refused by relativistic physicists but the founder of wave theory, *Oczy gm*, assumed from the beginning that environment, which surrounds and intermediate the electromagnetic waves, is ether the concept of which was in accordance with the classical *Pgy vpkp* understanding of absolute space (and absolute motionless without inherent arrow of time while *Ngkdpk*. on contrary, understood space and time to merely depict relations between objects and events).

*Rqkpectg* (1890s) stated the principle of *tgewttgpeg* (any isolated system returns in an enough long time back to its original state) thus undermined the notion of time, too. Latter on, *Nqtgpv* proposed transformations, the mixed space and time axis retaining ether valued at the strange contraction of physical bodies traveling through the space. It was very close to the famous

*Glpuwkp* theory of relativity, the existence of ether, however, was refused upon the notable *Okej quqp/Oqtngf* experiment with interferometry of two monochromatic perpendicular light rays that proved the absolute speed of light. Historical cosmology always assumed that ether is something celestial and indestructible (*'ckjgt'* meaning glowing, flickering, possibly related to the Aristotelian *'rtqvgj{rg'* - primeval matter). It gave birth to material universe in such a way that a delicate impact (*'dwf'*) in such a 'reactive solution' provided dissipation structures ready to grow. This idea is very close to the *tgcevkqp/fkhwukqp o qf gn'qhurceg/vko g* by *NcXkqrgwg* [43]. It is different from the so far accepted 'mechanical' anticipation of waves resulting from the primeval explosion that would never occur without reason-spontaneously and where the waves transporter medium holds on constant entropy (conservation of energy). On the other hand the diffusion waves can interact with carrier to undergo metabolic changes, enables entropy to increase and, most important, become self-organizing (and thus non-linear in character assuming Universe as an open and willingly evolving system, behaving alike weather).

As discussed in the Part 1, the self-organization approach is well known in chemistry for cross-reactions [44-47] where reactants pass between inherent reactions to form a closed loop (*\jcdqvkpurnf/Dgrqwuqx* chemical reactions or a computer simulation of self-organization known as *Dt wuugrcvqt*), cf previous Part 1. Such system has two states, sterile environment of sub-critical reaction and fertile environment of super-critical reaction. The latter can provide localized dissipative structures (e.g., wave's packet of hypothetical units) put to use in the speculative reaction-diffusion model of the self-organization of Universe. They may be hypothetically called 'etherons', hypothetically assumed particles like 'infons' or (in the earlier bosons string theory) 'tachyons' or more true (M-theory seeking) 'gravitons'. As a result we might even explain the red shift of light not on the traditional basis of planetary objects speeding away but by the phenomena called 'tired' light that loses part of its energy (that 'gen' energy that can be accounted for the discrepancy in relatively higher illumination of a red giant). It is interesting that even *Vgurc* in his theory of electricity proposed existence of such stationary waves in a compressed ether. In general, we should keep in mind that such a kind of self-organization property is familiar and next to our thermochemical sense even though it yet sounds superstition. There, however, are serious scientific proves

of self-organization that were thoughtfully demonstrated as early as in the seventies century and are known as *Tcrngkj/Dgtpctf* hydrodynamic self-organized instabilities due to already mentioned web processes of mass and heat transfer (cf Part 1. [30]). This phenomenon is particularly important in our terrestrial conditions of gravity force that drives density to move along gradients (based on convection) usually displaying conduction versus convection critical point (cf. above mentioned Bernard's instability). Therefore, non-linearity, both in the greater scale of environment or smaller case of reactions, appears as a basic execution procedure made acquainted by our imminent Universe and it can be understood as a kind of auto-catalytic process where the product self-catalyze itself by positive feedback (morfogenese, gastrulation, vortices). Its theory was introduced, in more details, by British decoder specialists *Vutlpi* (1950s) [48] when he was analyzing the symmetry breaking of growing embryo as well as other interesting aspect of self-organization. More details as well as other fascinating spheres of such novelty activated for holding self-acting systems lies, unfortunately, beyond the capacity of this text which is not even giving an exhausting answer to what extent is heat a source of order or disorder.

Although we tried to start at the text-book level of traditional thermo-statics [5,49], pointing out the development of non-equilibrium [25-27] and rational [50,51] thermo-dynamics we still could not get accross even the basic aspects of chaos [52-56], the domain most responsible for the current progress of our understanding the nature. Likewise this assay may be seen to be written somehow chaotically. This way, however, can be quite inborn while depicting particularity of how we can 'self-organize', which, in fact, is a part of any story dealing with a broader portrayal of disorder [52-56].

## 5. Conclusion - where we are going?

There follows a concluding question if such (and if any of) a complex system can ever have enough power to understand itself? Our brains contain about  $10^{14}$  synapses, or in modern jargon, 10 millions megabytes of information and all of them interacting. The brain complexity is sometimes taken commensurable with the extent of Universe. Can the human mind



understand with any completeness something as complex as itself or is it essentially impossible for any such complex system to do it? Can we ever recognize the mathematical beauty of a final theory based on super-symmetries and if yes and if the Universe can be adequately described by five yet existing super string theories, which is most suitable? Thus we can ask (*Ykwgp*) who would live in the rest four equally well-described Universes? Are we to plan what changes in humans will take place and then carry them out over relatively short periods of time neglecting the long lasting experience of nature in its gradual evolution? Who is to determine which ways are allowed or be justifiable? How far do we dare threaten Nature's more random evolutionary process in the future development of humans (cloning)? We surely will search for some sense of 'doing good' in the way of human's enrichment, however, that may be difficult to be precisely defined? Some of our goals will be like those of the past - encouraged by human curiosity, and interest in exploitation and enough coherent action on the part of some fraction of our population that knowledge and capability to modify our circumstances will continue to grow. Consequent increase in human abilities to manipulate our universe and the nature of human life itself presents us with increasingly big decision that will necessarily be based partly on knowledge and partly on other, yet unknown things. In ecological and environmental areas we must decide how much to compromise the immediate use of resources in order to protect ourselves and to what extent do parts of our Earth (and even Universe) have intrinsic values that are comparable to those of humans. We have to deal with carefulness, appreciation, understanding and affliction of yet intimidated heat. Our Sun has another few billion years of much the same benevolent heat support for us providing thus free energy sources to make possible our survival leaving much space to think about it most seriously even accounting on certain prophesy.

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*Cpcnqi qwur'vq vj g rtgegf kpi rctv3. 'vj g rctv4 qh'vj g ctvker'cnuq dgrupi u vq'c"eqpf gpugf rctv qh'o { pgy r' "y tkwgp dqqmšJ gcv Vgo rgtcwtg."Uekgpeg cpf Uekgvõ. y j kej ku k'vj g eqwtug'qhrtgrctcwkq lqt vj g {gct 42250vj g vgzv*

*y cu'y tkwgp'kp'c'eqo rtguugf 'lqto 'cpf 'kp'c'o qtg rqrwct y c{0Kku cnuq dcugf qp o { 'tgegvpvzr gt kgpeg y kj wpkxgtukx eqwtuguf kt gevxf vq'vj g pqxgn'rtqi tco qh'etquw/fkuekrkpct{ gf wecvkqp dtqwi j v cdqww pfgt vj g rtqlgev I C ET Pq 623D24D79; cpf vj g cwgo ru vq etgcvc pqxgnlqto qhi gpgt crk gf gf wecvkqp kp'vj ku kpvgtfkuekrkpct{ ctgc0 Vj g cuuqekcvxf vj go g ku vj g gzvwpukqp qh qwt rpi ruvki tgugctej fktgevxf vq'vj g uwf{ qh pqp/gswkrdtkwo rtqeguugu \*igrvxf cnuq'vq vj g rtqlgeu Pq 744D3B5; ; cpf I C ET. "C 6232323 I C" CX ET cpf 4522222; O UO -0Vj g cwj qt gzrtguugu'j ku'i tcvghwpguu'vq'vj g'lwtpcn Gfkqt/kp/ej kgh Rtql0\ kxcp \ kxnqxe. cpf vq'vj g Vgej pkecnf kqt. 'F t0F tci cpc \ kxnqxe. "\*dqj lqo 'vj g Vgej pkecn'Heewn' 'kp Dqt qh'Dgqi tcf Wpkxgtukx +lqt vj gkt nkp f uekpwkke cpf vgej pkecn'cuukxpeg cpf o wwwcn'tgi ct f 0*

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